Introduction
The natural environment with its numerous living and non-living resources are Man's most precious heritage. He is moulded by it and may, in turn, enjoy or cultivate it for his betterment. A body of water harbours a fascinating world of myriads of living organisms including microscopic plankton, green plants, fishes and variety of other aquatic animals. The community of living organisms along with water, which is their medium, functions as a dynamic integrated system.

Water resources have been the most exploited natural system since man strode the earth. On the one hand rapid population growth, increasing living standards, wide spheres of human activities and industrialisation have resulted in greater demand of good quality water while on the other, pollution of water resources is increasing steadily. Of the total amount of about 1500 million km³ of water in the hydrosphere, about 95% of it is seawater, 4% is frozen as snow in mountain and cold regions, and only 1% is available for human activity (Dooge, 1973).

For India's large growing population, water courses must satisfy various domestic demands besides those for agricultural, industry, fisheries, navigation and power generation, as well be a vessel for community, industrial and agricultural wastes. There is now a wealth of document evidenced from all over the country about the adverse effects of water pollution. These range from the transmittal of water borne diseases such as cholera, jaundice, typhoid and dysentery to fish kills and loss of agricultural productivity through the use of polluted water. From the Dal Lake in the north to the Periyar and Chaliyar rivers in the south, from the Damodar and Hooghly in the east to the Thana Creek in the west, the picture of water pollution is uniformly gloomy. Today, even
our large perennial river such as Ganga is heavily polluted. Investigations by the central and state boards for the prevention and control of water pollution show that the major sources of pollution of our natural water sources including coastal waters are the discharge of community wastes from human settlements. Most of the community and industrial waste water go straight into the water sources rendering them unfit for most uses, least of all as drinking water source.

More than 50% of India’s economy is dependent upon agriculture and India’s agriculture has to go a long way to match the yield of the advanced countries. Indiscriminate discharge of waste by agriculture has variety of problems including those owing to pesticide and other exotic chemicals that are inimical to all life forms. Excess fertilizers applied to the field naturally get washed away during draining operations or by rain into nearby water sources. This causes uncontrolled growth of aquatic vegetation. If the same thing happens to pesticides applied on the fields, it can lead to toxic effects on aquatic life and they may in many ways be transmitted to man himself. Improper use of pesticides and weedicides can also poison to man through fruits and vegetables we eat, the incident witnessed by Kasargod at Kerala reported by Down to earth (May, 2005).

Pollution of water bodies has become a universal phenomenon in the present day world. Water is considered to be polluted when it is altered in composition and is not suitable for domestic usage. This includes changes in the physical, chemical and biological properties of water. Discharge of liquid, gas or solid substance into water is likely to create nuisance or render such water harmful to public health and welfare and to domestic, commercial, industrial, agricultural, recreational and or other legitimate uses for livestock, wild animals and other aquatic biota (WHO, 1972). Poor quality of water
caused by the pollution is today's burning problem of both developed and developing countries (Pande and Das, 1980). Still worse pollutants are the chemicals including pesticides and radioactive materials, which are carelessly dumped by industries. There has also been increase in oil pollution due to refinery effluents, offshore production platform, and pipeline and tanker accidents damaging ecological systems and badly affecting aquatic fauna.

Pollution is one of the biggest killers of inland and traditional fish folk. Data from the Central Inland Capture Fisheries Research Institute (CICFRI), Barrackpore, shows that the fish catch in most riverine fisheries is declining. The Ganga, for example receives most untreated effluents from 29 cities, 70 towns and thousands of villages. Annual inland fish landing of major carps in Allahabad and Bhagalpur has drastically come down. Moreover, mass fish deaths have been reported in Gomti, a tributary of Ganga, on many occasions. Recently mass mortality of fish and migratory birds were observed at Annehole, Lingambudi and Kukkarahalli lakes near Mysore, Karnataka (Deccan Herald, 2001). In 2005 mass mortality of fish in Bangalore Lake and Hoskote in Karnataka as well in Pune (Maharastra) during Ganesh festival was witnessed (Vijay Karnataka, 2005).

