INTRODUCTION

Bivalves are filter the phytoplankton, bacteria and particulate organic matter from the water column. Corbicula and Sphaerids also remove organic matter from the sediments by deposit feeding, as many some Unionids. Filtration rate are varies with bivalves species and size, temperature, particle size and concentration and flow regime.

Bivalves affect nutrient dynamics in freshwater systems, through excretion as well as biodeposition of faeces and pseudofaeces. Excretion rates are both size and species dependent, are influenced by reproductive stage and vary greatly with temperature and food availability.

Bioturbation of sediments through bivalve movements increase sediments and oxygen content in the water and release nutrients from the sediments to the water column. The physical presence of bivalve shells creates habitat for epiphytic and epizoic organisms and stabilizes sediments and provides refugia for benthic fauna. Biodeposition of faeces and pseudofaeces can alter the composition of benthic communities.

One or more functional groups often play central roles in ecosystem processes (Tilman et al., 1997). In some marine and freshwater systems, bivalves mollusks are dominant filter-feeders
that make up most of the biomass and exert control over ecosystem structure and function (Damme, 1996; Strayer, 1990).

Understanding the role of freshwater mussels in stream systems is important because those nutrients released via excretion have been converted from particulate matter to a soluble from that is usable by primary producers (Nalepa et al., 1991, Arnott and Vanni 1996). In addition, pseudofaeces and faeces are available to other organism such as invertebrate deposit feeders (Nalepa et al., 1991). Thus, feeding activities of Unionids results in alteration of the quantity and quality of nutrients in stream ecosystem.

Nitrogen (N) and Phosphorus (P) are of particular interest in lotic water habitat due to their roles as limiting nutrients for primary production (Rosemond 1993, Mulholland et al., 1995). Nitrogen and Phosphors excreted by molluscs are present in the forms of ammonium \( (\text{NH}_4^+ - \text{N}) \) and Phosphate \( (\text{PO}_4^{3-} - \text{P}) \). We propose that the amount of ammonium and phosphate excreted by Unionids may serve as significant source of N and P to local primary producers.

Historical, physiological ecology of freshwater bivalves is based on taxonomy with notes on habitat, community composition, abundance and distribution. On the basis of life cycles, growth, reproduction, population dynamics and energetic (Burky, 1983),
modern physiological ecology of freshwater bivalves has more recently involved both field and laboratory studies.

Recently, a large body of research has focused on the functional effects of epifaunal Zebra mussels *Dreissena polymorpha* (Pallas, 1971) in freshwater systems (Ramussen and mills, 1995; MacIsaac, 1996; Caraco et al., 1997; Strayer et al., 1999).

Biological literature records many values of oxygen consumption by various aquatic invertebrates under the influence of various environmental conditions such as temperature, salinity, pH, carbon dioxide, oxygen tension, etc (Davis, 1975). Rate of oxygen consumption in these animals is also influenced by activity, body size, stage in the life cycle and time of day, as well as by previous oxygen experience genetic background (Prosser, 1973).

Indeed, a consideration knowledge is available on the interaction of oxygen availability, oxygen uptake and ventilation rates for many freshwater, marine and estuarine organism.

An excellent description on metabolic pathway, their evolution and relationship to the oxygen availability can be found in the details given by Hochachka and Somero (1973). Davis (1975) reviewed minimum dissolved oxygen requirement of aquatic life. Bodies of freshwater often show large variations in the
dissolved oxygen, both seasonally and geographically. This point was celebrated by Akarte (1985), Muley (1985), Muley (1988) and Vedpathak (1989) while working on the freshwater bivalves from Godavari river at Paithan near Aurangabad.

The Physiological-ecology and energy metabolism, during the reproduction in Lamellibranch molluscs have been studied by many investigations and reviewed by Bayne (1976), Sastry (1979), Hochachaka (1983) and Russel Hunter (1983). Bayne (1983) stated that the physiological ecology of bivalves can given an insight on adaptation of animal to function in its particular environment. Oxygen consumption can be considered for undertaking the physiological adaptation of the species in a given habitat.

In general, the rate of oxygen consumption in many species of bivalve molluscs has been found to vary with changes virtually by environmental variables.

