Fish makes a vital contribution to the survival and health of a significant portion of the world’s population, especially in the developing world. In some of Asian countries (Bangladesh and Cambodia) people drive as much as 75% of their daily protein from fish. Often referred to as “rich food for poor people” fish provides essential nourishment, by offering quality proteins, fats (macronutrients), vitamins and minerals (micronutrients) (Caruso et al., 2010). For those involved in fisheries, aquaculture and fish trade, fish is a source of income which can be used to purchase other additional food items. Therefore, the breeding of fish for food, recreation and aesthetic needs and/ or in the context of conservation of natural species against environmental odds is a matter of great concern and has global importance.

Fish lives in close contact with its environment (aquatic ecosystem/ waterbodies), is extremely dependent on it and hence get affected by any change in its quality. Fish health thus may also reflect and give a good indication of the health status of a specific aquatic
ecosystem, thereby acting as a “warning signal” to indicate the presence of pollutants in natural water. Now a days, the aquatic environment, where fish and other aquatic organisms live, is subjected to threat of different types of pollutants which enter waterbodies through industrial, domestic and agricultural discharge system and thereby becomes causative of stress to living creatures. Among these pollutants, heavy metals have been recognized as strong biological poisons because of their persistent nature, toxicity, tendency to accumulate in organisms and undergo food chain amplification (Kamble and Muley, 2000; Dinodia et al., 2002; Raina, 2011; Sachar, 2011 and Gupta, 2012) and thus also damage the aquatic fauna including fish.

Stress is a general and non specific response to any factor disturbing homeostasis. Physiological responses of fish to environmental stressors have been grouped broadly as primary and secondary. Primary responses, which involve the initial neuroendocrines, include the release of catecholamines from chromaffin tissue (Randall and Perry, 1992; Reid et al., 1998) and the stimulation of the hypothalamic-pituitary-interrenal (HPI) axis culminating in the release of corticosteroid hormones into circulation (Donaldson, 1981; Wendelaar Bonga, 1997; Mommsen et al., 1999; Shanker and Kulkarni, 2007 and Martinez-Porchas et al., 2009). Secondary responses include changes in plasma and tissue ions and metabolite levels, haematological features, and heat-shock or stress proteins (HSPs), all of which relate to physiological adjustments such as metabolism, respiration, acid-base status, hydromineral balance, immune function and cellular responses (Pickering, 1981; Iwama et al., 1997, 1998; Mommsen et al., 1999 and Gupta et al., 2012). Additionally, tertiary responses occur which refer to aspects of whole-animal performance such as changes in growth condition, overall resistance to disease, metabolic scope for activity, behaviour, and ultimately survival (Wedemeyer and McLeay, 1981; Wedemeyer et al., 1990; Martinez-Porchas et al., 2009 and Gupta et al., 2012). Depending on its magnitude and duration, stress may affect fish at all levels of organization, from molecular and biochemical to population and community (Adams, 1990).

Stress in fish may be induced by various abiotic environmental factors (change in water temperature, pH, O2 concentrations, starvation etc.) (Gupta, 2009 and Raina, 2011). Besides these natural stressors, heavy metals and xenobiotics (anthropogenic stressors) are regarded as the serious pollutants which act as major source of stress to fishes (Tavares-Dias
and Barcellos, 2005). All these natural and anthropogenic stressors disturb the homeostatic mechanism of fishes besides creating considerable stress to fishes (Vosyliene and Kazlauskiene, 1999). Stress caused by pollutants/ xenobiotics in the fish’s body involves alterations in the various physiological responses viz. blood composition, biochemical indices, histopathology, immune mechanisms, hormonal imbalance, feeding, osmoregulation etc. It has also been linked as one more major factor of disease outbreaks, low productivity and mortality in aquaculture. Other toxic end points include decreased growth, mobility and reproductive effects (Allen, 1994). Changes in environment quality can, therefore, be a major detriment of year class strength and eventually the long term dynamics of fish populations (Rose et al., 1993).

Blood is a vital tissue which is involved in the regulation of various metabolic activities of an organism. Blood composition of an organism is relatively constant under normal conditions for proper functions and it must have the ability to change under extreme conditions (Hartwing et al., 1981; Tyagi and Srivastava, 2005 and Singla et al., 2012). Physiological and biochemical mechanism in poikilothermic animals allow them to adapt themselves to various environmental stresses which are reflected by changes in blood (Mehrle and Mayer, 1980; Raina, 2011 and Gupta, 2012). Blood composition in fishes often reflects their total physiological condition if witness any change, are bound to get reflected in the values of one or more of the haematological parameters (Van Vuren, 1986 and Gupta, 2012). Thus blood cell responses are important indicators of changes in the internal and/or external environment of animals.

