INTRODUCTION

Ever since the dawn of civilization, man has been waging a ceaseless war for his survival from an army of pests consisting of bacteria, viruses, fungi, insects, certain species of plants called weeds and rodents. Bacteria, viruses, saprophytic, parasitic fungi and autotrophic photosynthetic algae are among the most primitive life creatures on the earth. Compared to them, the insects are recent entrants on the stage of evolution. In their present form, they appeared 200-300 million years age. There are over one million species of insects, roughly about 75 per cent of all the animal species on this earth (Vanden Bosch 1979). Besides their diversity, the insects are highly adaptable and capable of incredible reproductive performance.

The fight between man and pests commenced many years ago almost from the time he emerged from his cave dwelling, animal hunting and nomadic phase to the civilized era of tilling the soil, sowing the seed and reaping the harvest. It was only in the nineteenth century when it became evident that pests could be carriers of deadly diseases. Many weapons were deployed in the war against the ravages caused by pests and partial success was achieved in some instances. Search for powerful chemical agents was initiated in the early twenties and thirties of this century. For increased production of food, fodder and agricultural crops as well as for improvement of human health welfare insecticides and
other pesticides were introduced for controlling insect borne diseases. The pest control operations in developing countries which are naturally major users of the cheapest and most effective materials, produced higher toxic pesticides. The powerful insecticidal action of DDT was accidentally discovered by Dr. Muller in 1939 and it was manufactured widely from 1943 and soon became the most widely used single insecticide in India. The insecticidal properties of Benzene-Hexa-chloride were recognized from 1942. From about 1945 several insecticidal chlorinated hydrocarbons and cyclodiene compounds were introduced which became wide spread in use from the middle of 1950. Common examples include Lindane, Endosulfan, BHC, DDT, Aldrin, Dieldrin and Endrin etc.

The organophosphorous compounds represent another extremely important class of organic insecticides. The organophosphates which were by-products of defence research on nerve gases in the second world war were also found to be deadly toxic to insects. Earlier examples include the powerful insecticides malathion and parathion etc.

Though the excessive use of pesticide of higher toxicity increases tremendously the crop production, yet at the same time its indiscriminate use is proving extremely hazardous to the innocent man. In public health programmes, large quantities of pesticides are used to kill pests which are trouble-some to man and which transmit many diseases viz, mosquitoes fleas etc.
After the Second World War, there has been a marked increase in total pesticide usage and a rapid proliferation of synthetic organic compounds. There are now over 1,000 chemicals used against 2,000 pest species (Pimental and Goodman 1974). In order to control these pests the magnitude of pesticide production is increasing at a tremendous rate. The pesticide production in 1970 was 1-8 billion Kg and increased by 2 folds in 1980 with a production level of 2.29 billion Kg of formulated pesticide products (Gupta 1984).

Pesticide is a wide term used for the chemicals which are used to kill the pests. These are chemical compounds specially selected for their ability to affect vital processes of living cells at low concentration. As a result of chemical and biological researches there are now several hundreds of such materials and for each of these there exists many specialised formulations, most of which differ in detailed composition.

Pesticides may be broadly divided into three main categories (Benson 1969):

1. INSECTICIDES: These are the chemical compounds which are used to kill insects. Ex. BHC, Malathion etc.

2. FUNGICIDES: These substances are used to control fungal infections. Ex. Copper and sulphur compounds etc.

3. HERBICIDES: Herbicides are chemicals which are used to kill certain plants. Ex. Potassium cyanate, 2,4-D
4-Dichlorophenoxy acetic acid , Sodium arsenite etc.

According to their chemical composition insecticides may be classified as -

(a) Chlorinated hydrocarbons: These are hydrocarbons which contain chlorine atoms. Ex. DDT, BHC, Lindane, Endosulfan etc.

(b) Organophosphorous compounds: These include organophosphorous esters which have insecticidal properties such as Parathion, Malathion etc.

(c) Carbamates: This includes sevin, carbaryl, zinob etc.

(d) Botanicals: Botanicals are insecticides obtained from plants, such as Pyrrthrum etc.

(e) Inorganic insecticides: These are inorganic compounds used as insecticides for example Lead, Copper, Mercury etc.

