CHAPTER II

REVIEW OF LITERATURE

Most heavy metals released into the environment find their way into the aquatic phase as a result of various reasons responsible for aquatic pollution disturbs the flora and fauna have been studied by Veena et al. (1997), Wong et al., (2001), Ashraf (2004) and Gad (2009).

From the ecological point of view Fresh water biodiversity specially fish is very important because of sensitivity to ecological changes and represents a wide range of tolerance at community level have widely been used as biological indicators to estimate and evaluate the level of degradation and health of rivers and streams were observed by Marcovecchio and Moreno (1993), Admassu (1996), Coward and Bromage (1998), Stoddard et al., (2006), Vijaylaxmi et al., (2010).

Several publications presented to reveal the existence of pesticide residues in various aquatic ecosystems and reported that the dissolved metals and organic contaminants or their metabolites in the fish and their eggs affected the spawning behavior and duration by several investigators like Heath (1987), Barakat (2004), Tarek et al., (2007), Radwan et al., (2005, 2008).

Acute toxicity of heavy metal on the fish, *Anabas testudineus* during 24 to 96 hours at different dose levels exposure have been observed by Sinha and Kumar (1992). Adverse effects on haematological changes were reported by Joshi et al., (2002). High concentration of heavy metal in water due to heavy metal contamination have been reported by Chattopadhyay et al., (2002), Rajaganapathy et al., (2011), Ambedkar and Muniyan (2011). High concentration particularly due to anthropogenic activities (domestic, industrial and agriculture) by human being was observed by Langston (1990) and Gumgum et al., (1994).

Exposures to sub-lethal concentrations of metals on behavior have been studied by Jezierska and Witeska (2001), Idodo-Umeh (2002), Shafiq-ur-Rehman (2003). Toxic effects of heavy metals survivability growth and reproduction have been reviewed by many scientists like Adami et al., (2002), Waqar (2006). The most sensitive effects on parameters in the endocrine and nervous system, induction of oxidative stress and other stress related factors was observed by Vieira et al., (2009).

Heavy metal Copper is an element that has been subjected to intensive research. A range of responses has been given from copper exposure of which elevation of the hormone cortisol and an increase in adrenergic response, such as release of catecholamines can explain many of the observed effects such as effects on behavior and reproduction have been reported by Handy (2003). Furthermore, copper exposure causes degeneration of specific olfactory receptor cells, likely through oxidative-stress-mediated apoptosis have been observed by Julliard et al. (1993). Metal induced impairment of olfactory perception may interfere with spawning behaviour in fish have been pointed out by Kraemer et al., (2005), Kamo and Nagai (2008) and Aravind et al., (2009).

Bloom et al., (1978) observed that heavy metal zink exposed females did not react to sexual pheromone present at concentrations that attracted control individuals. Disturbances in spawning behaviour were reported by Weber (1993). An effect of zink was also reported by Sokolowska-Mikolajczyk et al., (2000).
The fish spent less time in mating, the males were less active and the females laid eggs less frequently than under control condition. Fish exhibit complex behaviour that provides the foundation for fish population structure and aquatic communities. Changes in social behaviour that affects reproduction may result in a decrease or even extinction of fish populations or communities in polluted waters, these all major studies was carried out by Jezierska and Witeska (2001), Shrivastava (2004), Kraemer et al. (2005), Valko et al., (2005), Kamo and Nagai (2008), Aravind et al., (2009) and Johnson et al., (2011).


The regulatory influence of the hypothalamus on the reproductive functions and atrophy of the gonads was observed by Dodd (1977), Peter (1973), Peter and Crim (1979). Regulation of gonadotropic functions of the pituitary by NPO and NLT, the presence or absence of NLT in teleost species and absence of NLT in Anabas testudineus have been reported by Ekengren (1973). The primary tissues involved in the hormonal cascade are the hypothalamus, pituitary gland and gonads, the hormone (GnRH) responsible for final maturation of the gametes was observed by Jeff & Anne (2008) and Taves et al., (2011).

The NPO, for the first time were observed by Herrick (1891) and later on special attention was paid by Kapper (1906) and Sheldon (1912) then the concept of neurohypophysial complex, their hypothalamic nuclei, NPO & NLT have been
described by Perks (1969), Peter (1973). Their axons Tractus preopticohypophysis and neurohypophysis which penetrates the pituitary, ramifies and terminates in the neurointermediate lobe, their composition pars magnocellularis and the pars parvocellularis, have been reported by Bargmann (1954, 1957, 1958), Knowles and Volirath (1965, 1966), Knowles (1967), Peter (1973) and Sathyanesan (1970a,b,c, 1972).