In this respect many workers have given emphasis to the relation between respiration and size and sex of the animal, level of ration, effects of temperature and salinity, exposure to atmospheric air, oxygen tension and seasonal variations (Bayne, 1976). Mussels and oysters were the main targets of the earlier studies (Schlieper, 1957, Moon and Pritchard, 1970). Per Famme (1980)
demonstrated relation between oxygen consumption and body weight in unfed and starved *Mytilus edulis*. Slatina (1991) studied the daily rhythms of oxygen consumption in the *Mytilus galloprovincialis*. According to the another, oxygen consumption is dependent on various environmental factors and endogenous regulation of reproduction are main synchronizers of the rhythm. Correlation between seasonal pattern of respiration and the cycle of gametogenesis, storage and utilization of nutrient reserves was also made by a few workers (Bayne and Thompson, 1970; Widdows and Bayne, 1971 and Bayne 1973).

The studies provided information on respiratory variation for field adopted bivalves during one season and estimation of other seasonal levels of metabolism forms a limited data. Among the Indian freshwater bivalves, the respiration of *Parreysia corrugata* (Lomte and Nagbhushanam, 1971); *Indonaia caeruleus* Khatib (1975) and Vedpathak (1989) have been studied to understand the effect of several environmental factors. Arkate (1985), Muley (1985), Muley (1988) Kulkarni (1993) and Patil (1993) made an attempt to understand the seasonal variation in the respiration of freshwater bivalves, *Lamellidens corrianus*, *Lamellidens marginalis* and *Indonaia caeruleus* exposed and unexposed to pollutants.
The study of Pandit (2005) and Mahale (2009) on *Lamellidens marginalis* and Ghodke (2007) on *Indonaia caeruleus* from lotic environment exist, which gives some information on the fortnight variations in the rate of oxygen consumption, which can be correlated with external and internal recurring factors. In addition, there exists paucity of information on the seasonal respiratory rates of freshwater bivalves from permanent flowing water environments of Maharashtra State.

Most of the aquatic organism can utilize several metabolic pathways as a mean of obtaining energy. These processes can be aerobic or anaerobic. Anaerobic processes yield energy in the absence of oxygen. Gill ciliary activity and the rate of heart beat were also shown to be very important factors while determining the rate of respiration in bivalve molluscs (Muley, 1988). It has been shown that the cilia of gills in bivalves are responsible for producing water current, through the water current they contribute to exchange and the removal of waste products. They also trap and transported food particles suspended in water. Their proper functioning is clearly essential to all aspects of metabolism.

There is an extensive literature on the physiology of the bivalve circulatory system and the major reviews are those of Krijman and Davis (1955), Hill and Welsh (1966) and Jones
(1983). The heart of bivalves consist of a pair of lateral auricles opens into a single median ventricle. The ventricle surrounds the rectum, one posteriorly and one anteriorly. Blood flowing in the body is oxygenated in the gills 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).

A large body of information has been accumulated in the rate of oxygen consumption of bivalve mollusks related to the fluctuations in the environmental parameters (Mane, 1975). However changes in the rate oxygen consumption during different seasons was shown by Arkate (1985), Muley (1985), Muley (1988), Vedpathak (1989), and Salve (2007) correlated with biochemical constituents from different body parts as well as with the gonad development.

Variations in oxygen consumption with external conditions have been worked out by investigators, such as temperature (Rao and Bullock, 1954; Newell and Pye, 1971), nutritional conditions (Newell et al., 1972; Marsden et al., 1973; Newell, 1973) and weather measurements and are made in air or in water (Toulmond, 1967). The subject of thermal compensation in poikilotherms has been reviewed by Bullock (1955), and Prosser (1955). The general
concept of thermal 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 physiological compensation. The subject has been nicely explained by Prosser and Brown (1961) and Bayne (1976). Metabolism in poikilotherms usually increases with increasing temperature and acclimation to seasonal temperature variation, seasonal changes in food availability and reproductive status may all influence respiration (Krough, 1941; Bullock, 1955 and Newell, 1957).

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 walkari*, Hornbach (1980) and Hornbach et al. (1983) on *Sphaerium striatium*, Alexander (1982) and Alexander and Burt (1982) on *Musculium lacustrae* provide comprehensive information on life cycle and habitat characteristic coupled with respiratory physiology. Apart from these studies several other investigators have worked out the aspects of respiration on many other freshwater species (Segal, 1961; Berg et al., 1962; Berg and

Amongst the Indian freshwater bivalves, the respiration of Parreysia corrugata (Lohagaonkar, 1974); Indonaia caeruleus (Khatib, 1975) and Vedpathak, (1989) have been studied to understand 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 bivalves, Lamellidens corrianus, Lamellidens marginalis and Indonaia caeruleus exposed and unexposed to pollutants. Similarly, Kulkarni (1987) on Indonaia caeruleus, 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 oxygen consumption of these animals.