(f) Fumigents: Fumigents are chemicals poisonous to insects when employed in the gaseous state for example Arsenic and cyanogen chloride etc.

Pesticides are chemicals designed to combat the attack of various pests on agricultural and horticultural crops. It is undoubtful that enormous agricultural development with crop protection has led to an almost explosive expansion in the development of synthetic organic insecticides and pesticides.
There are 820 pesticides available in the world market. In this group 308 are insecticides, 170 fungicides, 322 herbicides, 14 Rodenticides, 18 Neematocides and 6 Molluscides available in the market. In this range only about 80 are available in India (G.B. Report 1963). The advance in insecticides have closely followed the improvement in agricultural technology.

Chemistry and characteristics of some organochloro and organophosphorous insecticides used in the present study are discussed below:

BENZENE HEXA CHLORIDE (BHC)

This insecticide was first prepared in 1942. However its insecticidal properties were not discovered until Second World War. The product consists of eight possible isomers. Five of which have been violated in alpha, beta, gamma, delta and epsilon forms.

Formula and Structure –
A mixture of isomers of 1, 2, 3, 4, 5, 6 hexa chlorocyclohexane

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\text{Diagram of BHC isomers}
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\text{Diagram of BHC isomers}
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These compounds have been widely used outside the United States as a stomach poison insecticide. Their residues were frequently detected in all compounds of the environment (Edwards 1973). The rapid bioaccumulation and biomagnification of persistent BHC residues through food chain poses serious problems of health hazards in human and animal population (Hayes 1975). The symptoms of acute poisoning from the isomer are hyper sensitivity tremors and convulsions, which may be prevented by pentobarbital and to a lesser extent by the isomers. BHC also antagonizes convulsions normally produced by metazol, picrotoxin and hik theomide. Chronic poisoning with all of the isomers result in an increase in size of the liver with centrolobular hepatic cell enlargement.

LINDANE

It is the chemical name of 99 per cent gamma isomers of 1, 2, 3, 4, 5, 6 hexa chlorocyclohexane. Lindane is a commonly used insecticides in India.

ENDOSULFAN

Endosulfan is a broad spectrum insecticide of the cyclodiene group. It is used to protect fruits, vegetables, field crops and other crops like tea, coffee and tobacco.
from a wide range of insects and other pests, it is being widely used and as such it is expected that this insecticide may enter human and animal system either directly or indirectly as environmental contamination. Binder (1969) reported large quantities of endosulfan in River Rhine. Greve (1971) showed that endosulfan was strongly absorbed to sediments in streams and ponds. Greve and Wit (1971) found that endosulfan (82-85 per cent) was strongly absorbed to river silt and the absorbed endosulfan was rapidly decomposed. Van Dyk and Greeff (1977) did not find any residue of endosulfan in water, 7 hr after spraying into Jessivale stream water.

Little is known about the insecticidal mechanism of action of endosulfan. These insecticides are widely used in controlling agricultural pests and as such are likely to find their way through runoff from aerial and land application to near by water bodies.

Formula and structure –

\( \text{C}_9\text{H}_6\text{O}_3\text{Cl}_6\text{S} \)
MALATHION

Malathion (0,0-dimethyl dithiophosphate of diethyl mercapto succinate) is a broad spectrum organophosphorous insecticide. It is a major lethal poison which is widely used because of its efficiency and also its less persistence in the aquatic environment. Though it is less toxic to fish yet it has been shown to induce histopathological changes in some of the vital internal organs (Dubale and Shah 1979). Malathion is used to control a variety of insects on range-land, forest lands and agricultural lands. Many of these treated areas contain streams and lakes which harbour fish populations. Malathion dose levels for insect control is given as 1/2 to 3 ponds per acre (Thomson 1972). The major effect of this insecticide is the reduction of acetyl cholinesterase (ACHE) researches which in turn would bring about the inability of body muscles to perform properly. These are known to attack the animals by inhibiting acetyl cholinesterase activity. The tolerance of the toxicity of organophosphates has been studied recently in the mosquito fish (Gambusia affinis) by Chamber (1976).

