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# 'QUEEN BEE' REARING METHOD FOR INDIGENOUS HONEY BEE (*Apis cerana indica*) COLONIES IN SRI LANKA

A.M.D. ATHAPATHTHU and M.M.A.B MANATHUNGA
*Bee Keeping Development Unit, Bindunuwewa, Bandarawela, Sri Lanka*

## ABSTRACT

**Rearing of the 'queen bee' is an important operation in bee keeping, as the queen bee is responsible for the productivity and characteristics of a colony. A vigorous and less than one year old queen bee has a high reproduction rate and high pheromone production, which influences the honey production. Replacing the queen bee once a year, though she lives for three to four years, is a good practice in terms of higher productivity of a honey bee (*Apis cerana indica*) colony. Queen bee rearing process facilitates the introduction of genetically improved queens. Hence, this study was focused on ascertaining a queen bee rearing method suitable for honey bee. The rearing methods namely, (a) the beeswax cell cup and (b) plastic cell cup grafted with one-day old larvae, and (c) Jenter kit method that directly provides larvae to the cell, were tested. The success rate for rearing queen bee using the beeswax cell cup and plastic cell cup methods were 22 % and 66 %, respectively. The Jenter kit was not successful due to the cannibalism of eggs. However, the beeswax cell cup approach has practical difficulties, as it is fragile and easily damaged and thus, the preparation process needs skilled labour. In contrast, the plastic cups are available in the market, could be re-used, and they facilitate fixing the queen cage to trap the emerged queen bee. Therefore, among the two methods tested, plastic cup method is more suitable than the beeswax cell cup method.**

**KEYWORDS:** Queen rearing, *Apis cerana indica*, Plastic cell cups, Beeswax cell cups, Jenter kit

## INTRODUCTION

Bee honey is produced by honey bees (*Apis* spp.) from the flower nectar, and is a delicious, sweet food having high medicinal value. At present, the bee honey and other by products such as bee wax, royal jelly, bee pollen, propolies and bee venom have high market value. There is a considerable demand for bee honey in the current local market. Production of ayurvedic medicine, cosmetics and direct use of bee honey as a health food are the reasons for this increasing demand.

Sri Lanka has a high potential to produce bee honey mainly due to the rich diversity of flowering plants producing blooms throughout the year. In addition, the rubber plantations are a rich source of nectar. It is crucial to have efficient operational techniques based on scientific methodology in order to produce honey to meet the local demand using the available resources economically, through bee keeping.

In a bee colony, there are two female casts namely, the queen and workers, and the male cast, drones. The queen bee is the single mother of a colony and maintains the colony's cohesion through production of queen pheromones. 'Queen substance' (pheromones) stimulates the activities of workers, foraging, brood rearing, comb building and inhibit the ovarian development of the workers. The genetic back ground of the queen has a significant influence on the colony characteristics (Dzierzon, 1845), egg laying rate, honey production and disease resistance.

The *Apis cerana indica*, locally named "*mee massa*" is an indigenous bee species used in bee keeping in Sri Lanka. This Asiatic species is low productive than the western honey bee, *A. melifera*. A well-maintained *A. cerana* colony produces 5-8 kg of honey per colony per year, while *A. melifera* produces 40-50 kg of honey per colony per year. There are improved strains of *A. melfera* for honey production, but they are susceptible to various brood diseases caused by microorganisms and varroa mite [*Varroa destructor* Anderson and Trueman (Arachnida: Acari: Varroidae)], a serious pest of the western honey bees. The major diseases are still not recorded in Sri Lanka and *A. cerana* is resistant to varroa mite attack. Therefore, the introduction of exotic species of honey bee is always associated with the risk of introducing diseases of honey bee to the country. In order to increase the honey production in Sri Lanka, the productivity of *A. cerana* colonies should be improved, and selection of colonies from the natural habitat and breeding of high performing queens are a possibility (Punchihewa, 1994).

The honey bee queen normally lives 2-3 years (could live up to 5 years). The efficiency of pheromone production and egg laying rate of a queen bee gradually decreases with the age (Punchihewa, 1994). The bee colonies with vigorous new queens have shown less attempts to swarm and perform well. Therefore, replacement of a new queen once a year is practiced by western bee keepers, which is also a useful to practice with local colonies. Maintaining a breeding stock and rearing bees in bulk are imperative for this purpose. Small scale bee keepers could purchase new queens from the breeders. At present, there is a high demand for bee colonies especially from the beginners of bee keeping. Production of new colonies by dividing existing colonies is the normal practice, which needs much attention and time, where a single colony is divided into 4-5 divisions introducing a new queen per each division.