Many authors have showed that ammonia is general is a major nitrogenous excretory product of bivalves and there occurs a profound difference in loss of nitrogen between different sizes and seasons (Bishop et al.,1983). This indicate shifts in physiological capacity with change in temperature, seasons and reproductive cycle that affects the nitrogen economy and the metabolism rate in somewhat disperate fashions.
The O : N ratio is an index of protein utilization in energy metabolism. A few investigators also demonstrated the probable role of ammonia in the settlement of larvae of the different bivalves. Bayne and Scullard (1977) stated that in bivalve molluscs the relationship between ammonia excretion rates and body size can be variable due to a disproportionate reliance of protein catabolism for energy production by small individuals and O : N ratio was shown to vary considerably with the in complex interaction with the season, temperature and ration in *Mytilus edulis*.

Marine bivalves both translocate (Feed and Pump back out) and transform (change the chemical form) nutrients (Kuenzler, 1961), and this is undoubtly also the case for freshwater bivalves. Freshwater bivalves produce a hypo-osmotic urine consisting primarily of ammonia (Burton, 1983). Excretion rate varies between species of bivalves, as well as with individual size, temperature, stage in reproductive cycle and food availability (Potts, 1954; Dietz, 1985; James, 1987; Lauritsen and Mozley, 1989; Williams and McMohan, 1989; Nalepa, 1999, Malczyk, 1991; Christian and Berg 2000). Seasonal variation with spawning may be especially important, given that *corbicula* showed a 20-40 fold increase in excretion with spawning (Williams
and McMohan, 1989). In marine bivalves, excretion rate increases with individual biomass; however, the rate of excretion per unit biomass decreases an an invidual grows larger (Burton, 1983; Dame, 1996).

Bivalves are important cycles of nitrogen in coastal marine system releasing ammonium and dissolved organic nitrogen that can be taken up directly by phytoplankton (Dame, 1996). Several recent freshwater studies have concluded that excretory products from bivalves should be an important and readily usable resource for phytoplankton (James, 1987; Lauritsen and Mozley, 1989) and presumably the benthic algal community. Christian and Berg (2000) and Davis et al. (2000) compared seasonal nitrogen and phosphorus cycling by three unionid species in two streams. Prior studies indicated that nutrients were limiting in both systems, so any nutrients contributed by the bivalves should be useful biologically. They found that excretion rates varied seasonally.

We know little how burrowing bivalves influence phosphorus cycling. In contrast, epifaunal, bivalves (*Dreissena*) have known to be important for nutrients cycling in unproductive European lakes (Stanczykowska, 1984) as well as in lake Erie (Arnott and Vanni, 1996). On a basin-wise scale, phosphorus recycling by Zebra mussels, (*Dreissena polymorpha*) may be
sufficient to shift the phytoplankton community structure towards nitrogen limited cyanobacteria. Whether the excretion by burrowing bivalves can cause similar shifts is unknown. For freshwater bivalves, these paucity of information and scattered data indicated little work on Indian freshwater bivalve molluscs. Therefore, the present study was undertaken on Parreysia cylindrica.

In aquatic animals, regulations of the chemical composition of the body fluid an important function of ionic and osmotic regulation and of excretion which helps in the elimination of wastes and the conservation of useful metabolites for growth, maintenance and reproduction. In bivalve mollusks, several workers have studied nitrogenous excretory products and their reports show that although ammonia is the dominant product, large amounts of amino-nitrogen are lost and there is small but significant amount of urea also excreted by some species (Bayne, 1976). Rate of nitrogen excretion by bivalve molluscs are extremely variable, which is not surprising in view of the marked seasonal changes in nutrient storage and utilization of reserves (Bayne, 1976). However, very few workers attempted to understand the factors influencing the rate of excretion, despite the
voluminous literature on rate of oxygen uptake in relation to the environment (Bayne, 1976).

