

CHAPTER 6

CONCLUSION

- Six genera of ephemeropteran nymphs were found from three streams in Ulu Gombak Forest Reserve, namely *Baetis* sp. (Baetidae), *Thalerosphyrus* sp. (Heptageniidae), *Camponeuria* sp. (Heptageniidae), *Neurocaenis* sp. (Tricorythidae), *Platybaetis* sp. (Baetidae) and *Prosopistoma* sp. (Prosopistomatidae). The abundance and richness patterns of the ephemeropteran nymphs were likely related to more varied habitat of shallow and fast flowing water with large stones.
- Shannon's Diversity Index indicated low diversity among the mayfly nymphs in the study area while Shannon's Equitability suggested that the nymphs are more or less evenly distributed. The nymphs in Sg. Batu 19 were found to be the least diverse and equitably distributed in Ulu Gombak Forest Reserve although the nymphs were found to be most abundant at this particular site.
- Calculated values of Simpson's Index of Diversity indicated high diversity among the mayfly nymphs in the study area while Simpson's Index of Evenness showed

low equitability of ephemeropteran nymphs. According to Simpson's Index of Dominance, mayfly nymphs in Sg. Batu 19 were found to have the highest dominance tendency.

- Margalef's Richness Index suggested that Sg. Gombak has the highest diversity of ephemeropteran nymphs, coinciding with the results obtained from the calculated values of Shannon's Diversity Index as well as Simpson's Diversity Index.
- Shannon's Diversity Index ($t=13.44$, $p=0.05$), Shannon's Equitability ($t=13.73$, $p=0.05$) and Simpson's Index of Diversity ($t=16.50$, $p=0.04$) are significantly higher in Sg. Gombak (downstream) than in Sg. Batu 19 (upstream) using student t-test ($p \leq 0.05$).
- The constant physico-chemical parameters measured in throughout this study were found to be in acceptable levels as compared to the criteria and standards in the Interim National Water Quality Standards for Malaysia (DOE, 1994). Justified by median value of each stream, Sg. Batu 19 was classified as Class II which represents water bodies of good quality while both Sg. Gombak and Anak Sg. Gombak were classified as Class III where water under this classification may be used for water supply with extensive or advance treatment and also defined to suit livestock drinking needs.
- Results from this study found interactions between the abundance of mayfly nymphs and environmental parameters. However, according to the Pearson's

correlation coefficient, for all three sampling stations in Ulu Gombak Forest Reserve, the only environmental parameter that showed a statistically significant positive linear association with the number of mayfly nymphs was pH.

- The diversity of mayfly nymphs showed the same trend as that of the river water quality.
- The level of protein content was higher in *Baetis* sp. than of *Camponeuria* sp. The difference in protein content between both *Baetis* sp. and *Camponeuria* sp. were found to be insignificant ($t=2.07$, $p=0.29$) using student t-test ($p>0.05$).
- Enzyme bioassays conducted on control strains of *Baetis* sp. and *Camponeuria* sp. showed that esterases and acetylcholinesterase from *Camponeuria* sp. showed higher affinity for alpha-NA and ASChI respectively than those of *Baetis* sp. The difference in non-specific esterase ($t=2.13$, $p=0.28$) and acetylcholinesterase ($t=1.94$, $p=0.30$) specific activity values between both *Baetis* sp. and *Camponeuria* sp. were found to be insignificant using student t-test ($p>0.05$).
- The specific activity of glutathione-s-transferases from *Camponeuria* sp. strains were approximately 3-fold higher than that found in *Baetis* sp. strains. However, statistical analysis showed that the difference in glutathione-s-transferases specific activity values between these two species were insignificant ($t=1.99$, $p=0.30$) using student t-test ($p>0.05$).

- The order of fifty percent inhibitory concentrations (I_{50}) of non-specific esterase for *Baetis* sp. and *Camponeuria* sp. was: Dichlorvos > Malathion > Mercury (Hg) > Fenitrothion > Cadmium (Cd) > Lead (Pb) > Copper (Cu). There were no significant difference ($p>0.05$) found in the I_{50} values of the tested inhibitors between both ephemeropteran nymphs.
- The fifty percent inhibitory concentrations for acetylcholinesterase of *Camponeuria* sp. was as the following order: Dichlorvos (DDVP) > Malathion > Fenitrothion > mercury (Hg) > cadmium (Cd) > lead (Pb) > copper (Cu) while of *Baetis* sp. was: Dichlorvos (DDVP) > Malathion > mercury (Hg) > Fenitrothion > cadmium (Cd) > lead (Pb) > copper (Cu). Among all tested inhibitors, it appears that only I_{50} values of Dichlorvos (DDVP) between both ephemeropteran nymphs showed highly significant difference ($t=20.04$, $p=0.03$) using student t-test ($p\leq 0.05$).
- Overall, Dichlorvos (DDVP) was found to be the most potent inhibitor tested, for non-specific esterase and acetylcholinesterase from both species strains while copper (Cu) was the least toxic inhibitor for non-specific esterase and acetylcholinesterase from both species strains.
- The order of sensitivity, based on K_i values of *Baetis* sp. to AChE inhibition, was Dichlorvos (DDVP) > Malathion > mercury > Fenitrothion > cadmium > copper > lead, while that for *Camponeuria* sp. was Dichlorvos (DDVP) > Malathion > mercury > Fenitrothion > cadmium > lead > copper.

- The K_i value of Dichlorvos (DDVP) for both *Baetis* sp. and *Camponeuria* sp. were significantly higher than other tested inhibitors, ($t=21.44$, $p=0.03$) using student t-test ($p\leq 0.05$), indicating the inhibiting power of acetylcholinesterase by Dichlorvos (DDVP) was the strongest among all other tested inhibitors for both, *Baetis* sp. and *Camponeuria* sp.
- It can be concluded that the biomarkers responses can reflect the pollution degrees of the sites and predict the ecological effects of xenobiotics.