

ABOUT THE BOOK

The present book entitled 'Reviews in Aquatic Sciences' comprises chapters by well-known Indian experts and research workers in their respective fields. With its application oriented and interdisciplinary approach, we hope that the students, teachers, researchers, scientists, policy makers and environmental lawyers in India and abroad will find this volume much more useful.

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AQUATIC SCIENCES

Reviews in

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Dr. V.B. Sakhare • Dr. B. Vasanthkumar
Dr. A. D. Chalak • Dr. S.S. Jadhav

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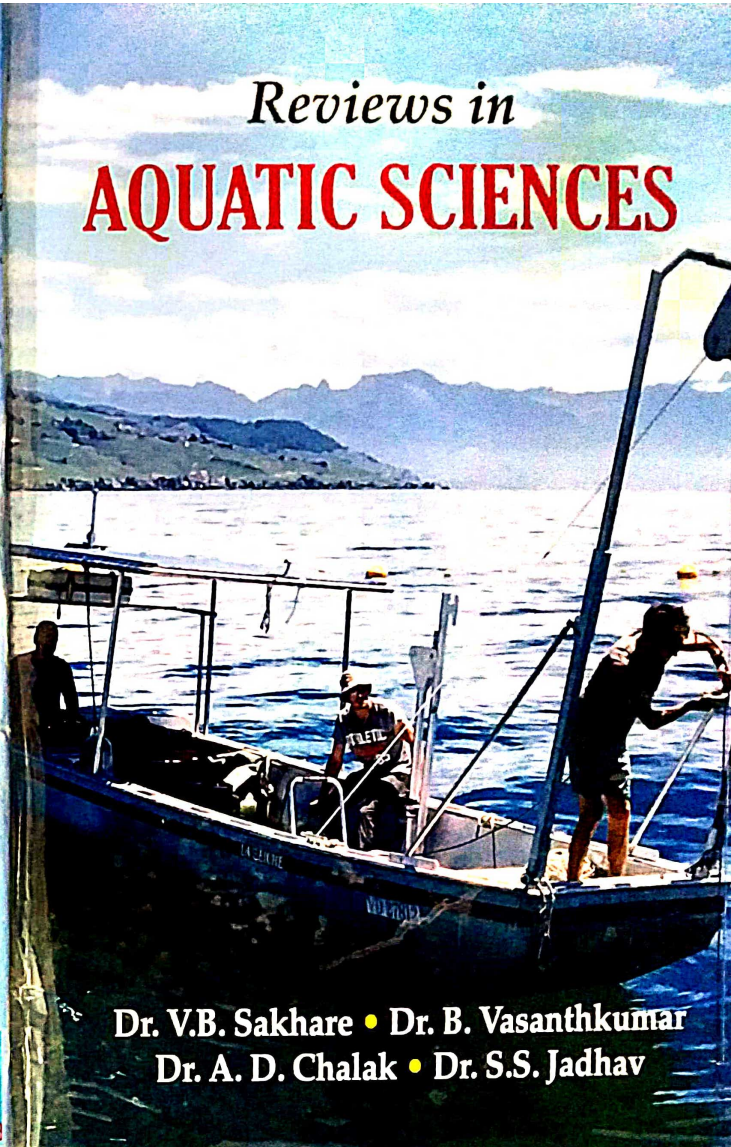
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Chapter-7

Study of Ecological Biodiversity and Screening of Freshwater Bivalves From Different Habitats of Marathwada Region

-S. D. Gulbhile

ABSTRACT

Different habitats, like water reservoirs and rivers from the Marathwada Region were surveyed for ecological biodiversity of bivalves. It has been observed that there are four major species as *Parreysia corrugate*, *Indonaia caeruleus*, *Lamellidens corrianus* and *Lamellidens marginalis* available in the water of Marathwada Region. Beside these species, there is a species of Corbiculid, the *Corbicula regularis* which is very rare and it being small is not useful for the food value and its shell is also not nacreous, therefore it is not important for the aquaculture. The details of the surveyed places and the availability of the bivalve species in different habitats are accounted and their ecological biodiversity was studied and the data was prepared.