The domestic wastes and the industrial effluents are being indiscriminately discharged into the nearby rivers, reservoirs, lakes and tanks with almost no pre-treatment (Jhingran, 1982). In South India also the pollution of the rivers arises due to industrial effluents (Srinivasan and Sunder Raj, 1967). Water pollution is turning India's famous lakes and tanks into dirty ponds and its major rivers into sewers threatening the health of millions of people.
**Pesticide Pollution**

Extensive use of pesticides could have been the ultimate answer to the recurring problem of pests. Prolonged exposures of pesticide establish resistant pests. A recent study of the World Health Organisation reveals that on an average, one person is poisoned every minute by pesticides in the developing world (Radhakrishna Rao, 1984).

The term pesticide includes a large variety of compounds of diverse chemical nature and biological activity grouped together, only on the basis of that they are used to destroy or eliminate pests. Under the U.S. federal environmental pesticide control act the term ‘Pesticide’ has been defined to include any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest (Gupta and Satankhe, 1985). Pesticide contaminate the environment by different means, 1) direct application to water, 2) surface run-off, 3) atmospheric transport, 4) ground water contamination, 5) release of industrial effluent, 6) house hold use and release through water treatment plants and 7) dumping of waste material.

Environmental disturbance however have been reported even when pesticides have been applied at recommended doses. A number of pesticidal factories are located near the aquatic ecosystems. Pesticide factories located at Mathura, Faridabad and Agra release their waste products, which require 8000 times dilution to render them free from immediate harmful effects (Agarwal, 1983). Yamuna is quite often referred to as an open sewer because of great degree of water pollution (Times of India, Bombay, June 1, 1992). The aquatic environment is the ultimate sink for all anthropogenic chemicals and global pollutants. Any compound that has been used in large quantities ultimately reaches the
aquatic ecosystem (Zitko et al. 1975). The size and nature of the water body and the extent of possible dilution influence the level of accumulation of residue by organisms.

Currently one of the most important problems connected with the use of pesticide in most developing countries is the incidence of intoxication, death and residue problems resulting mainly from the misuse of certain pesticides. Residues of pesticides in food, raw agricultural commodities, in relation to people and components of the environment have not so far been studied extensively.

Ever since the dawn of civilization, it has been the major task of man to engage in a continuous endeavor to improve his living conditions. One of the main tasks in which human beings have been engaged is securing relief from hunger, one of the basic human needs. Today India is engaged in the gigantic task of feeding over 1000 million people and a huge cattle population on which the poor farmer is dependent for his livelihood. Secondly, the control of insects, weeds, fungi and other pests of economic or public health is of utmost importance to our government. The task would have been impossible but for the Green Revolution of 1960, which has given reasonable hope for the country being not only self sufficient in the production of adequate food and fodder for feeding its teeming human and animal population but has become the largest producer of some important commodities. On the other side, pesticides have given rise to serious problems (Gupta 1989). With a shuddering chill in the spine we recall the horror of Bhopal. The catastrophe, resulting from the leakage of methyl isocyanate (MIC) gas from the pesticide factory of Union Carbide Limited at Bhopal in the morning hours of 3 December, 1984, in which thousands of animals and human beings died, will never be forgotten.
Consumption of pesticides in India

The main use of pesticides in India is in agriculture and public health sector to combat the various pests and diseases that affect man. To achieve this goal, the production of basic pesticides commenced in 1952 with the manufacture of benzene hexachloride (BHC), followed by DDT. Since then, the production of pesticides has increased tremendously. In 1958, India produced over 5000 metric tonnes of pesticides, especially insecticides like DDT and BHC (HCH). In the mid-nineties, about 145 pesticides were registered and the production was approximately 85,000 metric tonnes. Even today, the bulk of pesticide production is insecticides (Anonymous 2002). India is presently the second largest manufacturer of basic pesticides in Asia. It ranks 12th globally.