Formula and structure -

\[
\begin{align*}
\text{CH}_3\text{O} \quad \text{S} \quad \text{P-S-CH-C-OC}_2\text{H}_5 \\
\text{CH}_3\text{O} \quad \text{CH}_2-\text{C} \quad \text{OC}_2\text{H}_5
\end{align*}
\]
The source of pesticides is an important consideration for it may determine the cost, its stability and the materials with which it may be used. Insecticides may be classified according to the manner in which they can be applied, that is, as materials for spraying, dusting or fumigation. In spraying the insecticide is usually dispersed or dissolved in a liquid usually water, kerosine oil, turpentine etc. and this is sprayed using a sprayer. Fumigation is usually effected by liberating gas with in a building or under a covering.

The contributions of insecticides are mainly in three important fields viz. Health and Comfort, Economical and Agricultural fields.

Ellis et al. (1944), Hart et al. (1945), Surber (1946), Darsie (1952), McGee (1952), Anderson (1959), Faust (1964), Nicolson et al. (1964), Cain (1965), Peterle (1965), Johnson (1968), Hayes (1975), Edwards (1976), Hayes and Vaughn (1977), Gupta and Gupta (1976), Gupta et al. (1978), Gupta (1984), Verma et al. (1984) and Belsare and Belsare (1984) have reported that during agricultural operations many pesticides ultimately pollute through water, find their way into the rivers, lakes and ponds along with the water runoff during monsoon period or wind drafts from the agricultural and forest lands and this creates pollution. These materials in excess amounts harm the fish (Kleien 1957).
Some times the pollutants in water ways, may not produce immediate death of fish but do result in loss of balance.

To a large extent it is true that the pesticides go a long way to protect our food, cloths, timber and many more needs. But inspite of the plus points of pesticides, the fact that they are poisoning our environment and accumulating in the tissues of organisms including man cannot be overlooked. The toxicologists therefore are engaged in developing methods to control the movements and deposits of residues of pesticides in soil, water and air.

These pollutants which have posed an eminent danger are especially hazardous to human health as well as to the aquatic fauna particularly to the fish life. Some of the important workers who have investigated these hazards are Hagg (1948), Gillette et al. (1952), Mayhew (1955), Banneet et al. (1956), Burdick et al. (1957), George (1957), Harrington (1958), Hemphill (1954), Iatomi et al. (1958), Weiss (1958, 1959, 1961), Fukano and Hooper (1958), Nicholson (1959), Cottom (1959), Burdick et al. (1960), Bridge (1961), Cope (1961, 1963, 1965), Haynes (1961), Lloyd and Herbert (1962), King (1962), Muncy et al. (1963), Boyd (1964), Jones (1964), Langer (1964), Holway (1964), Nicholson et al. (1964), Egler and Edmunds (1964),

On the other hand a series of investigations has revealed resistant natural population of fish in areas of intense insecticide use (Boyd, 1974 and Ferguson, 1964). Resistance is believed to result from selective mortality in response to exposure to lethal concentration of a toxicant (Ferguson, 1963). Retention of resistance for several generations by descendants of resistant strains placed in an insecticide free environment indicates a genetic basis as does cross resistant to compounds to which a population has had no prior exposure (Boyd and Ferguson, 1964). Between 1960 and 1964, fish kills occurred in the lower Mississippi River involving cat fish, drum, buffalo, shad and possibly other species to a lesser extent (Ferguson, 1965).
Although considerable disargument exists concerning the cause of these extensive losses. U.S. Public Health Service Investigators conducted a survey which showed that endrin was responsible for the 1963–1964 kill and an industrial plant at Memphis, Tennessee was cited as a significant source of endrin and dieldrin contamination in rivers (U.S. Public Health Service 1964).

The insecticide-oriented agricultural yield is gaining ground in India and the present is the appropriate time to assess the possible pollutional impact of the various insecticides on the aquatic biotopes especially from an ecophysiological angle. Surber (1948) stated that studies of the effect of insecticides on fish and fish food organisms along with operational lines is an ideal method of approach.

