The present investigation mainly centres around the validity of analysing biochemical and histopathological biomarkers to assess toxic effects in fishes along with the exposition of ameliorative effects of vitamin C in repairing the damages caused by heavy metal, pesticide and drug toxicity. *Oreochromis mossambicus* is an interesting species to analyse such effects since the euryhaline capacity of the fish indicates the adaptability of the fish to changing salinity and differences of their habitat. The key enzymes concerned were assayed and histopathological evaluations were worked out and presented in the thesis.

The chapter on Introduction describes the aquatic ecosystems as the receptacle pollutants of anthropogenic origin, the concept and utility of biomarkers in environmental monitoring and the rationale behind the species selection for the present study. Harmful consequences of reactive oxygen species, cellular localization of antioxidant enzymes and the essentiality and role of vitamin C in piscine physiology are introduced based on literature survey.

Comprehensive information derived from investigations carried by different workers in the area of oxyradical research in general and in fishes in particular, are presented in the chapter on Review of Literature. The survey includes the studies concerned with the introduction of the concepts bioaccumulation, bioconcentration, biomagnifications and biomarkers, definition of oxidative stress, circumstances leading to
oxidative stress in aquatic organisms (including the presence of heavy metals, pesticides, and other xenobiotics), antioxidant machinery of fishes, relevance of vitamin C with reference to oxidative stress and bioassay techniques. An appraisal of malachite green as a therapeutic compound with reference to aquaculture and the significance of histopathological assessments in oxidative stress studies and pollution monitoring are also included in this part of the thesis.

Rapid lethal toxicity studies always gain attention as an important tool in bioassay methods. In this context, 96 hour LC\textsubscript{50} assessment was carried out for copper and Metacid 50 in the test animal and the details are presented in the chapter on Lethal Toxicity Studies. The section introduces the test animal, brings out the methods of collection and maintenance in the laboratory, preparation of test solutions, procedures adopted, results and discussion. The 96 hour LC\textsubscript{50} value determined for copper was 640 ppb and that for Metacid was 6.2 ppb. The behavioural responses of the fishes were more or less similar to both copper and the pesticide which included irritability to mechanical stimulation and strong phototrophic reactions. Rapid swimming, exhaustion and increased opercular rate were distinct behavioural responses.

The chapter entitled Sublethal Toxicity describes the biochemical and histopathological responses of the fish to the three test materials, \textit{viz.} copper, Metacid 50 and malachite green. The section includes description about the major enzymatic and non enzymatic antioxidant defense mechanisms in fishes, the specific physiological roles played by the test organs (gills, liver and kidney) with special reference to xenobiotic absorption and/or biotransformation, localization of antioxidant enzymes in cells and their course of action, material and methods adopted for
sublethal toxicity assessment using antioxidative enzyme assays, histopathology and statistical analysis of data, results and discussion.

The analysis of data on the activity of primary antioxidant enzymes revealed interesting ways in which they behaved with enormous interplay to counter the oxidative stress induced by copper, Metacid 50 and malachite green; some of them submissive and some others defensive in the face of oxidative damage. The onset and progression of oxidative damage in the target tissues due to exposure to the experimental toxicants was indicated by the concentration and duration dependent increase in lipid peroxidation. The activity of the enzymes of first line defense category [i.e. preventive antioxidants concerned with the scavenging of superoxide radicals (superoxide dismutase), hydrogen peroxide (catalase), hydroperoxides (glutathione peroxidase) and regeneration of glutathione (glutathione reductase)] and the level of reduced glutathione, shifted significantly from that of control group of fishes. A concentration and duration dependent increase or decrease in the activity of different enzymes indicated oxidative damage. The high experimental concentration of copper, malachite green and Metacid 50 evoked different degree of activity in different tissues, the liver, the gill and the kidney of copper exposed fishes showing maximal activity of this enzyme capable of conjugated excretion of xenobiotics. However, activity of this enzyme decreased drastically in the gills at high concentration of the pesticide and its activity decreased with duration in the tissues under high concentration of malachite green. Thus the status of high glutathione S transferase activity as the specific biomarker of organophosphorous pesticides seems questionable as it applies more suitably to copper as indicated in the present study. Furthermore, it is understood from the current study that oxidative stress resulting from exposure to low concentration of toxicants
is defended more or less successfully by antioxidant enzymes and the mechanism often failed when the animal encountered high concentration of toxicants. Duration dependent increase in degenerative changes (pycnotic nuclei in hepatocytes and necrosis) occurs in hepatic tissue of the fish due to the toxicity of copper and malachite green. Non fatty vacuolation of hepatocytes and pancreatic tissue develops in liver due to the exposure to malachite green. Toxic exposure to Metacid 50 results in characteristic fatty degeneration in the liver of the fish. Kidney of the fishes exhibits inflammatory features due to exposure to the toxicants which includes swelling of glomeruli (glomerular shrinkage in the case of Metacid 50), thickening of Bowman’s capsules, deposition of tubular casts and hyaline cytoplasm. The occurrence of intercapillary thickening of glomeruli, specifically known as ‘wire loops’ in histological terminology, was a special feature that resulted due to exposure to malachite green. The maintenance of more or less normal morphological nature of gills after exposure to malachite green indicates the free passage of the dye into the body of the fish. However, typical defensive (secondary lamellar hyperplasia and lamellar fusion) circulatory (hyperemia) and degenerative (necrosis and desquamation) changes manifest due to the toxicity of copper and Metacid 50. The significant increase in the intensity of damages in experimental tissues accompanying prolonged exposure, points to the risk of these fishes in chronically polluted environment. The study cautions against the liberal use of malachite green as an aquatic grade therapeutant. The present investigation recommends the utility of enzymatic and non enzymatic antioxidant responses as a biomarker to assess toxic effects.

The celebrated capability of vitamin C to repair oxidatively damaged tissues is tested, the details of which are illustrated in the fifth chapter.
The section covers the physiological role of the vitamin in fish followed by an account on material and methods. The results of antioxidant enzyme assays in the experimental tissues on supplementing the intoxicated fishes with vitamin C in diet, histopathology and discussion of the analyzed data are presented in the chapter.

It was found that biochemical and histological perturbations that resulted due to toxicity lead to certain range of restoration of the tissue morphology on supplying ascorbic acid through diet. The revival of antioxidant enzymatic activities that remained suppressed due to toxicity with associated reduction in lipid peroxidation and partial recovery from histopathological lesions are significant indicators to such repair. The maintenance of almost normal structural integrity of gills in spite of very low activity of superoxide dismutase under malachite green stress underlines the independent ameliorative effect of vitamin C which is capable of eliminating superoxide radicals from biological systems.