INTRODUCTION

According to the classification of Vokes (1980) the living freshwater bivalve molluscan fauna is represented primarily by three superfamilies—Unionacea, Corbiculaculaceae and Dreissenaceae. The freshwater mussels are falling under Unionacea, are documented by the members of the families Margaritiferidae and Unionidae and the members of the latter are composed of a relatively large numbers.

The physiological ecology of freshwater bivalves is historically based upon early descriptive work which includes basic taxonomy with notes on habitat, community, composition, abundance and distribution. Modern physiological ecology of freshwater clams has more recently involved both in field and laboratory studies based on growth, reproduction, population, and dynamics and energetic. Measurements of physiological parameters involved respiratory metabolism, biochemical diversion, feeding and excretion. Comparative information on closely related forms and for intraspecific inter-population comparison is critical to the basic understanding of the ecological function, as well as the broader concepts of the evolution of both physiological and life history facets of freshwater bivalves (Burky, 1983).

The influence of environmental temperatures on animals has been summarized by many workers, (Pretch et al. 1973; Hochachka and Somero, 1973; Wieser, 1973; Hazel and Prosser, 1974; Somero, 1978; Somero and Yancy, 1978; Kuhhemann and Precht, 1979). Since the changes in the kinetic energy of the environment are usually rapid and quantitatively transferred to the cellular chemistry of the organism, environmental changes cause unique problems. In general it has been
showed that the rates of biological processes under constant systems increase as experimental temperature increases to the maximum. When too much or too little kinetic is possessed by the atoms and molecules of the animals, the rates of vital processes and the cellular structure on which life depends may be adversely or even lethally disturbed.

Many environmental factors are known to affect the physiological processes, such as respiration, excretion, reproduction in the bivalve molluscs. The phases of the reproduction i.e. gonad development; spawning and fertilization; and development and growth of zygotes are functioning continuously in co-ordination with changes in environmental components, more especially temperature.

In bivalve molluscs, synchronization of breeding periods with environmental variables especially temperature, salinity, light and food for development and growth has been extensively reported (Andrews, 1979; Sastry, 1979; Mackie, 1984). Reproductive cycle of the bivalve species is genetically controlled in response to the environment (Sastry, 1970). Recent studies indicate that a reproductive response is produced through an interaction of environmental factors, especially temperature, salinity pH, light, food and endogenous factors within the organisms. After attaining certain physiological state, an organism exposed to the required environmental pre-requisitions begins the gonad growth and gametogenesis. The temperature was considered to be an important environmental factor which affect the survival activity and metabolic processes have been reviewed periodically (Widdows, 1973). The sequence of events related to gonad growth, gamete maturation, release of gametes and development of eggs are thermally sensitive (Kinne, 1962, 1970). Temperature also greatly influences the
sexual maturity, spawning and development of life stages of aquaculture species. The influence of temperature was reported by Giese, (1959a); Vernberg,(1962); Loosonoff,(1971) and Giese&Pearse,(1974).

Considering the immense scope as food resource, there is a need of shell-fish production through manipulated reproductions in aquaculture species by altering the environmental factors, especially elevation of temperature. Hence present study was undertaken on *Parreysia cylindrica*, during different seasons.

The rate of oxygen consumption due to desiccation was increased compared to the submerged bivalve from the control on 2nd day. Similar increase in the rate was found in desiccated animals on 8th day (Vedpathak *et al* 2007). As exposure period increased the rate of oxygen consumption decreased in control as well as desiccated group, perhaps due to starvation effect. Mane (1975) observed that the rate of oxygen consumption decreased with respect to oxygen consumption decreased with respect to starvation in marine bivalves. It is evident that due to desiccation (environmental stress) the reaction of an organism by a distributed physico-chemical balance to an abnormal impact of environment maintained high oxygen consumption (Dhert, 1992).