Trends in pesticide use

The worldwide consumption of pesticides is about two million tonnes per year, of which 24% is consumed in the USA alone, 45% in Europe and 25% in the rest of the world. India's share is just 3.75%. The usage of pesticides in India is only 0.5 kg/ha, while in Korea and Japan, it is 6.6 and 12.0 kg/ha, respectively. Currently, the pesticides are being used on 25% of the cultivated area. The three commonly used pesticides, HCH (only gamma-HCH is allowed), DDT and malathion account for 70% of the total pesticides consumption. These pesticides are still preferred by the small farmers because they are cost effective, easily available, and display a wide spectrum of bioactivity. Out of the total consumption of pesticides, 80% are in the form of insecticides, 15% are herbicides, 1.46% is fungicide and less than 3% are others. In comparison, the worldwide consumption of herbicides is 47.5%, an insecticide is 29.5%, and fungicides, 17.5% and
others account for 5.5% only. The consumption of herbicides in India is probably low, because weed control is mainly done by hand weeding. In addition to public health and agricultural use, pesticides also find their use in other sectors as well.

**Poisoning from pesticides**

The rampant use of pesticides has played havoc with human and other life forms. There is a serious hurdle in documentation because of lack of systematic and authentic data on poisonings. Pesticides account for a small but significant fraction of acute human poisonings. There have been a number of outbreaks of accidental poisoning by pesticides that deserve special mention. In India, the first report of poisoning due to pesticides was from Kerala in 1958, where over 100 people died after consuming wheat flour contaminated with parathion (Karunakaran 1958). The chemical used was ethyl parathion known as Folidol E 605, was introduced by Bayer. In the same year poisoning in Kerala caused deaths of 102 people. This was mainly due to careless handling and storage of wheat. Subsequently, several cases of human and animal poisonings, besides deaths of birds and fishes, have been reported (Sethuraman 1977; Banerjee 1979).

In Indore, out of the 35 cases of malathion (diazole) poisoning reported during 1967–1968, five died. ECG changes were recorded in all the cases. Autopsy and histopathological studies revealed damage to the myocardium (Sethuraman 1977). In another report from Madhya Pradesh, 12 humans who consumed wheat for 6–12 months contaminated with aldrin dust and gammexane developed symptoms of poisoning which consisted of myoclonic jerks, generalized clonic convulsions, weakness in the extremities. Two dogs and two bullocks were also affected with generalized seizures and myoclonic jerks (Gupta 1975). In another outbreak in 1977, eight cases of grand mal
seizures were reported from a village of Uttar Pradesh following accidental ingestion of HCH-contaminated wheat (Nag et al. 1977; Anonymous 1981). From time-to-time, several such cases of poisonings have been reported in human being, cows, buffaloes, and heifer calf. In the year 1978, six persons died in Bhopal, due to exposure to phosgene gas (Gupta 1986). There have been numerous suicidal deaths due to consumption of aluminum phosphide but no documented reports are available in the literature that can be cited. In 1984, the horror at Bhopal is well known. Since then several isolated cases of suicide poisonings have been reported. In the year 1992, six deaths due to aluminum phosphide have been recorded.

In general, it has been observed that organophosphorus pesticides are responsible for death in more than 70% cases and intentional poisonings (mainly attempted or successful suicides) make up a large proportion of the poisonings by pesticides of high toxicity in certain developing countries (Anonymous 1990). In Indonesia, Malaysia, and Thailand, for example, the proportion of acute pesticide poisonings that are due to suicide attempts has been reported to be 62.6, 67.9, and 61.4%, respectively (Jeyaratnam 1987). In India such suicide poisoning may even go up to 70% because such compounds are easily available in many households and become the 'method of choice' for individuals with suicide intent.

Water bodies are the ultimate sinks of both natural and anthropogenic inputs of contaminants into the environment and evidence suggests that releases of toxic substances have had dramatic impacts on fish and fisheries via direct and indirect mechanisms. Releases of toxic substances by either human activity or natural causes have resulted in dramatic fish kills, however, it is now known that exposure to sublethal
concentrations of toxicants may prove to be equally devastating to fish populations (Chris and Don 2000).

Exposure to pesticide formulations, either through the course of work with pesticides, or due to unintentional exposures to environmental contamination, or even through residues in food, can cause a range of adverse human health impacts. Most environmental pesticide contamination is a result of agricultural, commercial and household application to control insects. Pesticides washed by rain into streams, ponds or other wetlands can harm aquatic animals, and cause serious ecotoxicological problems mainly due to their persistence and high toxicity (Howard 1991).