After survey of Freshwater bivalves were collected from different localities of Marathwada region. Species i.e. *Parreysia corrugate*, *Indonaia caeruleus*, *Lamellidens corrianus* and *Lamellidens marginalis* were identified for screening. Their gonads were screened for the determination of the sex by taking the smear from different regions and the data was prepared to study the sex composition. *Parreysia corrugate*, *Indonaia caeruleus*, *Lamellidens corrianus* and *Lamellidens marginalis* after screening for the sex showed males, females and few hermaphrodites.

After screening of sex composition of *Lamellidens corrianus* and *Lamellidens marginalis*, Variations in the food value with respect to lipid contents among various sexes from lentic and lotic environment were studied from dry powders of gonads and whole body by estimating lipid contents using the method of Barnes and Blackstock (1973). All details are discussed systematically in this research paper.

Key Words: Ecological Biodiversity, Bivalves, Different Habitats, Marathwada.

INTRODUCTION

Bivalves as food, a baits for fishing, their shells as materials for preparation of toy, ornaments, utility articles, lime, cement and paint and for pearl production have immense importance. A stage based matrix model for cultivated mussels in PES blue mussel cultivation on Princes Edward Island is a major industry to earn 35 to 40 million dollars annually and employing about 1500 people. The artificial techniques have been developed for pearl culture in freshwater bivalves.

Diverse ways of reproductive strategies have come into existence in bivalves as adaptations to the environment. Primitive mollusks were dioecious and the unprotected gametes and charged in the seawater. The adults were limited to produce and release gametes and no parental care was taken. In the latter phase of evolution, brooding of eggs in the brood pouches of gills, as a strategy for parental care was evolved. Hermaphroditism was also evolved as an adaption for better reproduction.

Molluscs

Molluscs are coelomate animals which have an unsegmented body. These soft and delicate animals are enclosed in a calcareous shell. The shell is never thrown off as in Arthropods and it grows as the animal develops with the addition of calcium material. There is no internal shell in freshwater forms which is found in some marine specimens. External shell may be univalve or bivalve. The visceral organs are enclosed in the mantle cavity formed by the flaps of soft skin. The shell is secreted by this soft epidermis. The visceral organs include digestive, nervous, respiratory, circulatory, excretory and reproductive systems. Respiration occurs with the help of gills but the whole body surface can also helps in oxygen uptake especially in Pulmonata. The mollusks are found, almost in all freshwater habitats.

Very often they are found crawling on the bottom with their well developed protractible foot drawn out of the shell. Molluscs feed on decaying organic matters. Many larger animals feed on molluscs as revealed by the stomach contents of their predators. The molluscs can survive in drought periods also, by burrowing into mud and aestivating during the adverse environmental conditions.

Pelecypoda (Bivalvia)

Almost all the bivalves are aquatic and great majority of freshwater forms occur in the shallow banks of rivers. The size of the animal from 2 mm to 250 mm in ranges is occurring. The headless soft body of the animal is enclosed in the shell which has two valves as the name implies. These two valves are hinged together dorsally. The two valves have scars of the two transverse adductor muscles which help in the concentration of the valves. The valves are opened by the spring like ligament on the dorsal side of the valves. The hinge is provided with small teeth which keep the valves in juxtaposition. Arrangement of teeth is also used in classification. The raised area of the dorsal side is the point of growth from the juvenile stage. The shell is variously shaped and colored.

Projecting out of the shell is a hatchet or axe shaped muscular foot (Poda-Foot). The retraction and contraction of muscles make the movements of the foot. The active specimens are generally the thin shelled ones then the ones with heavy shells. The two lobes of the mantle are attached to the valves by means of small muscles.

The animal is exposed after removing one valve of the shell and shows three openings. The anal and bronchial openings may lead into two exhalant and inhalant siphons respectively. The bivalves are filter feeders and are always found in the regions where the water is available throughout the year. It therefore makes very difficult to collect the animals when they reaches at the depth as much as fifty feet due to the increase of the water level of the reservoir during rainy season. The rivers may not have flowing water through the year. Usually the river areas in which the water is released for the agriculture and drinking purpose from the dams have running water for most of the year. The rivers in such regions may not have flowing water throughout the year and in such situation the ponds and ditches in the basin of the river has these fauna.