The pH and hardness (as normally measured in terms of calcium) are usually inter related in natural waters, the pH being largely determined by the bicarbonate concentration resulting from the solution of calcium. it is usually not possible to state which of these two factors may be responsible for affecting the metabolic shifts.
the pH has been shown or by altering the nutritional status of the growth of organism either by directly or by altering the nutritional status of the medium (Rajaratnam et al, 1987). These authors further stated that in waste water treatment or energy production application pH control probably is not required, but for the mass culture application to maintain specific species pH, control is necessary.

Many commercially important bivalve molluscs occurring in freshwater and marine environments have to face periodic fluctuations which make specific demands on the animal present in it. Some times changes in the environmental conditions may be essential to an organism. Moreover, it is known that an animal may survive certain discomforts, if only they are followed by a period in which it can recover. This well known phenomenon may be caused by a certain environmental effects in the internal conditions of these bivalve requires a knowledge of the effect of naturally occurring environmental stress. Perusal of literature shows that effect of changes in pH on organic constituents in the tissues of freshwater bivalve molluscs has received little attention and hence considering the multiple role of pH (as major ecological factor), the present experiments were planned according to natural pH differences (maximum&minimum) occurring along the banks of Girna river at Jamda Dist. Jalgaon.

Most aquatic organisms can utilize several metabolic pathways as a mean of obtaining energy. These processes can be aerobic or anaerobic. Anaerobic processes yields energy in the absence of oxygen. Biological literature records many values of oxygen consumptions in various aquatic invertebrates changes under various environmental condition such as temperature, salinity, pH, carbon
dioxide, oxygen tension, etc (Davies, 1975). Rate of respiration in these animals is also influenced by activity, body size, stage in life cycle and time of the day, as well as by previous oxygen experience and genetic background (Prosser, 1973). Indeed, a considerable knowledge is available on the interactions of oxygen availability, oxygen uptake and ventilation rates for many freshwater, marine and estuarine organisms. An excellent description on metabolic pathway, there evolution and relationship to the oxygen availability can be found in the details given by Hochachka and Somero, (1973). Davis (1975) reviewed minimal dissolved oxygen requirement of aquatic life. Bodies of freshwaters often show large variations in the dissolved oxygen, both seasonally and geographically. This point was elaborated by Akarte (1985), Muley (1985), Muley (1988) and Vedpathak (1989).

Gill ciliary activity and the heart rate were also shown to be very important factors while determining the respiration of bivalve mollusc Muley (1988). It has been shown that the cilia of bivalve gill are responsible for producing water current through the water quantity and hence contribute to exchange and the removal of waste product. They trap and transported the food particle suspended in water. Their proper functioning is clearly essential to all aspects of metabolism. There have been a large number of investigation on the effects of various ecological factors of the ciliary activity (Schlieper, 1965), (Schlieper, and Kowkski, 1956); Vernberg et al., 1983; Van winkle, 1972). There is an extensive literature on the physiology of the bivalve circulatory system and the major reviews are those of Krijgmen and Davis, (1955), Hill and Welsh (1966) and Jones (1983). The heart of bivalves consists of a pair of lateral auricles discharging blood into a single medium ventricle. The ventricle along the rectum, one posterior
and one interiorly. Blood, flowing surround the body, each oxygenated to the gill and mantle and returns to the heart via the nephridium, where the oxygenated blood is mixed with deoxygenated blood returning from the viscera (Booth and Manhum, 1978). While studying the effect of temperature and salinity on the bivalve mollusc, Mantale et al. (1972) showed that the cilia of isolated gills of K. opima, M. meretrix and C. gyrephoides ceased their activities at 44°C, 45°C and 46°C. The authors further showed that the oysters survived for a longer time than the further correlated the salinity and temperature relationships.

A large body of information has been accumulated in the respiration of the bivalves molluscs related to the fluctuations in the environmental parameters (Mane, 1973). However changes in the respiration during different seasons was shown by Akarte (1985), Muley (1985), Muley (1988), correlated with biochemical divergenance from the different body parts as well as with gonad development.