The majority of insecticides currently in use are organophosphorus compounds. Organophosphorus insecticides (OPs) were developed in Germany during the 1930s as a substitute for nicotine and as potential chemical warfare agents (Costa 1987). Because of their relatively nonpersistent characteristics in the environment, OPs have become one of the most widely used classes of insecticides worldwide. Although these compounds offer the advantage of rapid degradation in the environment, they generally lack target specificity and have high acute toxicity toward many nontarget vertebrate and invertebrate species. Thus, many terrestrial and aquatic organisms may be at risk for intoxication caused by exposure to these compounds in the environment. Organophosphorus insecticides produce toxicity by inhibiting cholinesterase enzymes in both vertebrate and invertebrate organisms.

Organophosphorus insecticides are esters, amides, or thiol derivatives of either phosphoric acid or thiophosphoric acid. The majority now in use, such as azinphosmethyl, chlorpyrifos, and malathion, contain the thiono moiety (=S). The
substitution of the =S for =O on the phosphorus atom increases the toxicity of the insecticide, such as is the case with malathion and its oxygen analogue, malaoxon (Murphy 1986).

The uses of OPs are highly varied. In agriculture, OPs are used to control insects on fruits, vegetables, grain crops, and stored seeds (Derache 1977). The OPs chlorpyrifos and terbufos are the two most widely used insecticides in agriculture (Aspelin and Grube 1999). Household uses include the control of cockroaches, houseflies, and termites along with protection of plants of horticultural interest (Derache 1977). The most common insecticides used in home and garden applications are the OPs diazinon and chlorpyrifos. For industrial, commercial, and government use, the top insecticides are again OPs (chlorpyrifos and malathion (Aspelin and Grube 1999).

Organophosphorus insecticides produce toxicity by inhibiting cholinesterase enzymes in both vertebrate and invertebrate organisms. These enzymes are responsible for the removal of the neurotransmitter acetylcholine (ACh) from the synaptic cleft through hydrolysis (Habig and DiGiulio 1991). In vertebrates, ACh acts as an excitatory transmitter for voluntary muscle in the somatic nervous system. Acetylcholine also serves as both a preganglionic and a postganglionic transmitter in the parasympathetic nervous system and as a preganglionic transmitter in the sympathetic nervous system. In critical regions of the central nervous system, ACh serves as an excitatory transmitter. When the binding of OPs inactivates cholinesterases, an accumulation of ACh occurs at the nerve synapse, interfering with the normal nervous system function. This produces rapid twitching of voluntary muscles followed by paralysis (Habig and DiGiulio 1991; Ware
Once bound, organophosphorus compounds are considered irreversible inhibitors, as recovery usually depends on new enzyme synthesis (Habig and DiGiulio 1991).

**Experimental Toxicant**

Malathion (50% Emulsifiable Concentrate, EC).

Malathion is a nonsystemic, wide-spectrum organophosphate insecticide. First manufactured in 1956 by American Cyanamid, there are at least thirteen other producers worldwide, 342 registrants and 1218 separate registrations. These products are used in an wide range of locales against a variety of target pests on field corps, greenhouses and forests, as well as numerous indoor environments, from dog kennels to food processing plants, schools and hospitals.

Malathion is used to control aphids, mites, scale, flies, leafhoppers, leafminer, thrips, loopers, pear psylla, mealybugs, spittlebugs, corn earworms, chinchbugs, grasshoppers, armyworms, bollweevils, bollworms, lice, ticks, ants, spiders, and mosquitoes. It is applied to alfalfa, clover, pasture and range grasses, nonagricultural land, cereal crops, cotton, safflower, soybeans, sugar beets, corn, beans, blueberries, stored grain, and inside homes. Estimated use of malathion ranges from 10 to 15 million pounds of active ingredients used annually.