In fish, exposure to chemical pollutants can induce an increase or decrease in haematological levels. These changes depend on fish species, age, the cycle of the sexual maturity of spawners and diseases (Golovina, 1996 and Luskova, 1997). Haematological parameters of fish are often very sensitive to pollution induced changes (McLeay and Gordon, 1977 and Dimichelle and Taylor, 1978). Any alteration in blood parameters in fish may be associated with pathological conditions related to waterborne pollutants (Van Vuren, 1986).

Since hematological parameters reflect the quality status of fish more quickly than other commonly measured parameters, and because fishes respond quickly to changes in
environmental conditions (Alkinson and Judd, 1978), they (haematological parameters) have been widely used for the description of healthy fish (Blaxhall, 1972), for monitoring stress responses (Soivio and Oikari, 1976 and Kocabatmaz and Ekingen, 1984) for predicting systematic relationships and the physiological adaptations of animals. Haematological analysis are advantageous to culturists by facilitating an early detection of stress and/ or diseases that could affect production performance (Rehulka et al., 2004 and Tavares-Dias and Barcellos, 2005).

It is well known that blood is first line of defense against diseases mainly due to phagocytic properties of some of the leucocytes and antibodies of plasma (Selvakumar, 1981). The speed with which such effects get surfaced coupled with possibility of testing the animals without killing them makes haematology a valuable tool (Dawson, 1979). Changes in fish blood prior to onset of morphological and physiological changes can be indication of unfavorable habitat/ aquatic medium. The importance of studying haematological parameters also lies in the fact that even a single drop of blood is sufficient to furnish information regarding their physiological status and a number of haematological indices such as haematocrit (Hct), haemoglobin (Hb), total erythrocyte count (TEC) and so on are used to assess the functional status and oxygen carrying capacity of blood (Shah and Altindag, 2004; Orun et al., 2003; Aras et al., 2008 and Sachar, 2011).

Blood being the medium of intracellular and intercellular transport, comes in contact with various organs and tissues of the body and thus can pose a direct threat to physiological functions of fish (Joshi, 1986). Xenobiotics like heavy metals and pesticides rapidly bind to blood proteins and thus may induce alterations in haematological parameters on one hand and histopathological make up on the other (Tyagi and Srivastava, 2005; Sachar, 2011 and Gupta, 2012).

Fish constitutes an important animal group from the perspective of innate immunity and ecotoxicology. Impairment of innate immunity may be more significant in fish than in mammals, as mounting an adaptive or acquired immune response takes longer in fish (Alexander and Ingram, 1992). Understanding of changes in fish innate immunity is important for evaluating changes in the general health of the aquatic environment. Monitoring of fish health can give an insight into the condition of the aquatic environment
(Zelikoff et al., 2000). An effect on fish innate immunity can serve as a warning of potential impact on human and ecosystem health because ecotoxicants are often released first into aquatic environments, and then, by a variety of routes, reach humans and other terrestrial animals. Therefore immune system is one of the most readily mobilisable defence barrier, and immunological responses have therefore been proposed as biomarkers of exposure to environmental pollutants (Fournier et al., 2000 and Mohamad and Abasali, 2010).

Perturbations of immune functions caused by immunotoxic compounds may lead to immunosuppression which thereby can result in decreased resistance to the infections. Presence of contaminants in aquatic environment, therefore bear a definite correlation with increase in outbreak of infectious diseases in fish populations (Halloran et al., 1998; Xie et al., 2006 and Estaban, 2012). Xenobiotics can also result in such adverse immunotoxic effects in tissue as necrosis, multiple histopathological effects, chemical induced cellular pathology (abnormal proliferation and maturation of immunocompetent cells) as well as their functional alterations. Such structural and functional alterations of different organs of immune system through immunodepression may ultimately help to modify host’s defense mechanisms against infectious agents (Krzystyniak et al., 1995).