Variations in oxygen consumption with external conditions have been worked out by many investigators, such as temperature (Rao and Bullock, 1954; Barnes and Barnes, 1969; Newell and Pye, 1971). nutritional conditions (Newell et al., 1972; Newell, 1973) and weather measurements are made in air or water (Toulmond, 1967). The temperature is as recognized as one of the major environmental determinants of the rate of metabolism and the level of activity of poikilothermic organisms. However, bivalve molluscs, like many other littoral invertebrates, although apparently unable to regulate their rate of heat loss or gain from the environment, are able vary their
respiratory and feeding rates in such a way to maintain themselves relatively in independent of the environmental temperature. The subject of thermal compensation in poikilotherms has been viewed by Bullock (1955), Prosser (1955), Gunter (1957), Fry (1958), Percht (1962), Kinne (1970), Newell (1970, 1973), Vernberg and Vernberg (1972) and Wiesser (1973). The general concept of thermal adaptation includes both genetic and non-genetic aspects. Genetic adaptation takes place over many generations and sets the upper and lower limits of thermal tolerance. Non-genetic adaptation is influenced directly by the environment and can be divided into two categories on the basis of the time course of the physiological compensation. The subject has been nicely explained by Prosser and Brown (1961) and Bayne (1976). Metabolism in poikilotherms usually increase with increasing temperature, and acclimatization to seasonal temperature variations, seasonal changes in food availability and reproductive status may all influences respiration (Krogh, 1941; Bullock, 1955; Newell, 1967).

Studies on the respiration of several bivalve molluscs have been made by number of investigators (Collip, 1921; Bruce, 1926; Galtsoff and Whipple, 1930; Ishida, 1935; Krough, 1939; VanDam, 1954; Lane and Tierney, 1951). Several environmental factors are known to influence the respiration of bivalve molluscs. The rates of oxygen uptake under various environmental conditions are well documented by many investigators in marine and estuarine bivalves. Mussels and oysters were the main targets of the earlier studies (Collier, 1959; Schlieper, 1957; Read, 1962; Helm and Trueman, 1967; Moon and Pritchard, 1970). Respiration of many other bivalve species was also studied under various environmental conditions (Newell and

Few studies on freshwater mollusc give vigorous consideration to seasonal respiratory variation and acclimation (Berg et al., 1958; Burky, 1971; McMohan, 1973). The studies of Burkey (1969, 1970 and 1971) and McMohan (1973, 1975) on bivalve and Burkey (1973, 1974), Burkey and Burkey (1976) and Burkey et al. (1972) on gastropods give extensive information on the energetic of population growth and fecundity relation to respiration. For these studies, the adaptation of respiratory response takes on real significance in relation to the animal and their physical environment.

There are many reports on the respiration in freshwater bivalves as stated above; however, most of these deal directly with responses to temperature, anerobiosis and drying under controlled laboratory conditions. Other studies provide information on respiratory variation for field adapted bivalves during one season and estimates of other seasonal levels of metabolism from limited data. Most of these reports provide valuable but limited estimates because the status of growth, reproduction, or life cycle is often ignored or unknown. The studies of Burkey and Burkey (1976) on *Pisidium walker*, Hornbach (1980) and Hornbach et al. (1983) on *Spharium striatinum*, and Alexander (1982) and Alexander and Burt (1982) on *Musculilum lacustre* provide comprehensive information on life cycle and habitat characteristic
coupled with respiratory physiology. Apart from these studies several other investigators have worked aspects of respiration of many freshwater species (Dance, 1958; Segal, 1961; Berg et al., 1962; Alimov, 1975; Berg and Johanson, 1965; Lukascovics, 1966; Collins, 1967; Salanki and Lukascovic, 1967; Johanson and Brin Khurst, 1971; Bayne 1971; Johanson, 1972; Badman, 1974, 1975; ZsNagy, 1974; Dietz, 1974; Dezwaan and Wijsman, 1976; Holopainen and Rentas, 1977 a,b; McMohan, 1980 a, b; Waite and Neufield, 1977; Bleck and Heitkam, 1980).