Malathion is a nerve poison, which acts by inhibiting the enzyme acetylcholine esterase (AChE), and probably acts at other sites in the nervous system as well. Cases of long-lasting polyneuropathy, and sensory damage have been reported in humans, as well as behavioral changes. Corresponding indications of neurotoxicity are seen in animal studies.
The pesticide has been shown in animal testing and from use experience to affect not only the central nervous system, but the immune system, adrenal glands, liver and blood as well. Practically all routes including the gastrointestinal tract, skin, mucous membranes, and lungs rapidly and effectively absorb malathion. Animal studies indicate it is eliminated through urine and feces with a reported half-life of approximately 8 hours in rats and approximately 2 days in cows.

In a 1976 U.S. Army study, it was found that the avoidance behavior of rats was significantly impaired at a dose, which did not impair blood or brain AChE activity. In other words, malathion was found to cause behavioral changes at levels at which the standard hospital test for organophosphate poisoning would be negative.

Malathion has shown to be mutagenic in humans and animals. It has also been associated with birth defects in domestic and laboratory animals. A memo written by a Health Statistician with the Health Effects Division in the Office of Prevention, Pesticides and Toxic Substances, U.S. EPA, stated that 5,222 unintentional residential exposures were reported to Poison Control Centers from 1993-1996.

**Environmental Effects** - Malathion is a non-specific poison, is known to be highly toxic to bees, and available data suggest that it is highly toxic to many aquatic non-target species, such as freshwater fish, and moderately toxic to birds. Various aquatic invertebrates are extremely sensitive to malathion. Malathion is highly toxic to aquatic stages of amphibians and is toxic to many species of beneficial insects. It has a wide range of toxicities in fish, extending from very highly toxic in the walleye to highly toxic in brown trout and the cutthroat trout, and moderately toxic in fathead minnows.
Malathion is quite water-soluble (145 ppm at 25°C.), and preliminary data show that it is highly mobile in loam soils and thus a probable threat to groundwater. Malathion is of low persistence in soil with reported field half-lives of one to 25 days. Degradation in soil is rapid and related to the degree of soil binding. Breakdown occurs by a combination of biological degradation and nonbiological reaction with water. If released to the atmosphere, malathion will break down rapidly in sunlight, with a reported half-life in air of about 1.5 days. In river water, the half-life is less than one week, whereas malathion remained stable in distilled water for 3 weeks (Chemical Watch Factsheet 2003).

Some critical physico-chemical properties of malathion are presented in Table 2 which is important from ecotoxicological point of view.

**Table 2: The physico-chemical characteristics of malathion.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Datum</th>
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</thead>
<tbody>
<tr>
<td>Chemical name</td>
<td><em>O,O</em>-dimethyl dithiophosphate of diethyl mercaptosuccinate</td>
</tr>
<tr>
<td>Molecular formula</td>
<td>C(<em>{10})H(</em>{19})O(_6)PS(_2)</td>
</tr>
<tr>
<td>Molecular weight</td>
<td>330.3</td>
</tr>
<tr>
<td>Appearance</td>
<td>Clear, amber liquid</td>
</tr>
<tr>
<td>Odor</td>
<td>A mild mercaptan-like odor (skunk) of moderate intensity</td>
</tr>
<tr>
<td>Water solubility</td>
<td>145 mg/l (25°C)</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.23 (°C)</td>
</tr>
<tr>
<td>Melting point</td>
<td>2.85°C</td>
</tr>
<tr>
<td>Boiling point</td>
<td>156-157°C /0.7 mmHg</td>
</tr>
<tr>
<td>Vapor pressure</td>
<td>5.3 mPa (30 °C)</td>
</tr>
<tr>
<td>Partition coefficient</td>
<td>2.74</td>
</tr>
<tr>
<td>Log <em>K</em>(_{ow})</td>
<td></td>
</tr>
</tbody>
</table>
**Importance of biological assessment**

Pesticides that enter aquatic systems may cause a number of adverse effects in these environments. Since the compounds most commonly used in agriculture have a short half-life in the water column, and since water in lotic system is constantly moving, chemical analysis alone may not give an accurate indication of what has entered the water at a particular location (Bedford et al. 1968; Muncaster et al. 1990; Cairns 1995). In addition, chemical analyses may not effectively predict the potential for impact on aquatic systems since total contaminant loads may not always match those concentrations that are bioavailable. As a result, the most effective way to assess contaminant impact includes not only measurement of chemical residues, but also biological assessment (Kramer et al. 1989; Cairns 1995).