In teleosts, the involvement of NPO in the regulation of reproductive cycle, the co-relation between karyometric changes of NPO and reproductive cycle have also been established by Belsare (1967), Bhargav (1969), Kaur (1968), Muller et al., (1971), Polenov and Garlov (1973), Ekengren (1973), Saksena and Bhargava (1975), Tishchenko et al. (1976), Anant Prakash (1976), Bais (1977), Saxena et al., (1986). The experimental investigations on the co-relationship of NPO and reproductive cycle have been done by Palay (1960), Bhargava (1969), Belsare et al., (1970), Kasuga and Tkahasi (1971) and Michelle et.al, (1974).

Herrick (1891), Sheldon (1912), Scharrer (1932) and Palay (1945) described the process of neurosecretion in fish by using conventional stains, earlier to the application of improved staining techniques. The outstanding publication of Scharrer on hypothalamo-hypophysial system gave an impetus to other subsequent workers for further investigations.

These neurosecretory cells were demonstrated by Scharrer and Scharrer (1940, 1945). The neurosecretory material of NPO and their secretion (Neurocrine or Hydrocephalocrine) have been described by Stutinsky (1954), Knowles (1967), Leatherland and Dood (1969), Muller et al., (1971), Sathyanesan (1972), Pantic and Sekulic (1975), Upadhyay (1984), Saini (1984), Singh (1991), Saxena (1999), Siddique (2001).

The HPG axis functions as a dynamic system throughout each life-stage of an organism was studied by Norris (1996), Kime (1998), Van Der Kraak et al. (1998), WHO (2002). The principal HPG axis neurohormones were studied by EPA (1998) and Huet (2000).

Different stages of oocytes may be differentially affected by pesticide, similarly zinc affected primarily young stage of oocytes while copper and lead caused atresia in the older stage of oocytes were studied by Kumar and Pant (1984, 1988) and Shukla and Pandey (1984a).


Reproductive activities in most animals undergo cyclic rhythms. The patterns of these changes in the gonads are characteristic for each species. To understand the reproductive mechanism, to determine the stage of maturity of the gonad more correctly and for determining the developmental stages of the growing oocytes, a histological investigation was initiated by various workers like Saxena and Garg (1978), they studied on the carbaryl treatment arrested ovarian activities and caused increase in atrectic follicles in Channa Punctatus.

Kumar and Pant (1984) studied on a significant atresia in the ovary with major damage to younger oocytes in puntius conchonius, after exposure to zink on
Dutta et al., (1994) also reported notable microscopic changes in ovigerous lamellae, oocytes at different stages of development and the nucleus of the immature oocyte of the catfish Heteropneustes fossilis. Chatterjee et al., (1997) have reported that the impact of carbofuran in the oocyte maturation of catfish, clarias gariepinus and found the degeneration of follicular walls, connective tissue and vacuolization in the ooplasm.

Giri et al., (2000), Hossain et al., (2002) reported marked damage in germinal epithelium, atresia of oocyte, stromal hemorrhage, vacuolization of oocytes and general inflammation. Baruah and Das (2002) have reported that partial lysis, swelling, atresia and change in nucleus after exposure for 20 days. Severe necrosis, haemarrhage, nuclear pyknosis and degeneration of brain and liver were witnessed in Labeo rohita exposed to zink by Loganathan et al., (2006).

Histopathological changes have been widely used as biomarkes in the evaluation of the health of fish exposed to contaminants, both in the laboratory and field studies have been reported by Hinton et al. (1992), Schwaiger et al., (1997), Teh et al., (1997), Wester & Canton (1991), Giri et al., (2000), Hossain et al., (2002). One of the great advantages of using histopathological biomarkers in environmental monitoring is the category of biomarkers allows examining specific target organ like gonad.

One of the most common measures to analyse the effects of pollutants in both female and male fish is gonadosomatic index (GSI). The GSI as a percentage weight of ovary to the body weight has been used as a maturity index of fish is reduced by the effect of heavy metal pollutant have been studied by Ram and Sathyanesan (1986, 1987) Saxena and Mani (1985), Saksena (1976), Sehgal and Pandey (1984), Pundir and Saxena (1990), Kulshrestha (1984), Barse et al. (2006), Hanson et al. (2007) and Mir et al., (2012) in various species.