Amongst the Indian freshwater bivalves, Parreysia corrugata (Lomate and Nagabhushanam, 1971), Lamellidens corrianus (Lohgaonkar, 1974) Indonaia caeruleus (Khatib, 1975) and Vedpathak (1989) have been studied to understand the effect of several environmental factors. While studying the effect of various pollutants, including the pesticides and heavy metals, Akarte, (1985) and Muley (1985) made an attempt to understand the seasonal variations in the respiration of three freshwater bivalve Lamellidens corrianus, Lamellidens marginalis and Indonaia caeruleus, exposed and unexposed to pollutant. Similarly Kulkarni (1987) on Indonaia caeruleus and Rao (1988) on Lamellidens marginalis, while studying the effect of cerebralectomy on some aspects of physiology and reproduction of these bivalves made an attempt to understand the seasonal variations in the respiration of these animals.

Changes in biochemical constitutes are pronounced in invertebrates which are cyclic in reproduction since a great amount of energy must be channelized to the gonad during reproduction. This is reflected in the deposition or depletion of the nutrients with the advent
or departure of the reproductive period (Lambart or Dahnel, 1974). The aspect of energy metabolism and reproduction has been reported for a number of species of bivalves due to their commercial and edibility values. But the relative influence of gonad development on the distribution and storage of biochemical constituents in different body parts has been examined in only a few cases (Giese, 1969), Gabbott, (1975, 1976), Bayne (1976) and DeZwaan (1983) have reviewed much of the work on biochemical changes, particularly the carbohydrates. A review of lipids in marine invertebrates including bivalves is given by Giese (1966), Lawrence (1976) and Voogt (1983) seasonal variation in the biochemical composition of *Mytilus edulis* in British waters have been reported by Deniell (1920, 1921, 1922), Williams (1969) and Bayne and Thompson (1970). Seasonal changes in biochemical composition have been reported for *Pinctada mortensi* (Ashikogo, 1948; Tanaka and Hatano, 1952), *Teredo pediallata* (Lane et al., 1952; Greenfield, 1953), *Pecten jacopeus* (Lopez-Benito, 1955), *Donax vittatus*, *Abra alba*, *Chlamys septemradiata* and *Nucula sulcata* (Ansell, 1972, 1974), *Mytilus edulis* (Dezwaan and Zandee, 1972; Gabbolt and Bayne, 1973; Dare and Edwards, 1975), *Argopecten irradians* (Estabrooks, 1973) and *Pecten maximus* (Comely, 1974). Ansell et al., (1964) determined seasonal changes in biochemical composition of adductor muscle, mantle, siphon, visceral mass (gonad), digestive gland and foot in *Mercenaria mercenaria*. Bayne and Thompson (1970) determined the biochemical composition of mantle, gonad (germinal) and non-mantle (somatic) tissues of *Mitylus edulis*. In *Mytilus edulis* the mantle tissue serves as a site of storage of nutrients and gamete productions. From India relatively few investigators such Durve and Bal (1961) on *Crassostrea gryphoides*,
Nagabhushanam (1961) on *Mertesia striata*, Nagabhushanam and Mane (1975 a, 1978) *Katelysia opima* and *Mytilus viridis*, Bidarkar (1975) on *Crassostrea cucullata*, Dhamane (1975) on *Paphia laterisulca* have reported changes in the biochemical composition correlated with annual reproductive cycle of bivalves. Seasonal changes in biochemical composition of different body parts of few species have been reported by Nagabhushanam and mane (1975 a) on *Katelysia opima* and Mane and Nagabhushanam (1975) on *Mytilus viridis*. Freshwater bivalves from Indian rivers have received little attention in the field of biochemical energetic during reproduction. Few workers reported seasonal variations in the whole body of few freshwater species (Lomte, 1968) on *Parreysia corrugata* Lohagaonkar, 1974 on *Lamellidens corrianus* Khatib, 1975 on *Indonaia caeruleus*, Godbole, 1977 on *Indonaia caeruleus* and Jadhav, 1980 on *Lamellidens corrianus*).