Rearing of the queen bee is done by bee colony itself, when the insects need swarm or loss of queen from the colony. The queen bees are produced from fertilized eggs, exactly the same as for the worker bees. The main deference is feeding, especially using the brood food (royal jelly) produced by the worker bees

where a worker larva is fed only for two days while the queen bee larvae is fed for five days. The body size of a queen bee is larger than that of the worker bees, and the queen bee is reared in the "Queen cell", which is bigger than the worker cells. In a queen-less bee colony, a day-old worker bee larva is placed in a queen cell or a structure made as a queen cell, and raised to a queen bee by the worker bees. The efforts to rear queen bees using domestic bee colonies are not commmon in Sri Lanka, due to the unavailability of utensils, finance and skilled human resources. However, many queen bee rearing methods are been used for *A. melifera* in other Asian and European countries. The objective of the study was to develop a successful protocol for queen bee rearing that is acceptable and suit the natural environment of *Apis cerana indica* colonies.

## MATERIALS AND METHODS

### Experimental site and climatic conditions

This study was conducted at the bee keeping sub unit at Buttala belonging to the Bee Keeping Development Unit of the Department of Agriculture, Bandarawela, Sri Lanka. Buttala is situated in the Moneragala District in the agro-ecological zone $DL_{1B}$. The temperature of the site ranged from 28 – 30 °C with 75-80 % RH.

### Colony selection and preparation

*Apis cerana indica* colonies were maintained in eight framed hive boxes. The mother colony was selected during the honey flow season (August to October, 2011). The age of the queen, vigor of workers, honey production and colony performance were observed. When the mother colony was prepared for natural swarming by forming the queen cells, it was divided into eight small colonies (nucleus) to obtain colonies with sister queens. The colonies were continuously fed by using the sugar syrup (sugar solution prepared dissolving sugar in water 1:1 v/v; water was boiled and cooled prior to usage in order to remove the microbes) to achieve rapid growth, until the colony completes eight brood combs with adequate worker population along with drones. The queen bee rearing was started in January 2012, which is the colony growth season of the study site.

### Queen bee rearing methods

The beeswax cell cup method, plastic cell cup method and Jenter kit methods were tested for the success of queen bee rearing for honey bee colonies in Sri Lanka.

**Beeswax cell cup method**

*Preparing the wax cell cup* – The beeswax cell cups were prepared by using a wooden cell coup mold according to the measurements taken from a natural queen bee cell. The blunt end of the mold stick was smoothly rounded to obtain a concave shape and smooth finish of the cell cup. The diameter of the cell cup was 7 mm. The bee wax obtained from a newly formed comb was used and the wax was melted in a water bath at 64-65 °C. The mold was dipped in cool water, and then dipped in the melted wax up to 7 mm deep.

The mold was then taken out and left to solidify the wax and dipped again in the wax. This procedure was repeated four to five times in order to get a thick layer of wax. Finally the mold was dipped in water and left for few minutes to remove the wax cup. In order to attach wax cups, an extra wooden bar was attached to the standard hive frame, about 5 cm below the top bar, in a way to allow easy detachment from the frame. A strip of wax foundation sheet was fixed to the lower surface of the bar to facilitate the attachment of wax cups. The wax strip was gently warmed and attached to the wax strip using melted wax. The space between two cups was about 30 mm. Six cups were placed on each frame.

*Obtaining one day old larvae* - The colony with the mother queen was used as breeder colony. The queen confinement apparatus (Figure 1) was used to get one day-old larvae, all in one place for easy selection. A metal box (323 mm height x 182 mm wide x 20 mm thick) was made by punched metal sheets. The punched holes allowed worker bees to pass though but not the queen bee. An empty brood comb was placed inside and the queen bee was kept in the box for one day. A day after laying eggs, the queen bee was removed, and the confinement box was left for three days to hatch eggs.