The changes in the relationship between excretion rate and body size may be explained in part by seasonal changes in the synthesis and utilization of nitrogenous compound as substrates for energy metabolism. According to Ganzalo and Cancino (1988) oxygen consumption and ammonia excretion of the bivalve *Guimordia bahamondei* is a function of body weight. The rate of oxygen consumption and ammonia excretion showed linear correlation relationship with body weight. Seasonal changes in oxygen uptake and ammonia excretion in the gastropod, *Concholepas concholepas* reported by Navarro and Torrijos (1994). Oxygen uptake was mainly depended on reproductive condition during summer but ammonia excretion was maximum during spring.

Proteins ingested through food are hydrolyzed in the digestive system to their constitutive amino acids by proteolytic enzymes. These amino acids are then accumulated for carbon and nitrogen catabolism. A number of investigators have studied nitrogen excretion of molluscs. It is clear from their study that the size (Jonannes, 1964), physiological state (Widdows and Bayne, 1971) or environment of the organism (Feng et al., 1970) can affect nitrogen excretion.
It is evident that the energy content of excreta comprises a significant component of total energy loss. The nitrogenous excreta, a major component in excretory loss, could be more readily estimated. The composition of this component varies between species as a result of environmental condition. But in most marine molluscs, ammonia is assumed to be the dominant end product of protein catabolism. Review of literature reveals paucity of information on O : N ratio of bivalve molluscs from India. Howkins et al. (1986) reported O : N ratio of *Perna viridis* and *Perna indica* from Cochin waters where impact of entrophication is pronounced.

Mathew and Menon (1993) reported heavy metal stress induced variation in O : N ratio in *Perna indica* and *Donax incarnates*. Recently, Nagwanshi (1996) and Dhakane (2005) reported O : N ratio of freshwater mussels *Lamellidens corrianus* and *Lamellidens marginalis* while Yennawar (1997) determined this ratio in oyster *Crassostrea cucullata* from Maharashtra coast. In view of the paucity of information on O : N ratio from this area, a study was undertaken on different size groups of this species of bivalves from Girna river at Jamda in district Jalgaon.

In invertebrates changes in the biochemical constituents are pronounced and 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 advert or departure of the reproductive period (Lambert and Dehnel, 1974).

Due to the commercial importance and edibility value of number of species of bivalve molluscs, the aspect of energy metabolism has been reported by number of workers but the relative influence of gonad development on the distribution and storage of biochemical constituent in different body has been examined only a few cases (Sastry, 1979; Giese, 1969; Gabbott, 1975, 1976; Bayne, 1976 and DeZwaan, 1983) have reviewed most of the work on biochemical changes in bivalves molluscs particularly with reference to the carbohydrates. A review of lipids in marine invertebrates including bivalves is given by Giese (1966), Lawrence (1976) and Voogt (1983). Aminoacid metabolism and molecular biomechanics of proteins have been reviewed by Bishop et al. (1983) and Shawdwick and Gosline (1983).

Seasonal variations in biochemical constituents has been studied by many investigators in both marine and freshwater bivalves (Fatima et al., 1986) in *Perna viridis*; Thomson and Medonald, (1990) in *Placopecten Magillariaeus*; Traumen and

Seasonal variations in the biochemical composition of Mytilus edulis in British waters have been reported by Williams (1969) and Bayne and Thompson (1970). Seasonal changes in biochemical composition have been reported for Mytilus edulis DeZwaan and Zandee, (1972); Gabbott and Bayne, (1973). 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) tissue of Mytilus edulis. In Mytilus edulis the mantle serves as a site of storage of nutrients and gamete production. From Indian relatively very few investigators such as Durve and Bal (1961) on Martesia striata, Nagabhushanam and Mane (1975,1978) on Katelysia optima and Mytilus viridis, Bidarkar (1975) on Crassostrea cucullata, Dhamme (1975) on Paphia laterisulca have reported changes in the biochemical composition correlating 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) on
Katelysia opima and Mane and Nagabhushanam (1975) on Mytilus viridis. Freshwater bivalves from Indian freshwater system have received little attention in the field of biochemical energetic during reproduction. Lipid composition in different tissue have been reported Trumen and Pekkarinen, (1990) in Macoma balthica, Keith et al., (1993) in Mytilus edulis, chambered nautilus, Nautilus pampilus and Heliotis rufercens.

Romonova et al. 1993 determined biochemical indices from molluscs (Mytilus galloprovianalis) and related it with age, weight and size.