Ascorbic acid is water soluble vitamin and it is required for collagen and bone formation (Halver, 1969; Mallet et al. 1968), in Wound healing (Gould, 1963) and Haemorrhage and vertebral injuries (McCann and Jospher, 1972) in many vertebrate fast mobilization of fat by ascorbic acid and formation of glucose from fat has also been shown (Sinha *et al.* 1978). In mollusca it has been shown that ascorbic acid also plays an important role in steroidegenesis (Chinoy and Seethalakshmi, 1977) and in endowing the organism with increased power of resistance towards polluting substances on the freshwater bivalve molluscs *Indonaia caeruleus*. Perusal of literature shows that the ascorbic content in the tissues of freshwater bivalve mollusc has received little attention. Considering the multiple role of ascorbic acid (Chinoy abd Seethalakshmi, 1977; Kachole *et al.*, 1977; Ali *et al.*,
1983), and paucity of information on its label in the tissues of freshwater bivalve, and considering the impact of temperature and pH on this content as suggested by Kulkarni et al., (1988), it was planned to study the changes in the ascorbic acid contents during different seasons from the different tissues of *Indonaia caeruleus*.

Food availability and the mobilization of the nutrients for the gonads is an important aspect of bivalve reproduction. Considerable work has been done on food, feeding and digestion and much of this literature has been reviewed in detail by Vanweel (1961) Johanson (1966), Owen (1966 a, 1974). Purchon (1968), winter (1969, 1970) and Newell (1970). The question related to the rate of products of digestion and their transport to sites of storage and utilization relative to changes in environment has been examined for only a few species (Sastry, 1979). Seasonal changes in the body weight in relation to reproductive activity have been reported by a few investigators (Sastry, 1966 a; Ansell and Trevellion, 1967; Kirby-Smith, 1970). Seasonal changes in the body component indices have been determined for a few species throughout the year to learn whether they vary in relation to the reproductive cycle in terms of possible supply of nutrients to gonad for the growth and gametogenesis (Sastry, 1966, 1970; Giese et al., 1967); Nagabhushanam and Mane, 1975). Experiments on physiological and biochemical effects of temperature stress on *Mytilus edulis* have been conducted by Bayne and Thompson (1970), Gobott and Bayne (1973) Bayne (1973 a, 1975) and Bayne et al (1974). Their studies revealed better insight into the relationship between food level and temperature, and the energy requirements for growth and gametogenesis .Nutrients distribution and sites of storage have been examined in only a few species with the use of radiotracer method (Allen, 1962, 1970) and
many questions still remain as to how nutrients transfer from one body organ to another affecting reproductive activity. The amount of nutrients mobilized for the gonads could be affected by the energy requirements of somatic growth and basic metabolism. These relationships may change according to age and reproductive stage and also according to changes in food concentration and temperature conditions in the environment (Sastry, 1979). Evidence of nutrients transfer to gonads with the initiation of gametogenesis in *Argopecten irradians* was obtained by Sastry and Blake (1971) and in *Chlamys hericia* by Vassallo (1973). The connective tissue around the follicles of the gonad of *Ostrea lurida* (Coe, 1932; Loosanoff, 1937), *Crassostrea angulata* (Bargeton-couteanx, 1942), *Mytilus edulis* and *Mytilus galloprovincialis* (Lubet, 1959; *Chlamys varia, Chlamys Distorta, Chalmys tigerina, chlamys furtiva* (Reddash, 1962), *Barenea cundida* (Dulval, 1962) and *Crassostrea virginica* (Kennedy and Battle, 1964; Loosanoff, 1965) disappears with the growth of follicles and then appears again after spawning. It has been suggested that lipids and glycogen accumulated in these cells during the recovery period which serve as nutrient for the development of gametes (Chipperfield, 1953).