**In vivo experimental model: The fish**

In conventional ecotoxicity testing strategies, fish are an indispensable component of integrated toxicity testing strategies for the aquatic environment. Current OECD guidelines acknowledge this importance by covering acute toxicity (OECD 203 (OECD 1992a)), early life-stage toxicity (OECD 210 (OECD 1992b)). The prominence of fish in ecotoxicity guidelines and subsequently environmental risk assessment has several reasons:

- The aquatic environment is a sink for many chemicals, as illustrated by the occasionally high pollution levels and frequencies of chemical spills;
- fish play a critical role in aquatic food webs by top-down and bottom-up regulation of nutrient and energy flow;
Fish have been used as sentinels for the quality of waters that serve as sources for human drinking water;

Accidental fish kills are visible to the public when they occur and sociologically indicate to the public on the need to protect natural waters from pollutants;

Fish are an important food resource for humans;

Fishing has a large recreational value in many cultures.

In general, the edible freshwater fishes constitute one of the major sources of nutritious food for humans.

*Labeo rohita* (Hamilton) is an important edible fish with great commercial value, occurring abundantly in the freshwater tanks, rivers, reservoirs and ponds in and around Dharwad, Karnataka state. It is largely employed for pond culture throughout the country. It plays a dominant role in composite fish culture. Besides its wide availability and commercial importance, this fish is known for its adaptability to laboratory conditions and suitability to toxicity studies. Hence, this fish was selected as the experimental animal for the investigation.
Classification: Systematic position of *Labeo rohita*

<table>
<thead>
<tr>
<th>Classification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phylum</td>
<td>Chordata</td>
</tr>
<tr>
<td>Sub-Phylum</td>
<td>Vertebrata</td>
</tr>
<tr>
<td>Division</td>
<td>Gnathostomata</td>
</tr>
<tr>
<td>Super Class</td>
<td>Pisces</td>
</tr>
<tr>
<td>Class</td>
<td>Osteichthyes</td>
</tr>
<tr>
<td>Super order</td>
<td>Teleostei</td>
</tr>
<tr>
<td>Order</td>
<td>Cypriniformes</td>
</tr>
<tr>
<td>Genus</td>
<td>Labeo</td>
</tr>
<tr>
<td>Species</td>
<td>rohita</td>
</tr>
</tbody>
</table>

**Biological features**

Body bilaterally symmetrical, moderately elongate, its dorsal profile more arched than the ventral profile; body with cycloid scales, head without scale; snout fairly depressed, projecting beyond mouth, without lateral lobe; eyes dorsolateral in position, not visible from outside of head; mouth small and inferior; lips thick and fringed with a distinct inner fold to each lip, lobate or entire; a pair of small maxillary barbels concealed in lateral groove; no teeth on jaws; pharyngeal teeth in three rows; upper jaw not extending to front edge of eye; simple (unbranched) dorsal fin rays three or four, branched dorsal fin rays 12 to 14; dorsal fin inserted midway between snout tip and base of caudal fin; pectoral and pelvic fins laterally inserted; pectoral fin devoid of an osseous spine; caudal fin deeply forked; lower lip usually joined to isthmus by a narrow or broad bridge; pre-dorsal scale 12-16; lateral line distinct, complete and running along median line of the caudal peduncle; lateral line scales 40 to 44; lateral transverse scale-rows six
or six and a half between lateral line and pelvic fin base; snout not truncate, without any lateral lobe; colour bluish on back, silvery on flanks and belly.

Habitat and biology

In its early life stages rohu prefer zooplankton, mainly composed of rotifers and cladocerans, with phytoplankton forming the emergency food. In the fingerling stage, there is a strong positive selection for all the zooplanktonic organisms and for some smaller phytoplankters like desmids, phytoflagellates and algal spores. On the other hand, adults show a strong positive selection for most of the phytoplankton. In the juvenile and adult stages rohu is essentially an herbivorous column feeder, preferring algae and submerged vegetation. Furthermore, the occurrence of decayed organic matter and sand and mud in its gut suggests its bottom feeding habit. The nibbling type of mouth with soft fringed lips, sharp cutting edges and absence of teeth in the bucco-pharyngeal region helps the fish to feed on soft aquatic vegetation which do not require seizure and crushing. The modified thin and hair-like gill rakers also suggest that the fish feed on minute plankton through sieving water. In ponds, the fry and fingerlings exhibit schooling behavior mainly for feeding; however, this habit is not observed in adults.