According to Coe (1943), about 96 % of the Pelecypods are dioecious while only 4% are monoecious or hermaphrodites, the details of reproduction in freshwater species are given by Purchon (1968) and Mackie (1984). Different phases of reproduction such as proliferation, maturation, spawning, fertilization and development are coordinated with environmental variations and are species specific (Sastry, 1979). Some hermaphrodite bivalves like *Thoracica* and *Pandora* etc. are functionally ambisexual. Hermaphroditism is an adaptation for reproduction, when chances of fertilization of eggs are less, due to less availability of male gametes.

The unlimited aim of living organism is reproduction and hence maximum biochemicals are channelised to gonads as per the stage of reproduction. Some biochemicals are utilized for growth and some for respiration to produce energy for metabolic and vital activities. Excess of absorbed food materials are deposited in tissues which are utilized during scarcity of

food or high demand of energy. It therefore reflects on the biochemical composition of different parts of organism. Many of the molluscs being the source of food to man are studied in respect to their seasonal biochemical changes. Among various classes of molluscs the nature of reserve food material is variable. One can therefore classify molluscs depending on the type of stored material. Lamellibranches may be considered to be polysaccharide oriented (Martin and Goddard, 1966) and amphineurons lipid oriented (Giese, 1966) while cephalopods do not preferentially accumulate nutrients (Chaige, 1933; Giese, 1959).

Mudkhede (1974) studied seasonal changes in whole body of *Corbicula reticularis*. Jadhav and Lomte (1982) and Mule (1988) made extensive work on seasonal variations in biochemical composition of different organs of *Lamellidens corrianus*. Bayne and Thompson (1970) determined biochemical composition of mantle, gonad (germinal) and non mental (somatic) tissues of *Mytilus edulis* where mantle serve as a storage site of nutrients as well as for gamete production. Wenne and Styczynska (1987) studied biochemical composition of *Macoma balthica* while Polak et.al., (1987) made seasonal estimation of lipids in it. The paper focused on various aspects i.e. ecological biodiversity of bivalves from different habits, screening of sex and biochemical compositions of selected bivalves.

MATERIALS AND METHODS

Survey of Different Habitats of Marathwada Region

The water bodies and the areas where the availability of the water was throughout the year were surveyed. The sites at freshwater bodies for the collection of bivalves from lentic and lotic habitat in Marathwada region were confirmed. Bivalves were collected from different lentic and lotic localities of Marathwada region as per their availability. The collected bivalves were identified as per the manual of the Zoological Survey of India and their availability in different locations was recorded.

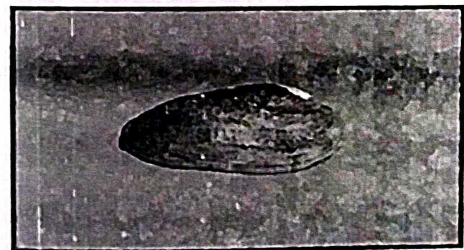
Table 1: Data of the Survey of the Lentic and Lotic Habitats and the Availability of the Bivalves in Different Habitats