The biochemical constituents shown cyclic changes in reproduction due to great amount of energy to be channelized to the gonad during reproduction (Vedpathak, 1989 and Pandit, 2004). This is the reflected in the deposition or depletion of the nutrients with the advent or departure of the reproductive period (Lambert and Dehnel, 1974). Bivalves can be considered to be polysaccharide oriented (Martin and Goddard 1966). Due to the commercial importance and edibility value of number of species of bivalves, the aspect of energy
metabolism has been reported by a number of workers but the relative influence of gonad development on the distribution and storage of biochemical constituents in different body parts has been examined in only a few cases (Sastry, 1979; Giese, 1969), Gobbott (1975, 1976), Bayne (1976) and Dezwaan (1983) have reviewed much of the work on biochemical changes in bivalve molluscs, particularly with reference to the carbohydrate metabolism. A review of lipids in invertebrates including bivalve molluscs is given by Giese (1966), Lawrence (1976) and Voogt (1983). Amino acid metabolism and molecular biomechanics of protein have been reviewed by Bishop et al. (1983) and Shandwick and Gosling (1983). There are some reports stating the seasonal variations in the biochemical constituents, of different body parts of bivalves from Indian species (Nagabhushanam and Mane, 1978). The reports also states that polluting substances like pesticides can cause disruption in the biochemical mobilization (Mane et al., 1986) while studying the effect of polluting substances, like pesticides, Mane and Akarte (1987). Mane and Muley (1987) and Akarte and Mane (1988) stated that the toxicity to the species depends upon the temperature changes and the physiological changes in different seasons. Muley (1988) while studying the reproductive physiology of Lamellidens corrianus from Godavari river at Kaigaon near Aurangabad stated that, the while body weight and weights of different body parts like mantle, foot, hepatopancreas and gonad show significant fluctuations in relation to the gonad development and release of gametes (the study based on the fortnight analysis of the samples). He further showed that mobilization of reserve can take place from hepatopancreas to gonad (as was stated earlier by Sastry, 1979).
Reproduction of bivalve molluscs has been studied extensively. Much of the work has been reviewed exclusively on the marine species (Bayne, 1976; Giese and Pearse, 1979) and very brief description on reproduction in freshwater species is given by Purchon (1977) and Mackie (1984). Anatomy of the reproductive system and functional significance have been described in a number of bivalve molluscs (in *Thysire flexuosa*, (Bernard, 1972) *Musculista senhausia*, (Morton, 1974; Patero and Anomiea, Yonge, 1980) *Chione cancillata* and (Jones, 1979). Mackie (1984) briefly reviewed the anatomy of the reproductive system and functional significance. He stated that males and females of gonochoristic bivalves possess paired gonads located near or adjacent to the digestive gland. Often two gonads are so close together that the paired condition is difficult to detect (in freshwater *Unionidae*). In many molluscs the gonopore is remote from the gonad and long reproductive duct are needed to convey the gametes to the outside. However, in bivalves the gonad is in such proximity to the gonopore that the reproductive ducts are very short. The reproductive system also is closely associated with the digestive system. In diocious lamellibranches, the gonad commonly occurs among the intestinal loops in the base of the foot, as in most freshwater *Unionidae*, or is intertwined among the stomach, the intestine, and the digestive gland, as in sexicavaceans. Actually, accessory sexual organs are not present in gonochoristic bivalves. However, some structure of other organ systems is modified to serve as accessory reproductive organs. The most conspicuous of these are the elamellibranchs which serve as marsupia in freshwater unionid and margaritiferid clams. The females of *Anodonta* mussels have tripartite organizations of water tubes and septa in the outer demibranches, which creates ovisacs for brooding
glochidia (Heard, 1975). Accessory sexual organs in bivalves have been described by Purchon (1941) and Smith (1979). The reproductive system of functional hermaphrodite is only marginally more complex than that of gonochoristic bivalves. The simplest system consists of one pair of gonad connected along midline and one pair short gonoduct that empty into the kidney or the suprabranchial chamber. Coe (1945), showed that in many species of *cardium* there are intermingled zones of male and female acini, and the gametes share the same gonoduct which open on a common papilla with the renal opening. The gonads of hermaphroditic species of *Anodonta* are similar, but the gonoducts opens separately from the kidney (Heard, 1975). Most functional hermaphrodites have gonads that consist of male and female acini in originally distinct separates zones so that a part of gonad functions as a testis and remaining part as an ovary. The basic differences in the reproductive system among the species with this type of gonad lies in the location of the gonoduct (as in the details on the anatomy of organs in functional hermaphrodites exists through the studies carried out by Purchon (1941), Allen (1954), Morgen and Alline (1976) and Heard (1979). Much of the literature on reproduction in bivalve molluscs is concerned with the gonad development and reports on breeding periods, (Sastry, 1979). Several environmental factors have been shown to control the reproductive cycle. Gamatogenesis begins shortly after growth and maturation of the gonads. Maturation of the gametes is under several environmental factors such as temperature, lunar periodicity, depth, mechanical factors, light intensity and few others, and endogenous such as genetic and hormonal controls (Mackie, 1984). The maturation of the gonads are also dependent on the richness of the food supplies which intern are dependent on the climate. Thus,
amongst these exogenous factors, food also acts as environmental clue and synchronizer in regulating reproductive activities (Giese and Pearse, 1974). In tropical and arctic waters there are marked seasonal changes in temperature and elimination and the increase in the food supply and in general metabolism in spring and the period of early summer will inevitably impose a limited peak and breeding activity. In this processes there may be two contrasted features, firstly a period of increasing metabolic activity with growth and maturation of gonads; secondly, there may be some trigger mechanism, which sometimes a threshold temperature, which initiates the act of spawning. In tropical seas there may be a very little annual variations in temperature, no marked seasonal changes in abundance of food so far as is known (Purchon, 1968).