Rohu is a eurythermal species and does not thrive at temperatures below 14 °C. It is a fast growing species and attains about 35-45 cm total length and 700-800 g in one year under normal culture conditions. Generally, in polyculture, its growth rate is higher than that of mrigal but lower than catla. The minimum age at first maturity for both sexes is two years, while complete maturity is reached after four years in males and five years in females. In nature, spawning occurs in the shallow and marginal areas of flooded rivers. The spawning season of rohu generally coincides with the southwest monsoon, extending
from April to September. In captivity with proper feeding the species attains maturity towards the end of second year. However, breeding does not take place in such lentic pond environments; thus induced breeding becomes necessary. The fecundity varies from 226 000 to 2 794 000, depending upon fish size and ovary weight; on average it ranges from 200 000-300 000 eggs/kg BW. Rohu is a polygamous fish and also seems to be promiscuous. The optimum temperature for spawning is 22-31 °C.

Market and Trade

Almost all the rohu produced from aquaculture is consumed in local markets. Post-harvest processing is almost non-existent. Rohu is a highly preferred carp and fetches comparatively high market prices. In most areas, they are either marketed fresh in the local market or carried to nearby urban markets with ice (FAO 2009).

Rationale

Recent evidence indicates that fish, an extremely valuable resource, are quickly becoming scarce. One consequence of this scarcity is the increasing concern for fish survival and a growing interest in identifying the levels of various chemical pollutants, which are safe for fish and other aquatic life. Pesticides are among the most hazardous chemicals to men and ambient. However, these chemicals may reach other ecological compartments as lakes and rivers through rains and wind, affecting many other organisms away from the primary target. The injuries of insecticides to aquatic environments are incontestable. The significant increase of chemical emissions in the water resources has lead to deleterious effects for aquatic organisms (Livingstone 2001; Matsumoto et al. 2006). In recent years, there has been increasing interest in the relationship between aquatic organisms and toxic pollutants, such as the toxicity of pesticides or/and heavy
metals to aquatic organisms (Pandey et al. 2005; Morley et al. 2001; Sherrard et al. 2002; Choi et al. 2004; Khan et al. 2006), the bioaccumulation of organic pollutants in aquatic organisms (Sancho et al. 1998; Diran et al. 2006) and the effects of pollutants on the behavior and some haematological parameters of fish (Satyanarayan et al. 2004; Singh et al. 2004; Koprucu et al. 2006).

Although newer pesticides tend to be less persistent in the environment, they do not come without risks. While some risks are due to the acute lethal toxicity of the pesticides to the affected animal, more often the risks include sublethal changes in performance or physiological processes that can ultimately impact the animal’s fitness. Biomarkers are measurements in body fluids, cells or tissues indicating biochemical or cellular modifications due to the presence and magnitude of toxicants, or of host response (NRC 1987). Effects at higher hierarchical levels are always preceded by earlier changes in biological processes, allowing the development of early-warning biomarker signals of effects at later response levels (Bayne et al. 1985). In an environmental context, biomarkers offer promise as sensitive indicators demonstrating that toxicants have entered organisms, have been distributed between tissues, and are eliciting a toxic effect at critical targets (McCarthy and Shugart 1990).

In view of the foregoing account the present investigation was to elucidate "Toxic Potentials of Malathion on Some Biochemical, Histopathological and Haematological Aspects in the Freshwater Edible Fish, Labeo rohita (Hamilton)"
To achieve the above said objective following studies were conducted:

- Toxicity expression
- Behavioral toxicity
- Oxygen consumption
- Bioaccumulation
- Oxidative Stress
- Ions and associated ATPases
- Haematotoxicity
- Histopathology
- Ultrastructural Study