Changes in the biochemical contents are shown to depend on environmental conditions and utilization of these reserves during the gametogenic cycle and maturation of the animals. Soniat and Ray (1985) reported that availability of food material is an important factor for the composition of reserve material and reproduction in Crossostrea virginica. The authors also showed that metabolism of protein and nucleic acids in the tissue of marine molluscs are influenced by changes in salinity. Zwarts (1991) has shown the higher weight when the animals were inactive. Gimeno and Carman (1990) detected carbohydrates and protein from the gonad, in Ruditapes philipinorum and also detected. Isolation and
separation of fatty acids profile from the digestive glands and mantle tissue.

The proteins are versatile, complex and fragile macromolecules with high molecular weights. They not only serve as fuel to yield energy but also play a vital role in every aspect of the structural and functional characteristics of the organism because they are the major essential constituents of the protoplasm and are extremely complex nitrogen containing macromolecules forming the physical basis of life. They occupy a unique position in the cellular metabolism and are highly specific to each tissue. These biopolymers play an important role in nearly all biological processes as structural components, of receptors, help in transport, storage, mechanical support, control of growth, differentiation, act as buffer in the internal miles and also exhibit osmotic properties. They also act as catalyst (enzymes), regulators (hormones) and repositories of genetic information. The unique role of these biological macromolecules can lead to changes in physiological functions of the metabolically important toxicological studies, for overall homeostasis, since it determines whether there is net uptake or release of amino acids by the tissues. The ranges of function medicated by proteins resulted from diversity and versatility of amino acids.
Glycogen is the chief carbohydrates of the tissue just as glucose in the blood and other body fluids. Glycogen as reserve or storage carbohydrate is reversibly converted to blood glucose and normally serves to maintain blood sugar level, when supply of carbohydrates from intestinal absorption is in adequate. Glycogen synthesis and break down appear to occupy a central position being controlled by extrinsic and entrinsic factors thereby altering the physiological state of the organism.

Carbohydrate serves as reservoir of the chemical energy which is to be increased or decreased according to the organismal needs. The importance of carbohydrate metabolism has been observed in a variety of physiological disorders and pathological conditions (Latner, 1975).

In recent times, investigations on the physiological and biochemical responses of the mollusks to environmental agents have been expanded significantly. Amongst the several molecules available in the cells, carbohydrates play an important role in the cellular processes. Metabolic pathways of carbohydrates provide energy and essential structural and functional components to cell. Quantitative measurements of metabolites and enzymes related to carbohydrate metabolism in the tissues of animals exposed to toxicants indicate the nature of functional impairment.
Carbohydrates are the major source of energy for vital activities of the organism. Bivalves store energy in the form of glycogen (Hemelraad et al., 1990, Naimo et al., 1998). Glycogen stores fluctuate seasonally, typically ebbing during periods of gametogenesis, and decrease rapidly in response to reduced food availability and environmental stress (Williams and McMohan, 1989; Haag et al., 1993 Patterson, Parker and Neves, 1997; Naimo and Monroe, 1999; Patterson, Parker and Neves, 1991). Examining seasonal fluctuations in the glycogen content of bivalves may provide an additional explanation for the decline in North American unionid species diversity (Strayer, 1999). If low glycogen stores coincide with periods of low food availability and environmental stress (Williams and McMohan, 1989; Haag et al., 1993 Patterson, Parker and Neves, 1997 ; Naimo and Monroe, 1999; Patterson, Parker and Neves, 1991). Examining seasonal fluctuations in the glycogen content of bivalves may provide an additional explanation for the decline in North American unionid species diversity (Strayer, 1999). If low glycogen stores coincide with periods of low food availability in a stream, bivalves may have reduced tolerance for additional stresses such as competition with exotic species or reduced food availability. In a different stream where food is not limiting however, the same type of
bivalve community would appear to be much more tolerant of species invasions or human interventions. The interplay between energy storage, food availability and environmental stress may help to explain the variability in unionid, (Gardner et al., 1976; McMohan, 1991; Miller and Bayne, 1998; Strayer, 1999).

