SUMMARY

This thesis has been arranged in five chapters viz. physiological repose, incidental pathology, histopathology, ultrastructure and environmental load of petroleum hydrocarbons in the Cochin estuary. A general introduction that precedes the chapters gives an overview of oil pollution and the objectives of this study.

Results of experiments with juveniles and subadults of the penaeid shrimp *Metapenaeus dobsoni* (Miers), a commercially important benthic species, subjected to lethal and sublethal toxicity tests are presented in Chapter 1. Analysis of these results revealed that the toxicity of the water-accommodated fraction of Bombay High Crude was dose-, time-, size- and moult stage-dependent. Oxygen consumption and accumulation of petroleum hydrocarbons in the tissue of the shrimps when exposed to sublethal doses were investigated to gain an insight into the sublethal physiological stress responses. The increased rate of oxygen consumption was found to correlate with increased tissue load of hydrocarbons in the lower doses and lower periods of exposure. An inverse relationship was seen when the dose and time were high. Suppression of moulting in shrimps exposed to higher concentrations of hydrocarbons was noticed. Repeated incidence of pathological infestations took place in 13-15% of shrimps (size 30-35 mm) exposed to 1 ppm and 5-8% of shrimps exposed to 4 ppm beyond 18 days in a 30-days moulting pattern.
study. Curiously enough the shrimps exposed to 8 ppm as also those maintained under control conditions did not show any signs of disease. This phenomenon is discussed in detail in the following chapter.

Chapter 2 is a detailed analysis of the disease afflicting the shrimps mentioned in the previous chapter. This pathogen caused the formation of dark lesions on the abdominal segments and occasionally the carapace of the shrimps accompanied with opacity of musculature. Isolation of the causative factor, a chitinoclastic Vibrio sp. was accomplished by using microbiology techniques. Kochs Postulate was successfully proved to establish the pathogenicity of the isolated bacterium. The pathogen was found to be virulent when injected into the shrimp at a dilution of even 100 cells/ml. Mortality, disease manifestation and moulting as a response to the induction of the pathogen into body of the shrimp was quantified and found to be statistically significant at 1% level in terms of the first two phenomena. The Vibrio sp. was presumed to be an opportunistic pathogen as no such condition was recorded in the shrimp maintained under control conditions. Chronic exposure of shrimps to low sublethal doses of petroleum hydrocarbons was found to render them susceptible to vibriosis. The environmental ramifications of the same have been mentioned.

The chapter on histopathology presents and discusses the results of the exposure of juveniles of penaeid shrimp M. dobsoni (30-35 mm) in the intermoult stage to lethal and sublethal doses of water accommodated fraction of Bombay High Crude, which resulted in histopathological changes in the hepatopancreas.
and gills. Comparisons with the histology of starved and normal hepatopancreatic tissue and normal gill tissue were also made. Six plates with micrographs taken under a light microscope have been included. The deterioration of the hepatopancreatic tubules was found to be dose- and time-dependent under sublethal toxic conditions. Cytorrhexis in the proximal tubules, proliferation of R-cells, proliferation of haemocytes, reduction in tubule width due to shrinkage of the tubules, detachment of the tunica propria, obliteration of the tubule lumen by cellular debris and delaminated cells, reduction in epithelial height due to atrophy of cells, increase in epithelial height due to vacuolation and storage of lipid, proliferation of B-cells, vacoulation of E-cells, reduction in the number of E-cells and proliferation of connective tissue were the twelve parameters studied. These changes are presumed to be related to a reduction in feed intake, assimilation and excretion of high caloried faeces due to the deterioration of the tubules. In the gill tissue there was varied degree of necrosis of the gill filaments. Necrosis of haemocytes, proliferation of haemocytes, distention of pillar cells, shrinkage of pillar process cells and sloughing off filaments were the notable changes. The histopathological parameters studied were quantified and subjected to statistical analysis using Wilcoxon signed rank test, Spearman’s rank correlation, analysis of variance and discriminant function analysis.

The histopathological changes observed in light microscopic studies were further investigated by fine structure analysis and the results are presented and discussed in the chapter on ultrastructure. Twelve plates of electron micrographs,
depicting the changes to cell organelles within the cells of the hepatopancreatic tubules and the filaments and cuticle of the gills, are included. The stress responses at fine structure level include disruption of cell membranes and organelles, presence of large lipid droplets, marked pyknosis of the nucleii, proliferation of endoplasmic reticulum, distortion and disruption of microvilli and proliferation in and distortion of mitochondria in the R-cells of the hepatopancreas. The changes appeared to be dose and time related. In the gill tissue, atrophy of cuticle and filament cells, formation of melanised plaques and coagulated haemolymph appeared to be dose related. Proliferation and necrosis of haemocytes and accumulation of petroleum hydrocarbons as large lipid droplets was also recorded. Clearly the hepatocytes and gill filaments are seen to be actively involved in the breakdown and expulsion of PHCs from the shrimp. Toxic effects of PHCs on subcellular organization are also evident. The light microscopic and fine structure findings correlated well with the rate of oxygen consumption and the PHC load accumulated by the shrimps during the course of the experiments.

The fifth chapter presents the results of the monitoring of the seasonal and spatial distribution of petroleum hydrocarbons in the water and sediment of Cochin estuary during the premonsoon, winter and post monsoon periods and discusses the findings. The Cochin harbour and the adjoining backwater are moderately contaminated with petroleum hydrocarbons with surface water values for dissolved and dispersed petroleum hydrocarbons ranging from 2.8 – 298.46
μg/l, subsurface values ranging from 1.12 - 573.93 μg/l and sediment values ranging from 0.67 - 652.96 μg/g. Contamination can be directly linked with anthropogenic use of the harbour and backwaters which may be directly related to shipping/berthing activities and transport of crude oil and its derivatives. The recovery of the harbour from an event of episodic pollution was found to be rapid and this was attributed to the peculiar circulation pattern prevalent in this estuary. The status of the estuary with regards to petroleum hydrocarbon contamination remains below the critical level though in pockets the values recorded for sediments remains high, which predicts deleterious effects on benthic communities and species.

All findings in this thesis are supported by literature, the relevant ones among which have been listed at the end of each chapter in alphabetical order.

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