The use of gonadosomatic index and volume of the gonad as indicators of gonadal state, gonadal maturity and the fecundity have been suggested by Saksena.

Inhibition of spermatogenesis, with large numbers of spermatogonia, spermatocytes, few spermatids and sperm malformation, low activity, atrophy or necrosis of the interstitial cells and changes in sertoli cell structure are common effects of heavy metal poisoning reported by Sehgal and Pandey (1984), Sehgal et al., (1984), Shukla and Pandey (1984 b, c, d), Ram and Sathyanesan (1983, 1986), Srivastava (1987), Pundir and Saxena (1990).

Other structural changes to the male reproductive system caused by heavy metals include misshapen, damage to the sperm duct, damaged lobular walls and blood vessels were observed by Sangalang and O'Halloran (1973), Sangalang et al. (1981), Sehgal and Pandey (1984), Sehgal et al., (1984), Shukla and Pandey (1984 b, c) Sadhu and Mukhopadhyay (1985), Saxena and Mani (1985, 1987), Srivastava (1987), Pundir and Saxena (1990).

Scientists such as Katti and Sathyanesan (1985) observed exposure time dependent and concentration-mediated changes in testis. Kinnberg et al., (2000), Zutshi (2005), Zutshi and Murthy (2001), and Kumar et al., (2007) have reported various cytotoxic effects on testis due to the exposure of the different toxicants. These changes may culminate in a partial or total arrest of spermatogenesis.

Billard and Roubaud (1985), Khan and Weis (1987 a, b), Anderson et al., (1991) have demonstrated the inhibitory effects of heavy metals like zinc, copper and mercury on fertilization. They noted that direct exposure of sperm may result in malformed sperm and has been used as a toxicological measure. According to some investigators Sokal et al. (1985), Ruby et al., (1986), Ruby et al., (1987), Gaber et al., (2013) testicular inflammation has been documented as one of the common responses on the aquatic animals exposed to environmental toxicants.

Seasonal reproductive cycles in teleosts, often regulated by photoperiod and temperature, are mediated by the hormones of the hypothalamus (GnRH) and of the pituitary (GtH) which in turn act on the gonads to stimulate synthesis of steroid
hormones. According to Kavlock (1996), Environmental Protection Agency, US (EPA-2002) an environmental endocrine disruptor is an exogenous agent that interferes with the synthesis, secretion, transport, binding, action or elimination of natural hormones in the body that are responsible for the maintenance of homeostasis, reproduction, development and behavior.

The approach have been used to examine the effects of pollutants on the hypothalamic-pituitary system is histological study, explained by Ram and Sathyanesan (1983, 1986 and 1987) in Channa punctatus when exposed to mercury, the pituitary gonadotrophs are small, inactive and few in number, similar in fact to fish in the resting phase, while in control fish they are hypertrophoid and actively secreting.

Deformed cells, vacuolization and exhaustion of cytoplasm and severe damage to the acidophils and cyanophils of the proximal pars distalis with decreased neurosecretory material in the pars intermedia and deformed hypothalamic nuclei, nucleus preopticus (NPO) and nucleus lateralis tuberalis (NLT) were observed by Shukla and Pandey (1984 d), Katti and Sathyanesan (1986), Van der Kraak et al., (1992) and Ghosh et al., (1990).

Lead treatment of Clarias batrachus gave a marked accumulation of neurosecretory material in the anterior neurohypophysis and degenerative changes in the neurones of both the nucleus preopticus and nucleus lateralis tuberis, resulting in inhibition of gonadal maturation was observed by Katti and Sathyanesan (1986). GnRH stimulated plasma GtH less in fish which had been exposed to bleach kraft pulp mill effluent than controls studied by Van der Kraak et al., (1992). Hypothalamic GnRH, as determined by bioassay may also be affected by pesticides noted by Singh et al., (1989), Ghosh et al., (1990) and this in turn could be responsible for some of the observed effects on GtH.

Accumulation of toxic metals of hazardous levels in aquatic biota has become a problem of increasing concern and could lead to health hazards in man either through drinking of water or consumption of fish has been reported by
Mathis and Cummings (1973), Heath (1987). The *Anabas testudineus* is a local fish of this area and consumed by the people inspite of the polluted fish habitat because they are not aware of the health hazards due to lack of awareness of the species. The advantage of studying the fish of this region is that, its results reflect the bioavailability of pollutants in the system and thus helps environment.