Lipids are responsible for a variety of functions in molluscs. However, there has been no systematic study of the lipids and lipid components in these organism. The information available so far for lipids related to distribution of lipids and their physio-chemical properties such as melting point, degree of unsaturation and optical rotation. The lipid synthesis and the translocation of different lipid fractions from one part of the cell to the other part play a major role in the sense that lipids are an integral part of the cellular membrane structure. Any particular stress, (environmental or pesticidal) bound to change the course of events associated with the lipid synthesis and its translocation in the membrane structure. Apart from its structural role, lipid contributes to the energy production in metabolic exigencies as they have very high calorific value. They also contribute towards energy synthesis as an alternative to the carbohydrate (Guotan, 1981, Harper, 1983), act as insulators and as a reserve source of energy (Oser, 1979).
Ramana Rao and Ramamurthi (1980) reported changes in total lipids under Sumithion stress in snails. Swami et al., (1983) studied the change in total lipids, triglycerides, cholesterol, phospholipids and other lipid fractions under Meracid stress in freshwater mussel Lamellidens marginalis.

From India relatively a few investigators such as Nagabhushanam and Mane (1975,1978) on Katelysia opima and Mytilus viridis and Bidarkar (1975) on Paphia laterisulca have reported changes in the biochemical composition correlating with reproductive cycle of the bivalves. Many workers have also studied changes in the biochemical constituents of freshwater bivalves due to pollutional stress, including heavy metals, Akarte (1985), Patil (1993), Gokhale (1995) while Muley (1988) and Vedpathak (1989) observed fortnightly and monthly changes in biochemical composition.

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, 1978) and very brief description on reproduction in freshwater species is given by Purchon (1977) and Muckie (1984). Anatomy of the reproductive sytem and functional significance have been described in a number of bivalve molluscs in Thysira flexuosa (Bernard, 1972);
Musculista Senhausia; (Morton, 1974); Patro and Amonia, (Yonge, 1977, 1980), Chiane cancillata (Jones, 1979). Mackie (1984) briefly reviewed the anatomy of the reproductive system and functional significance. He stated that male and female of gonochoristic bivalves possess paired gonads, located near or adjacent to the digestive gland. Often two glands are so close together that the paired condition is difficult to detect (in fresh water bivalves). In many molluscs long reproductive ducts are convey the gametes to outside. However, in bivalves the gonad is in such proximity to the gonopore that the reproductive system closely associated with the digestive system. In dioecious lamellibranchs, the gonad commonly occurs among the intestinal loops in the base of the foot. In most of the freshwater unionidae, it intertwined among the stomach, intestine, and the digestive gland, as in sexicavaceans. Accessory sexual organs are actually not present in gonochoristic bivalves. However, some structures of other organ systems are modified to serve as accessory reproductive organs. The most conspicuous of those are the Enulamellibranchs which serve as marsupia in freshwater unionid and margaritiferid clams. The female of Anodonta species have tripartite organization of water tubes and septa in the outer demibranchs, which creates ovisacs for brooding glochidia (Heard,
Accessory sexual organs in bivalves have been described by Purchon (1941) and Smith (1979). The simplest system consists of one pair of gonad connected along the midline and one pair of short gonoduct that empty into the kidney or the suprabranchial chamber. Coe (1945) reported 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 a ventral opening.

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. Gametogenesis begins shortly after growth and maturation of the gonad. Maturation of gamete is under the control of several environmental factors such as temperature, lunar periodicity, depth, mechanical factors, light intensity and few others and endogenous factors such as genetic and hormonal control (Mackie, 1984). The maturation of gonads is also depends up on the richness of food supply which inturn are dependent on climate. Thus, among these, exogenous factors, the food, also act as environmental clue and synchronizer in regulation of reproductive activities (Giese and Pearse, 1974). The seasonal changes in temperature and illumination, affect the reproduction.
The increase in the foots apply and general metabolism in spring and the period of early summer will inevitably impose a limited peak and breeding activity. In this process there may be two contrasted features. Firstly, a period of increasing metabolic activity with growth and maturation of gonads and secondly, there may be some trigger mechanism, which is sometime a threshold temperature, which initiates the act of spawning. Gametogenesis in bivalve has been reported by many investigators on *Mercenaria Mercenaria* and *Cyprina islandica* (Loosanoff, 1937, 1953), *Pinctada* species (Tranter, 1959), *Mytilus edulis, Chlamys varia* and *Pecten maximus* (Lubet, 1959), *Argopecten irradians* (Sastry, 1963, 1966, 1968, 1970), *Placopecten magellancus* (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 resting period (Giese, 1959, 1976; Giese and Pierce, 1974; Sastry, 1966, 1975). Reproduction in bivalves 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 phase, functioning continuously in co-ordination with seasonal environmental changes, produce a pattern characteristic of a species (Sastry, 1979). As stated earlier,
the timing and duration of reproductive activity may be determined through an interaction between endogenous and exogenous factors. Geese (1959) described the method for determining the annual reproductive cycle for marine invertebrates, and criteria for determining the breeding season of an animal is used for spawning, numbers of larvae, the appearance of ripe gametes in gonads, brooding of eggs and relative size of gonad. Dinamani (1987), while studying the gametogenic pattern in populations of oyster, *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 gonad in the different part of the year on *Donax cuneatus*, (Rao, 1967); *Donax faba*, (Algaraswami, 1966), *Katelysia opima* and *mytilus (perna ) viridis*, (Nagabhushanam and Mane, 1975); *Crassostrea madrasensis* (Joseph, 1979; Joseph and Madhyastha, 1981, 1984); *Perna viridis* (Ramchandran, 1980, Roy, 1984). Comparatively a very few species from freshwater habitats are being studied, *Parreysia faridens*, (Patil and Bal, 1962); *Parreysia corruggata* (Lomte and Nagbhushanam, 1969); and *Lamellidens marginalis* (Ghosh and Ghose 1972). These workers studied the reproductive cycle of fresh water species by collecting monthly
samples of the animals and employed a classic histological technique.