Not only this, pesticides also affect the living tissues in various ways. The information regarding the effect of these pesticides on different tissues is very meagre. Rounsefell and Evenhart (1953) said that pollutants may affect the aquatic organisms in many ways and categorized their effects as direct or indirect. Directly, their action may be on the gills or by absorption through the body resulting in the damage of internal organs and affecting metabolism in organisms. Discharge of hot waters or heavy salts and other chemicals may cause instantaneous death. Indirectly, pollutants may destroy the food supply, cause silting of
different water sources and may decrease in light penetration, destruction of the spawning beds, reproductive physiology and integration of biochemical reaction on the central nervous system. These pesticides are not readily removed by usual excretory routes because they inhibit directly as well as indirectly the enzymes participating in the detoxification and excretory reaction of fishes (Gillete 1980).

The pesticides also contain the toxic substances which alter the physico-chemical conditions of the aquatic environment and destroy the utility and beauty of the fresh water. The toxicity of pesticides to fish have been well documented (Doudoroff et al. 1953; Weiss 1959, Henderson et al. 1959, Katz and Chadwick 1961, Lewallen and Wilder 1962, Eisler 1965, Post and Schroeder 1971, Mayhew and Allister 1970, Kabeer and Maleque 1974, Anees 1975, Joshi et al. 1975, Robinson et al. 1976, Smith 1973, Coldwell et al. 1978). Verma et al. (1978 b) inferred that the mechanism of organochloro insecticides in poisoning is characterized by the disruption of ATP dependent active transport which involves ATPase system. Wildish et al. 1971, Alsen et al. 1973, Verma et al. 1979 and many other workers reported that organophosphorous insecticides and carbamate insecticides are characterized by their inhibitory action on cholinesterase but their studies could not establish a linear relationship between the death of fish and the degree of enzyme inhibition. Singh et al. (1981) pointed out the toxicity of some organic
biocides to a fresh water fish *Cyprinus carpio* and detected $LC_{50}$ values, relative toxicity and safe concentration. Verma *et al.* (1979) reported acute toxicity of twenty-three pesticides on a fresh water teleost *Saccobranchus fossilis*. Saxena and Parashari (1983) has reported a comparative study of the toxicity of six heavy metals on *Channa Punctatus*. Abidi (1983) has observed a maximum data regarding the toxicity of certain pesticides to fishes and the range between $LC_{20}$ and $LC_{80}$ values. This gives an idea of the hazards involved in using a pesticide in more than its anticipated amount.

organochlorine insecticides are quite persistent and consequently accumulate in the tissues of animals like fish. Intake of pollutants variously affect the fish physiology and metabolism. Organochloro insecticides due to their persistent and non-biodegradable nature accumulate in the different tissues of fish and their parent compounds persist longer in the environment therefore, the organophosphorous compounds are being used extensively to control a wide variety of pests.

In fishes, especially the gills naturally become more vulnerable because of their location and constant intimate contact with the water. Gills are liable to damage by any irritant material. The gills of fishes are not only respiratory but are also excretory in function to some extent (Lemke and Mount 1963, Mahajan and Singh 1973). Herbert (1962) has pointed out that a chemical variable can influence toxicity by affecting respiratory rate. Variance in toxicity is also related to the histopathological gill structure, gill surface area, or consumption tolerance of tissue and control of permeability.

Most of the studies on the histopathology of the gills in fishes are based on fish exposed to detergents. Important studies on the effect of the various pollutants on gills of fishes are those of Schmid and Mann (1961), Frommpaul et al. (1971), Mahajan and Singh (1973, 1975), Geoffary (1976),
Ansari and Shrivastava (1984). Effect of heavy metals on the gills of fishes have been studied by Westfall (1945), Crandall and Goodnight (1963), Gardner and Yeisch (1970), Skidmore (1970), Skidmore and Tovell (1972), Burton et al. (1972), Bilinski and Jones (1973), Brown et al. (1974), Verma et al. (1975), Ghate et al. (1979) and Kumar and Pant (1980). Also Wong et al. (1977) reported the effect of zinc and copper salts on the gills of Cyprinus carpio and Ctenopharyngodon idelus. Gupta and Rajbanshi (1979) have shown the effect of zinc sulphate on the gills of Channa punctatus. Shrivastava and Shrivastava (1980) have shown the effect of zinc sulphate on the gills of Mystus vittatus.