Gametogenesis in bivalves has been published by many investigators on *Mercenaria mercenaria* and *Cyprina islandica* (Loosonoff, 1937, 1953), *Pinctada spp.* (Tranter, 1958 and 1959), *Mytilus edulis*, *Chlamys varia* and *Pecten maximus* (Lubet, 1959), *Argopecten eradians* (Sastry, 1963, 1966, 1968 and 1970), *Placopecten magellanicus* (Periodo et al., 1987). Generally the reproductive cycle of a bivalve molluscan population includes a series of events, namely, activation, growth and gametogenesis, ripening of gametes, spawning and a resting period (Giese, 1959, 1976, Giese and Pierce, 1974; Sastry, 1966, 1975). Reproduction in bivalve is cyclic and it may be annual, semiannual or continuous. Reproduction may be divided into three major phases: gonad development, spawning and fertilization, and development and growth. These phases, functioning continuously in coordination with seasonal environmental changes, produce a pattern characteristic of species (Sastry, 1979). As stated
earlier, the timing and duration of reproductive activity may be
determined through an interaction between endogenous and exogenous
factors. Many freshwater and terrestrial animals breed in a restricted
part of the year as do many marine animals (Macgintie and macgintie,
1949). Giese (1959) described the method for determining the annual
reproductive cycle for marine invertebrates; criteria for determining the
breeding season of an animal used are spawning, number of larvae, the
appearance of ripe gametes in gonads, brooding of eggs and relative
size of gonads. Dinamani (1987) while studying the gamatogenic
pattern in population of oysters, *Crassostrea gigas* used histological
techniques for follicular and maturity indices. The reproductive cycle
in Indian bivalve molluscs has been studied extensively by dividing
into number of stages based on microscopic examination of
histological sections of gonads in the different part of the year (on
*Donax euneatus*, Rao, 1967; *Donax faba*, Algaraswami, 1966;
*Katelysia opima* and *Mytilus (Perna) virtidis*, Nagabhushanam and
Mane, 1975 a, b; *Crassostrea gryphoide* Mane and Nagabhushanam,
1976; *Crassostrea madrasensis*, Joseph, 1979; Joseph and
Madhyastha, 1981; 1984; *Perna viridis*, Ramchandra, 1980; Roy,
1984; *Villorita exprimaides*, Reddy 1983; *Saccostrea cucullata*,
Sukumar, 1984). Comparatively a very few species from habitats are
being studied (on *Parreysia faridens*, Patil and Bal, 1962; *Parreysia
corrugata*, Lomte and Nagabhushanam, 1969; *Lamellidens marginalis*,
Ghosh and Ghosh, 1972). These workers studied the reproductive cycle
of freshwater species by collecting monthly samples of the animals and
employed a classic histological technique. Since Scharres (1928, 1930
and 1933) reported the occurrence of secretory cells like
neurosecretory cells in the hypothalamus of various vertebrates using
different staining affinities, many investigators began to pay attention to the neurosecretory phenomenon in a wide variety of animals. In vertebrates several investigators have shown the occurrence of neurosecretory cells (in Echinodermata, Chel, 1966; in Annelida, Gabe, 1966; Nagabhushanam and Kulkarni, 1983; in mollusca, Highnaam and Hill, 1978). Perusal of literature reveals that the aspect of neurosecretion in bivalve molluscs has been reviewed by Gabe (1965, 1966), Lubet (1966, 1973), Martuja (1972) and Golding (1974). The development of the