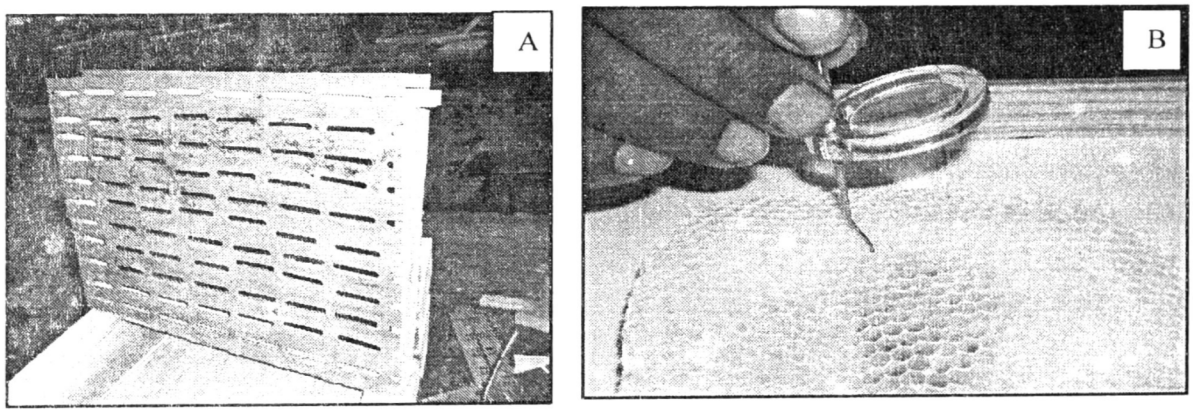


**Figure 1. The queen confinement box (A), and obtaining one day-old larvae from the comb (B)**

*Preparation of the queen rearing colony* - The queen bee was removed with one brood comb into another hive box and kept away from the rearing colony, three days prior to introducing to the queen cell cup to induce the workers to rear the queen. After the worker bees started constructing queen cells in brood combs, and before inserting cell cups, all the natural cells were removed and were used to obtain royal jelly for grafting. Six cups from each treatment per each colony were introduced into three colonies.

*Grafting* - Before grafting the one day-old larvae, cell cups were inserted to the queen-less rearing colony for about 2 hrs in order for acceptance by the worker bees. Then the cell cups were taken out from the colony and a small amount of royal jelly was deposited in the cups. One day-old larvae collected from a confined comb was transplanted using the grafting tool, which is specially designed for grafting (Photo 2). Thereafter, the cell cups with larvae, were introduced to the cell raising colony.

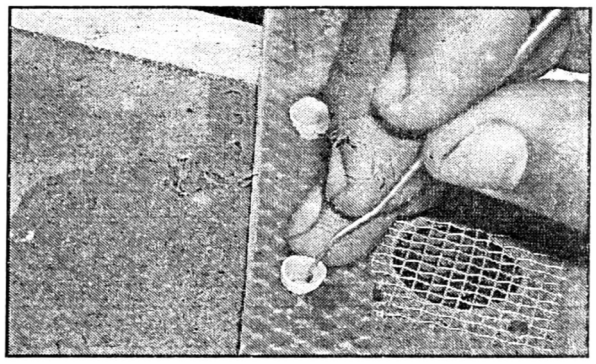

**Figure 2. Transplanting of larvae**

*After care* – The colonies were fed by sugar syrup.

## Plastic cell cup method

In this approach, the plastic cell cups (Photo 3) were used in place of wax cells. The plastic cell cups (several variations and different colors of plastic cups are in the market) designed for *A. melifera* was used in this study as the body size of the queen bee of *A. cerana* was not significantly different to that of *A. melifera*. The dimensions of the cell cup were 9 mm diameter x 9 mm deep, and had a basal part to facilitate sticking on the hive frame. The same procedure used for wax cell cups was practiced for the plastic cell cups method.

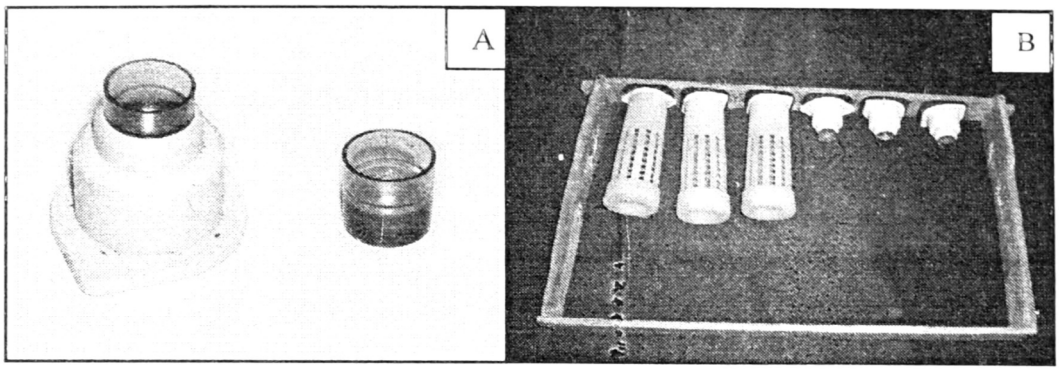


**Photo 3. Plastic cell cup and its basal part (A) and Queen cages fixed to the cell cups (B)**

### Jenter kit method

The Jenter kit (Photo 4) was designed to get larvae directly to rear queen bees without transplanting. The concept of the kit is that the queen lays eggs in the confinement box that looks-like worker cells. Every other cell bottom of every other row has a plug in the bottom. When the eggs hatch, the plug is removed and placed on top of the cup. The cup has been designed to attach to the wooden bar of brood frames. This apparatus, which was also designed for *A. melifera*, was placed in a queen-less colony for three days to be accepted by the worker bees. The queen bee was confined in for 24 hrs.