The pesticides present in water cause various structural alteration in the gills as shown in a few recent studies. Verma et al. (1975) have shown the effect of Lindane on the gills of Colisa fasciatus. Rao et al. (1983) observed changes in gills after Malathion poisoning in Tilapia mossambica. Shrivastava and Shrivastava (1984) studied the effect of Malathion and chlordane on gills of Channa gachua. Jauhar and Shrivastava (1984) studied the effect of Endosulfan and carbaryl on the gills of Channa striatus.

The liver of fishes is relatively a large organ concerned with several vital functions such as absorption of digested food stuff, detoxification secretion of bile, excretion of detoxification and harmful substances, synthesis of several components of blood plasma, storage of glycogen,
release of glucose and control over general metabolism. The liver has no direct contact with the pollutants dissolved in water but due to its contact with blood it is directly affected. The liver is susceptible to a number of toxic and metabolic disturbances. It therefore serves as a suitable index to toxicity of polluted water. Hence studies on the histopathology of the liver induced by pesticide are in progress.

Hagg et al. (1948) failed to find out such pathological changes. Woodard and Hagon (1947) reported that the liver of Dog is damaged by the gamma isomers of BHC. Laugh et al. (1950) have described the histopathological changes in liver of rats at a very low concentration of DDT. The effect of pesticides on various aspects of liver of fish have been reported by King (1962), Mathur (1962, 1965, 1976), Konar (1970), Bhattacharya et al. (1975), Verma et al. (1975, 1976), Mathur (1976, 1978, 1979, 1981), Ammnikutty and Raje (1977), Dubale and Shah (1979), Mandal and Kulshreshtha (1980), Kulshreshtha and Jouhar (1984). These authors have shown the destruction of hepatocytes and pycnosis of nuclei due to acute and chronic exposure of fishes to various insecticides. Mathur (1962 a, b, 1965) mentioned some histopathological changes in the liver of certain fishes induced by BHC and Lindane. King (1962) described various histopathological changes in liver, particularly cell vacuolation in guppies and Brown trout fry due to DDT. Eller (1971) reported
hyperplasia of the islets of Langerhans when Cutthroat trout (Salmo clarki), were chronically exposed to endrin by bath or in food. Eisler and Edmunds (1966), Mount and Putricki (1966), Annesa (1974, 1975 and 1978), Dikshit (1975), Dragomiver cuetal (1975), Shastri and Sharma (1978, 1979), Singh and Singh (1981), Murthy et al. (1981 a) and Rashtawar and Ilyas (1984) also reported the histopathological changes in the liver of fishes. Ammini Kutty and Rege (1977) reported that chronic exposure to Widow tetra (Gymnocorymbus terhetze) to thiodan and Agallol caused rapid degeneration and vacuolation of hepatocytes in liver tissue. Bhattacharya et al. (1975) observed liver cord necrosis and cytoplasmic and nuclear distintegration of the hepato pancreas of a teleost fish Clarias batrachus. Though the studies on the effects of heavy metals to fish life have received considerable attention in recent years (Baker 1969, Bhatia 1970, Hazel and Meith 1970, Bilinski and Jones 1973, McKim and Brown 1974, Benoit 1975, Brungs et al., 1976, Gupta and Rajbanshi 1979, Kumar and Pant 1981), fertilizer pollution is also one which has posed an eminent danger especially in regard to normal maintenance of fish life as reported by Gillette et al. (1952), Holden (1964), Shank (1964, 1966), Théron (1965), Clifford (1966, 1967), Tripathi et al. (1974) have given only anatomical changes induced by urea in the urinary, hepatic and vascular systems of fry and fingerlings of Labeo rohita. Shrivastava and Shrivastava (1979) have stated that the hypertrophy of hepatic cells and degeneration
of cytoplams and widening in the blood vessels was also noticed.