subject has been hampered by the presence of shell, by the defused distribution of neurosecretory cells and by the ignorance of the chemical nature of the neurohormones. Presence of neurosecretory cells has been demonstrated by classic histological studies on a number of species. There number and location has been shown to vary among species. Neurosecretory cells are located in the central ganglia. In highly evolved bivalves, neurosecretory cells are less numbers and more localized. Their location in the central ganglia has been reported by Lubet (1955, 1959); Nagabhushanam (1963, 1969), Nagabhushanam and Mane (1973) and Mane (1986). A close relationship between neurosecretion and sexual cycle in Mytilus and Chlamys (Lubet, 1956). Dreissena polymarpha (Fahrmann, 1961), Crassostrea virginica (Nagabhushanam, 1963), Katelysia opima (Nagabhushanam and Mane, 1973), Crassostrea gryphoides (Mane and Nagabhushanam, 1976) and Mytilus viridis (Mane, 1986) has been established. Among almost all the above investigators have shown that the neurosecretory cells from the cerebral ganglia reveal a close relationship in their secretory activity with the maturation and release of gametes from gonads. However, further studies carried out by Herlin Houtteville and Lubet (1974), Lubet et al., (1976) Whittle et al.
(1983), Kulkarni, (1987), Rao (1988) and Vedpathak (1989), suggested that both cerebral and visceral ganglia in bivalves are responsible in the regulation of breakdown of reserve material and gametes maturations. These authors attributed this to the role of neurosecretion from these ganglia. Comparatively very little work has been done on the role of neurosecretion in reproduction of the freshwater species from India (Kulkarni, 1987, and Rao, 1988).

Many commercially important bivalve molluscs occurring in freshwater and marine environment have to face periodic fluctuations in the environments which make specific demand on the animal present. It is sometimes supposed that changes in the environmental condition may be essential to organisms. Moreover, it is known that an animal may survive certain discomforts, if only they are followed by a period in which it can recover. This well-known phenomenon may be caused by a certain passive reproduction of the environmental effects in their internal condition of the animals, especially with fluctuations in the temperature and salinity. Hence, intelligent management of these bivalves requires knowledge of effect of naturally occurring environmental stress. Such information is also necessary for effective management of future commercial ponds and hatcheries.

The existence of freshwater mussels along the banks of Girna river at Jamda, Dist. Jalgaon, Maharashtra State provided to an opportunity to study some of the effects of temperature, pH change as well as oxygen tension desiccation. The dam has been constructed on the Girna river at Jamda Dist. Jalgaon and there is an irregular flow towards the down streams. This causes the exposure of mussel beds and unfavorable environment exists particularly in summer season.
Considering these situations, in the presence study it has been planned to find out the effects of rise in temperature, changes in pH, exposed to the atmospheric air and oxygen tension on the survival and behavior, respiration, excretion biochemical divergence, reproduction and neurosecretion from the central ganglia in different seasons.