CHAPTER 6

CONCLUSION

- After being discovered in ca 2700 BC tea has come a long way from wilderness of jungles to the cup of civilization eventually becoming worlds much loved beverage.
- As tea is grown as a perennial monoculture crop, it provides room for large number of pests, precisely 300 species of arthropods and nematods all over the world.
- Synthetic pesticides are the primary weapon to tackle these pests, however, indiscriminate use of these pesticides has brought up problems like tolerant variety of pests and higher MRLs in made tea.
- Many insects and mite pests have attained the status of major pest in tea ecosystem due to their capability to inflict considerable damages. Termites also pose serious threat to tea cultivars but are often neglected due to their subterranean existence. These tiny creatures cause significant amount of damage to wooden furniture, buildings, fences, trees, crops and anything that consists of cellulose as they are phytophagous and chiefly depend upon cellulose for their nutrition.
- Termites are exclusively controlled using chemical pesticides. Though, many workers have reported different organic control measures but none seem to have very effective

results at field level. Moreover, the eusocial structure of termites enables these insects an added advantage over other solitary insects.

- Present study was undertaken to determine the diversity of different termite species associated with tea plantations; phylogenetic relationship of these species among each other based on morphological and molecular similarity and finally level of tolerance exhibited by two species of termites against commonly used pesticides.
- The abundance study revealed ten species from the tea plantations of Darjeeling Terai and the Dooars. This accounts for more than 20% of total reported termite diversity of West Bengal.
- Among these 10 species *O. obesus* and *M. obesi* were the most abundant species and were also considered to be serious pests of tea.
- Besides, species like *Coptotermes heimi*, *Heterotermes indicola*, *Pericapritermes assamensis* and *Odontotermes parvidens* were also found to attack tea however, their severity of attack was much lesser than the above two species. Moreover, their distribution in Terai and the Dooars plantations were very sparse.
- *Heterotermes indicola*, *Synhamitermes quadriceps* and *Pericapritermes assamensis* are some species which were previously been reported from this part of West Bengal but based on present study they are being reported for the first time from tea ecosystem. *Procapritermes holmgreni* and *Euhamitermes lighti* have been recorded for first time from this part of country and for the state of West Bengal.
- A phylogenetic relationship was drawn among the 10 termite species based on morphometric characters and RAPD based polymorphism. Dendrograms were constructed on the basis of shared fragments and the Similarity coefficients. Due to the lack of an out group the dendograms were an unrooted tree.

- The presented morphometric data based dendrogram shows broadly three major clusters (I, II and III), whereas RAPD based dendogram represented two broad clusters with coefficient value ranging from 0.38 to 0.86.
- The topology of the tentative phylogenetic relationship revealed by the RAPD analysis is partially concurrent with the dendogram based on morphometrics, and both showed an overall similarity among the cluster I and II. Phylogenetic results of present study based on morphometric and RAPD analysis are in agreement with the results of other workers.
- Present phylogenetic study is a preliminary inventory to shed light on the phylogenetic status of the termites from this part of India. A further more elaborate work may give clearer picture of phylogeny of termites from this part of world.
- A pesticide based analysis of tolerance was performed for two major pest species namely *O. obesus* and *M. obesi*. Four commonly used pesticides were chosen for bioassay.
- Bioassay results of these chemicals clearly indicated that a population from organically managed plantation has less tolerance level against these pesticides. But populations from conventionally managed plantations required higher amount of pesticides to kill indicating higher level of tolerance.
- Similar trend was observed in case of enzyme profile as well. Populations from conventionally managed Western and Eastern Terai and Western, Central and Eastern Dooars exhibited higher level of enzyme expression with more of AR values, whereas populations from organically managed Dooars and Terai plantations showed very low detoxifying enzyme (GE, GST and CYP450) activity.
- Even the densitometric analysis of NATIVE-PAGE of GE revealed intense and darkly stained bands in case of populations from conventionally managed plantation

indicating over-expression of enzymes containing genes, at the same time organic population expressed very light stained bands showing less amount of expression.

- Eventually all the above LC_{50} and detoxifying enzymes based results suggested that there is a directional selection of termite pests based on their physiological capability of tolerating pesticide load. More use of pesticide forces the selection of less tolerant population of pest helping the one with higher tolerance to proliferate.
- The simple regression relationship of Resistance Factor (RF) of chlorpyrifos and Activity Ratio (AR) of each detoxifying enzymes (GE, GST and CYP450) from both pest species distinctly showed a dependence of RF on AR. These findings suggest that with an increase in detoxifying enzyme, tolerance level of a pest increases. Therefore, hyperactivation of detoxifying enzymes can be used an indicator of high tolerance level in termite pests.
- A termite colony has as many as four castes at different stages of development. In a pesticide laden environment like conventionally managed tea plantation all castes get exposed to pesticide exposure, however, level of exposure varies depending on their role in the colony.
- To check if there is any difference in the tolerance status at caste level, worker and soldier castes of *O. obesus* and *M. obesi* were subjected to bioassay of pesticides and detoxifying enzyme analysis.
- An analysis of worker and soldier caste's tolerance status (LC_{50}) and detoxifying enzymes profile revealed that worker castes are more tolerant and express more of GE, GST and CYP450 enzymes. In addition densitometric analysis of non-denaturing gel of GE showed a distinct higher expression of allozymes in worker than compared to soldier where some allozyme were either very faintly expressed or even completely off.

- The differential showcase of tolerance and enzyme profile in the worker and soldier castes may have come from the fact that worker is responsible for maintaining of the colony for which it goes out for foraging food on a regular basis. This probably lead to the contact with toxicant more often than any other caste, due to which worker exhibited higher expression of all the detoxifying enzymes and also higher level of tolerance.