The kidney in fishes is another internal organ which is effected by pollutants. Though the kidney has no direct contact with the pollutants dissolved in water yet it is affected through the blood vascular system. The pesticides present in water cause various alterations in the kidney as shown in a few recent studies (Mathur 1962, Mount and Putnicki 1966, Konar 1970, Grant and Mehrle 1970, Verma et al. 1975, Amminikutty and Raje 1977, Kulshreshtha et al., 1984, Rashtawar and Ilyas 1984).

The gonads have been attributed an important role in development and reproductive physiology. Very little work has been done to investigate the effects of pesticides on fish reproduction. Kapur et al. (1978) studied the effect of fenitrothion on reproduction of a teleost fish Cyprinus carpio. Saxena and Garg (1978) have studied the effect of carbaryl and fenitrothion on reproductive recrudescence of a teleost fish Channa punctatus. Singh and Singh (1980) have shown short term effects of two pesticides on Heteropneustes fossilis. Pandey and Shukla (1980, 1982, 1983) investigated the effects of DDT, BHC and Malathion on the testicular physiology in Tilapia mossambica. Comparatively, few studies have been done to see the effects of heavy metals in aquatic ecosystem, their influence on the gonadal structure and function in fishes.
in fishes (Behoit 1975, Kaviraj 1983, Chetty and Agrawal, 1984). Pesticides have been shown to interfere and interact with various physiological activities of the fish including reproduction (Pickford 1953, Sperm 1976, Zutshi and Saxena 1980, Kalla and Bansal 1980). The effects of heavy metals on the gonads of fishes have been studied by Grande (1966), Vishwanatha Rao and Chandrasekhar (1976), Malone and Blaylock (1970), Speranza (1977), Mahapatra and Medda (1977), Uiovo and Beatty (1979). Toxic effects of thiourea on the ovary of a fresh water fish *C. punctatus* has also been reported by Saxena and Mani (1979).

Little is known about the effects of pesticides on brain (Edson 1957, Weiss 1958, Carter 1971 and Datta and Ghosh 1982). Verma et al. (1982) observed the effects of three phosphotase pesticides combination in some tissues of a fish *Mystus vittatus*.

However, quite a few works relating to the effects of other chemicals on the brain are available. In the brain Khosa and Chandrasekhar (1972) have observed the effects of copper sulphate and cobalt on preoptic nucleus of *Clarias batrachus* and *Ophiocephalus punctatus*. Pahari and Pahari (1979) have seen effects of mercury on the preoptic neurohypophysis system of *Heteropneustes fossilis*. Haider and Sathyanesan (1973, 1975a, b) have shown the
effect of different chemicals on neurosecretory system of
dishes. Banerjee (1978) has reported the effect of carbon
tetra chloride in the gardon lizard Calotes versicolor and
observed depletion of neurosecretory cells. Vishwanatha Rae
and Chandrasekhar (1976) observed the increased activity of
cyanophils of the pituitary and caudal neurosecretory neurons
in Clarias batrachus by treatment with clomiphene. Van Dyke
et al. (1959) have shown the long term effects of deuteron
irradiation on the rat pituitary. Tanimura (1957) reported
the changes of the neurosecretory granules in the hypothalamo-
hypophyseal system of rats. Tanlanti (1967 a, b, c) reported
the effect of thiouracil on the hypothalamus of rat.

In the present research work the author has studied
the histopathological effects induced by four pesticides on
the gills, liver, kidney, gonads and brain of two fresh water
teleosts fishes viz., Rasbora daniconius and Puntius ticto.

The problem of insecticide pollution and hazards in
India is quite serious. The chronic toxicity aspects of the
problem concern large magnitude of pesticidal residue in
food fodder, soil etc. Indiscriminate use and lack of
effective checks and control are the main factors responsible
for the situation.