In bivalve molluscs, the digestive diverticula comprises a series of blind ending tubules that communicate with the stomach via system of ducts (Nakazima, 1956). Generally speaking it accepted that in most bivalves being that digestive diverticula function primarily as an organ of absorption and intra-cellular digestion. A secretary function has also been postulated but this may reflect no more than passage into the stomach of unused enzymes from the intracellular digestive cycle. Bielefeld (1991) histologically observed the digestive gland of starved bivalves from two different depths.

The digestive tubules comprises a number of possible cell types and many authors have discussed only two general cell types. Morton (1969) suggested that these cells may at certain times, be responsible for the production of new tubules. There is a general agreement that the digestive cells of the tubules are primarily organ of endocytic absorption and intracellular digestion.

Many authors have described (As in Tridacna), the presence of digestive cells, pyramidal basophilic cells, flagellated cells and smaller stem cells, which does not extent to the lumen of the tubule and ultimately give rise to the flagellate cells and the pyramidal
cells. Some authors believed that pyramidal basophilic cells which comprise mature secretory cells to comprise mature secretory cells other believed that it remain a possible source of digestive cells replacement.

In the view of the general agreement that various cell types in the digestive tubules of bivalve molluscs do undergo a pattern of cytological and structural changes in accordance with a rhythm of environment (Saokar, 1994; Dakane, 2005 and Salve, 2007). It was felt essential to know as to how these changes can be correlated with day-night cycle in different seasons.

To extend the knowledge in this field of eco-physiology, the present work has been undertaken on the freshwater bivalve shell fish, *Parreysia cylindrica*, This species is abundantly occurred throughout the year along the banks of Girna river at Jamda, district Jalgaon, hence it is used in the present work.

The tubules, generally consists of digestive cell and secretary cell. The primary tubules in the *Parreysia cylindrica* showed synchronized pattern such as fragmentation of spherules, holding phase absorption phase, according to changes in water level over the animal bed, rainfall, oxygen content and probable changes in the detritus matter (i.e. food availability) on the habitat. Tubules consist of two type of cell (a) digestive cell and (b) secretary cell.
Amoebocytes are found scattered in the interlobular connective tissues. During monsoon tubules were in fragmentation spherules phase. The tubule progressed in holding and absorption phase from late monsoon to winter season. The absorption phase in the tubule was found dominant during winter which probably indicated lees availability of food.

been studied by Moore (1991). The studies on the rhythmic changes in the digestive tubule in accordance with the environment of marine bivalve molluscs have been carried out by many workers (Morton, 1971, 1975 and Lowen and Clarke 1989). Similar studies on freshwater bivalves are comparatively less (Morton, 1973, Akarte 1985, and Saoikar, 1994). Recently, Salve (2007) studied the pattern of cytological and structural changes accordance with a rhythm of environmental fluctuation in the freshwater bivalve *Indonaia caerulea*.

In the view of paucity of information, it was essential to know the histological changes in the digestive tubules of *Parryesia cylindrica* from Girna river at Jamda district Jalgaon, hence the present study was undertaken.