Sr. No	Name of the Water Reservoir/Caption	Distance from the Aurangabad, Km.	Lentic/Lotic	Incuse-ment Period	Species of Bivalves	Remarks
1	Kagrapura Reservoir	20	Lentic	10 to 12 months	<i>Lamellidens corrianus</i> , <i>Lamellidens marginalis</i>	
2	Kalyan	30	Lentic	10 to 12 months	<i>L. marginalis</i>	
3	Mahagan Reservoir	70	Lentic	10 to 12 months	<i>Parreysia corrugata</i>	
4	Ambadi Reservoir	60	Lentic	10 to 12 months	<i>P. corrugata</i>	
5	Harsool Reservoir	05	Lentic	1 to 12 months	<i>L. marginalis</i>	
6	Jangam	15	Lentic	12 mo. to 12 months	<i>L. marginalis</i> , <i>L. corrianus</i>	
7	Nath-Sagar, Faithan	55	Lentic	12 months	<i>L. corrianus</i> , <i>L. marginalis</i> , <i>Indonesia caeruleus</i>	<i>Indonesia caeruleus</i> rare
8	Chitarpimpulgaon	18	Lentic	10 to 12 months	<i>L. marginalis</i> , <i>L. corrianus</i>	
9	Salam Ah Lake	05	Lentic	10 to 12 months	<i>L. marginalis</i> , <i>L. corrianus</i>	Both species very rare
10	Siddheshwar Dam	120	Lentic	10 to 12 months	<i>L. corrianus</i> , <i>L. marginalis</i>	
11	Yeldari Dam	260	Lentic	10 to 12 months	<i>L. corrianus</i> , <i>L. marginalis</i>	
12	Shanhar Rao Chavan Dam, Nanded	290	Lentic	10 to 12 months	<i>L. marginalis</i> , <i>Indonesia caeruleus</i> , <i>Corbicula regularis</i>	<i>I. caeruleus</i> rare
13	Nagpur Dam, Parli	270	Lentic	12 months	<i>L. corrianus</i> , <i>L. marginalis</i> , <i>Indonesia caeruleus</i>	<i>I. caeruleus</i> rare
14	Wan river Near, Nagpur, Parli	275	Lotic	10 to 12 months	<i>L. corrianus</i> , <i>L. marginalis</i> , <i>Indonesia caeruleus</i>	<i>I. caeruleus</i> rare
15	Gadavari River Near Kausan Village of Faithan	60	Lotic	10 to 12 months	<i>L. corrianus</i> , <i>L. marginalis</i> , <i>Indonesia caeruleus</i>	<i>I. caeruleus</i> rare
16	Gadavari River at Nagvena Ghat near Nanded	310	Lentic	10 to 12 months	<i>L. marginalis</i> , <i>Indonesia caeruleus</i>	<i>I. caeruleus</i> rare
17	Budisara Dam Beed	150	Lentic	10 to 12 months	<i>L. marginalis</i>	<i>I. caeruleus</i> rare

Different bivalve species were brought from different localities as per their availability to the laboratory during the first week of each month from, January 2005 to March 2005, *Parreysia corrugata*; December 2004 to January 2005, *Indonesia caeruleus*; November 2004 to October 2005, *L. corrianus*, and *L. marginalis* and were screened for sex composition. 100 specimens, each of *L. corrianus* and *L. marginalis* from lentic and lotic habitat in each month were screened. 100 bivalves of each species were divided in three groups as small, medium, and large, as per length and breadth of shell as mentioned in the table No.2 and 3. After separation of bivalves, gonads of each species were screened by taking the smear from different regions of gonads and observing in the microscope. The data has been prepared and given in the respective table. The gonads of male, female and hermaphrodite were fixed in aqueous Bouin's fluid, processed by usual microtechnique method, sectioned at 6 m thickness and serial sections were affixed on albumenized numbered slides. The sections were stained with Mallory's triple stain. The oocytes (ova) in female, sperms in male and both ova & sperms in hermaphrodites were observed. Microphotographs of histological structure as observed in different sexes of each species of bivalves are given in the photo plate No. 1, 2, 3 and 4.

Parreysia corrugata

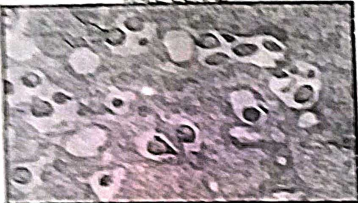
Plate No. 1





MALE GONAD

- S = Sperm
- SG = Spermatogonium
- T = Testicular follicle



FEMALE GONAD

- N = Nucleus
- NO = Nucleolus
- IM = Immature oocyte
- M = Mature oocyte



HERMAPHRODITE GONAD

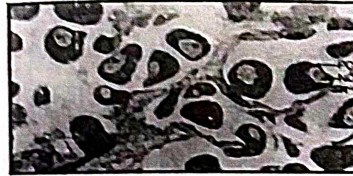
- S = Sperm
- N = Nucleus
- NO = Nucleolus
- PK = