9.0 Outlook

This thesis is a pioneering research in the field of application of propolis for the control of the honeybee parasitic mite *Varroa destructor* and the honeybee pest *Galleria mellonella.* Therefore, a lot has to be done before propolis can be applied in the beehive environment. Some of the most important tasks that have to be accomplished are summarized below.

A preliminary *in vivo* experiment by spraying bees with mites on their surface displayed that propolis killed the mites but did not affect the bees. This was not, however, exhaustive, and investigations have to be conducted on the behaviour of the bees by applying propolis in laboratory and field experiments.

In addition to the use of the crude ethanol extracts of propolis, it may be desirable to fractionate it and screen for its active fractions. The use of only the active fractions of propolis could reduce the burden of unnecessary chemicals on the bees and in the hive products.

Chemical analyses of the effective antivarroa fractions of propolis have to be done, and the chemicals responsible for the antivarroa action have to be identified. Identification of the chemical make-up of the effective fractions of propolis may help in the search for such fractions from abundantly available sources, since the availability of propolis is usually limited.

Application of propolis in the beehive could be done by spraying or dripping a solution of it; these methods have to be optimized, and the proper application instruments have to be developed.

The antivarroa actions of propolis investigated in this thesis were its Varroa narcotizing and varroacidal effects. It is, however, possible that the volatile components of propolis could affect the mites by interfering with their chemical cue and orientation; this remains to be investigated. The effect of some essential oils on orientation of Varroa mites has already been demonstrated by several researchers.

In order to use propolis as an agent to control *Galleria mellonella,* methods of application in weak colonies, and in honeycomb storehouses have to be developed. The identification and use of only the effective fractions of propolis is desirable, as such fractions reduce the chemical burden in the beehive.

In order to elucidate the exact mechanism of action of propolis against bacteria and fungi, detailed investigations have to be conducted about the effect of propolis on cell division and associated events, protein synthesis, cell membrane function and integrity, cell wall

function and integrity, and so on. Some of these can be performed by transmission electron microscopic (TEM) technique.

Practice oriented investigations about the potential applications of propolis against saprophytic fungi that destroy paper products in libraries and archives, and degrade leather have to be carried out.