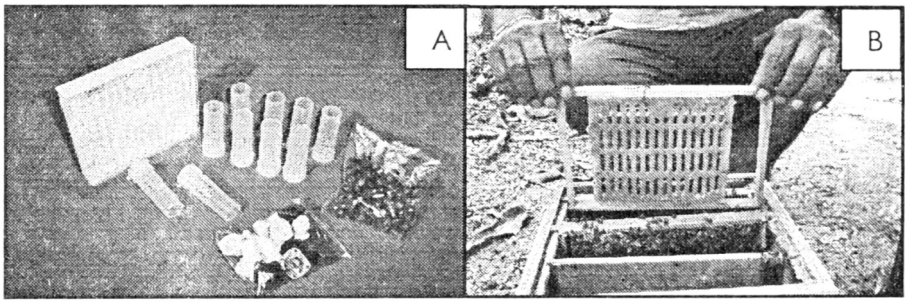


**Photo 4. Jenter kit (A) and the way of introducing in to a bee colony (B)**

The results of the experiment were analyzed using the Chi square test ($p=0.05$).

## RESULTS AND DISCUSSION

### Grafted wax cell cups and plastic cell cup methods

After four days, some of the cups were rejected to be built as queen cells. The bees started constructing other cells using own wax, however, some of those cells were not capped. The queen bees emerged after 14 days (Table 1). The rearing

of queen cells is associated with the type of cell cups provided. The plastic cell cup method was more successful than the beeswax cell cup method (Table 2).

**Table 1. Acceptance of beeswax cell cups and plastic cell cups by worker bees**

| *Colony Number.* | *No. of cells rejected at the beginning* | *No. of cells that were not sealed by workers* | *No. of queens emerged* |
|---|---|---|---|
| Beeswax cell cups | | | |
| 1 | 3 | 3 | - |
| 2 | 3 | 3 | 1 |
| 3 | 1 | 5 | 3 |
| Plastic cell cups | | | |
| 1 | 1 | 2 | 3 |
| 2 | 1 | 0 | 5 |
| 3 | 1 | 1 | 4 |

**Table 3. Acceptance of queen cell cups introduced to *Apis cerana* colony**

| *Type of cells introduced* | *Acceptance* | | *Total* |
|---|---|---|---|
| | *Number emerged* | *Number rejected* | |
| Beeswax cell cups | 4 (22.2 %) | 14 (77.8 %) | 18 |
| Plastic cell cups | 12 (66.7 %) | 6 (33.3 %) | 18 |

The damage to larvae could be the reason for rejection of cell cups at the beginning. Accepted cells were further constructed by the worker bees. After five days from transplanting, the successful cells were sealed by the worker bees, but some of them were rejected lately. Further studies are needed to find out the reason for rejecting the cells after construction. The dimensions and low acceptance of natural beeswax cells should also be investigated further. The emerged queens in this study were active and well developed.

Preparation of the natural beeswax cell cups is a difficult task and it needs skill and experience, a labor and time consuming process, and a fragile structure. Plastic cups are easily available at the market and are much easier to prepare for rearing queen bees, and attaching queen cage to collect the emerged queens safely. Considering all these factors, plastic cell cup method is the most applicable and affordable approach in rearing of queen bees. Acceptability, followed by successful progress was also high in the plastic cell cup method.

**Jenter kit method**

The Jenter kit was accepted by the worker bees and the queen bee laid the eggs inside. However, the eggs were cannibalized after removing the queen bee from the confinement box (data not shown). The Jenter kit has been reported as the most reliable method for queen rearing method in New Zealand (http://www.Outdoorplace.org/beekeeping/queens.html) and warrants further investigations to modify the method to be suited for *Apis cerana indica*.

## CONCLUSIONS

Queen bees were successfully formed from both the beeswax cell cups and plastic cell cups, which were accepted by the worker bees. The plastic cell cup method is successful than the beeswax cell cup method. Research should be carried out to determine the correct dimensions of cell cups suitable for *Apis cerana indica*.

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