Histopathology is the gold standard when defining toxicological effects (Teh et al., 1997). Histopathological changes in animal tissues are powerful indicators of impact exposure to environment stressors and are net result of adverse biochemical and physiological changes in organisms. Histopathological changes, therefore have been widely used as biomarkers in the evaluation of the health of fish exposed to contaminants, both in the laboratory and field studies (Teh et al., 1997; Thophon et al., 2003; Kasherwani et al., 2009; Sachar, 2011; Raina, 2011 and Gupta, 2012). One of the great advantages of using histopathological biomarkers in environmental monitoring is that it allows examining specific target organs. These include gills, kidney and liver, which are responsible for vital functions such as respiration, excretion, accumulation and biotransformation of xenobiotics in the fish (Gernhofer et al., 2001 and Camargo and Martinez, 2007). Furthermore, alterations found in these organs are normally easier to identify than functional ones (Fanta et al., 2003), and serve as warning signs of damage to animal health (Hinton and Lauren, 1990 and Sorour, 2001).
The neuroendocrine system is the primary means by which an organism maintains homeostasis (Mazeaud and Mazeud, 1981 and Bern and Madsen, 1992). In fishes like mammals, the glucocorticoids are important in regulating a number of functions that enable them to respond to stress and to resist stressors (Munch et al., 1984). Glucocorticoid steroid hormones regulate the production and functioning of a great many proteins and are important not only in regulation of homeostatic functions like metabolism and osmoregulation but also in their capacity to affect immune functions. Stress has been reported to elevate plasma cortisol which is one of important glucocorticoid (Pottinger and Mosuwe, 1994; Wendelaar Bonga, 1997; Pottinger et al., 2003 and Haukenes et al., 2008) and many researchers consider it as a “rule of thumb” that fishes undergoing stressful situations exhibit plasmatic increase in cortisol levels. Cortisol not only activates glycogenolysis and gluconeogenesis in fish but also activates the chromaffin cells to increase the release of catecholamines which further increase glycogenolysis and modulate cardiovascular and respiratory function (Reid et al., 1992, 1998). This whole process increases the substrate levels (glucose) to produce enough energy as per the demand and thus prepare the fish for an emergency situation (Rottmann et al., 1992 and Gupta et al., 2012).

Stress can affect reproduction as well, depending on the stage of the life cycle, and the severity and duration of the stressor (Shanker and Kulkarni, 2007). It can have varied effects and may either accelerate ovulation or inhibit reproduction. Constraints involving mate choice can also result in greater number of gametes to compensate for poor-quality of gametes (Gowaty et al., 2007). Stressors encountered during one developmental phase can also have effect during later phases. Many aspects of fish physiology are affected by stressors as the fish mature and reproduce (Jalabert, 2008). Earlier workers who proposed that stressors have effects on fish performance is the potent measure which help in redirection of energy resources associated with the stress response (Schreck and Li, 1991).

Fish reproduction, in general and breeding, in particular may cause physiological stress in fishes (Kortet et al., 2003 and Gupta, 2012). It is on record that production of testosterone during breeding season may involve a concomitant reduction in male immune defense (Folstad and Karter, 1992) and moreover studies in captive fishes have indicated a down regulation during the reproductive period (Iida et al., 1989; Slater and Schreck, 1998 and Hou et al., 1999; Kortet et al., 2003 and Rohlenova et al., 2011).
Understanding of reproduction is of paramount importance for rational establishment of fishery, as it is a very stressful and energy demanding process on one hand and involves interplay of very many complex events on the other. Energy demand due to stress of breeding can be taken care by blood parameters (haematological), immune system and stress hormone cortisol. Knowledge of changes occurring in oocytes during different phases of reproductive cycle and their relation with haematological parameters in general and immunological in particular needs to be thoroughly understood.

Against this scenario, present studies have been undertaken to analyze the effect of seasonal variations on haematological parameters, reproductive cycle and cortisol secretion of fish *Garra gotyla gotyla*. Besides studies on the effect of natural (starvation) and anthropogenic (manganese) stressors on haematological parameters (total erythrocyte count, haemoglobin, haematocrit, mean corpuscular volume, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration, total leucocyte count and differential leucocyte count), histology of haemopoietic organs (liver, head kidney and spleen), immune organs (thymus, spleen and head kidney), gonads and cortisol secretion of fish *Garra gotyla gotyla* have also been conducted. Based on these studies haemato-immunological responses of fish during reproductive cycle have also been worked out. Such studies would definitely help in assessing and mitigating the physiological status of fish under the impact of natural and anthropogenic stressors in general and production of quality fish in particular.