CHAPTER 5 GENERAL CONCLUSION

This study established that respiration in honey bee eggs is mainly influenced by temperature and the age of eggs at incubation. Respiration rates in honey bee eggs are highly synchronized to the biochemical activities and changes taking place at the morphogenetic centers of developing embryos. These changes are crucial at the optimum range of 34.8 ± 0.2^0C (Owens 1971, Seeley and Morse 1976, Seeley 1985, Southwick 1988, Levin and Collison 1990) for honey bee egg development. Any deviation from the optimum range affects embryonic development and survival. Eggs incubated at 34^0C had the lowest mortality compared to those incubated at 28^0C, 31^0C, and 36^0C. The eggs at extreme temperature treatments of 28^0C and 36^0C showed higher mortality than those at 31^0C. The findings from this study agree closely with those from Schnetter (1934), Harbo and Bolten (1981) and Levin and Collison (1990). From the results obtained, there are no differences between the eggs laid by queens and those of laying workers, when respiration rates are measured at the same temperature treatment and stage of embryonic development. Since there may be differences in the way the initiation of embryogenesis takes place in fertilized and unfertilized eggs, there is need for more research to determine respiration rates during this brief period. There is also a need to study the critical temperature at which embryonic death occurs in fertilized and unfertilized eggs under the same environmental conditions.

For nutrients, the eggs produced by queens and those from laying workers showed gradual decline in trehalose, sucrose and fructose from day 1 to day 3, while glucose increased on day 2 but declined on day 3. In all cases, the total amount of sugars in the fertilized eggs of queens remained higher than those in the unfertilized eggs of workers. However, in the case of lipids, the percentage recorded in laying workers' eggs was higher than that in the queens' eggs. The levels of nutrients analyzed were found to be within the range of carbohydrates and lipids found in the eggs of other insects (Premkumar et al. 1991, Stein and Fell 1994). During embryonic development, the rate of utilization of nutrients also varied depending on the age of the eggs. The amount of lipids in fertilized eggs declined more rapidly with age than that of carbohydrates. The main differences between the eggs produced by queens and laying workers include weight (Winston 1987)

and the rate of depletion of nutrients during embryonic development (Ute and Crailsheim 1997). Woyke (1994) compared the eggs of queens and those of laying workers and observed no major differences in the dimensions of the eggs. Consequently, no major difference has been observed in the size of embryos at eclosion (Henderson 1993). During larval development, the difference between the queen and the worker has been proved to depend on the nutrients consumed post-emergence (Wheeler 1996, Ute and Crailsheim 1997). The nutritional influence on larval development has also been proved to transform a worker destined larva to a queen during emergency queen rearing (Winston 1987, Seeley 1985). Even though queen and worker larvae are not similarly developed at eclosion, some basic morphological and functional similarities remain. From the information obtained, it can be inferred that the rate of utilization of nutrients may be a function of the egg weight, type of nutrient, temperature and the duration of embryonic development.

Although the behavioral and morphological differences between the queen and the worker has been explained by some researchers as an evolutionary step (Starr 1987), the queen and the worker are similar in terms of reproduction and may only have undergone structural changes as a prerequisite to division of labor in a colony. Starr (1987) further argued that the queen is a more derived female compared to the worker. While the queen has the morphology and physiology that suits her to the role of egg laying, the worker performs all the work in a hive, hence the difference in the level of development of their reproductive systems. The results of this study demonstrate that both ovaries function in a similar manner even though the worker's ovary is under-developed compared to the queen's. The queen has a more competent ovary capable of converting nutrients more efficiently to oocytes or none at all depending on the population structure and requirements of the colony. When a queen dies or becomes a drone layer, workers can and do revert to egg laying, but the eggs usually become drones with only a very few becoming females (DeGrandi et al. 1998).

The strategy for colonial survival may also help in explaining the difference in the fertilized eggs from queens and unfertilized eggs from laying workers. The demand from emerging larvae at the critical time during peak oviposition by the queen and rapid eclosion (also called build up period) in the broodnest before the honey flow, may

influence feeding regimes in emerging larvae, hence their survival inside the hive. The feeding of larvae at peak eclosion may mean that the worker larvae are given preference over the drone larvae. It is during this critical time that energy reserves in the body are utilized to reduce larval mortality. This reserve energy may also be utilized to generate body heat should adversely drop in temperature occur in the brood area. Ute and Crailsheim (1997) established that the levels of glycogen in drone larvae are higher at eclosion than in the queen or worker larvae. This study has established that high levels of lipids are present at eclosion in drone eggs of laying workers than in fertilized eggs of queens. Further research needs to be done to establish the utilization of nutrients in post-emergent larvae, in order to establish the fate of nutrients in newly hatched larvae before provisioning commences and how it influences larval survival. This may finally explain the reason for differential depletion of some nutrients in the eggs of honey bees during embryonic development. Perhaps it was a strategy from an evolutionary standpoint in the life of honey bees, where the queen, worker and drone, each had a developmental period dependent on the suitability of each member to the survival of the colony.