As regards the metabolism of pesticide it is shown that
all pesticides undergo chemical or biochemical alterations
after their introduction into the environment and uptake by
living organisms. It is through analytical and biochemical studies that we can determine the fate of these pesticides in animals, plants, soil, water and the atmosphere. The bioaccumulation of pesticides in fishes results from eating contaminated food and also from breathing contaminated water by the organisms. Once the pesticides enter the circulation of an organism and becomes bound to various tissue components, its clearance from the whole organism is directly related to turn over of the tissue components which in turn is related to metabolic rate or some other specific time dependent and definable function such as body size. Damage is caused to different internal organs which effect the physiological and biochemical processes within an organism following exposure to environmental poison and thus causing metabolic disturbances. The pesticide residues enter aquatic animals like fishes mainly through food (Durham et al., 1965, Morgan and Roan 1971). The rapid bioaccumulation and biomagnification of persistent pesticide residues through food chin poses serious problems of health hazards in human and animal populations. Gage (1961), Holden (1962, 1966), Duggan (1965), Breidenbach (1965), Burdick (1964, 1967) have shown pesticide accumulation in water and air. Mitchell (1958) and Hayes (1978) reported the separation and identification of pesticide by paper chromatography. Depletion of tissue protein in fishes exposed to various pesticide toxicants have been reported by many earlier workers (Eisler and Edmunds 1966, Mehrle et al., 1971, Shakoori et al., 1976, Kabeer et al.,
Further, it has been reported that acute or chronic treatment of pesticides cause biochemical alteration in organs involved in detoxification mechanisms (McFarland 1961, MacLeod 1973, Clark 1973, Dikshit et al., 1975, Tanaka 1976 b, Tanaka et al., 1977 b, Stijve and Cardinale 1972, Bevenue et al., 1972, Bender 1969 a, b, and Davis 1967).

Toxicants have undoubtedly been metabolized by living systems since the first cells were formed in the primordial ooze. According to Nortan (1975) the defense mechanisms of the body for toxic substances include - (1) elimination unchanged (2) modification of the structure, usually by making it more water soluble to facilitate secretion via the kidney (3) structure modification to detoxify, whether water solubility is increased or not and (4) host defense mechanisms such as immunity, tolerance and encapsulation or trapping.

Among pesticides the chlorinated hydrocarbons pose potential hazards because they are very persistent. The thiophosphates, although much less persistent are hazardous because a few of the important one (Ex. Parathion, Malathion) have such high intrinsic toxicity (Chen et al.,
1962). Considerable effort has been made to develop insecticides with higher insect selectivity, lower residual and lower mammalian toxicity. This effort has had considerable success, but the chlorinated hydrocarbons are hard to surpass in cost and effectiveness in the control of a number of important pests.

So far there are no studies on the identification of pesticide residues in fish tissues. Although the chemistry and metabolism of pesticides in various substances have been studied extensively (Ferguson 1964, 1965; Richard 1970, O'Brien 1971, Analytical quality control laboratory and Leschev 1972, Goeke 1972, Kaufman 1972, Bruce 1972, Talvanon 1972, Deubert 1973, Sawyer 1973, Post and Leasure 1974, Crockett et al., 1975, Cooke and Moore 1976, Cooke et al., 1976 Arnold and Herman 1977). No residue data has been reported for pesticides in fish tissues. Only Verma et al. (1981) have described the accumulation and elimination of organoethyl parathion (an organophosphate) in the gonads of *Notopterus notopterus*.

In the present investigation an attempt has been made to study the accumulation of the pesticide residues in the gill, liver, kidney, gonads and brain of *Rasbora* and *Puntius* by thin layer chromatography (TLC).
These pesticides i.e. BHC, Lindane, Endosulfan and Malathion were selected because of following criteria:

1. They are used extensively in agriculture and industrial operations in India.

2. They are available and can easily be handled.

3. They display a wide range of toxicity.

4. Their concentration can be analytically determined.

5. They belong to different groups of insecticides.

Keeping in view that fishes are important human food stuff their availability and their varying degree of sensitivity to toxic substances is the main criteria for their selection as test animals in the present investigation.

To conclude, the present research work includes a study of the toxicity assessments of BHC, Lindane, Endosulfan and Malathion on two fresh water teleost Rasbora daniconius and Puntius ticto. LC<sub>50</sub> values, relative toxicity and safe concentration have been evaluated. Mortality and behaviour of these fishes have also been observed. Histopathological effects induced in the different tissues have been investigated. In
addition the accumulation of pesticide residues in the different organs (gill, liver, kidney, gonads and brain) have been studied by thin layer chromatography (TLC) which has enabled to throw some light on the metabolism of these pesticides in the different tissues of the fishes studied.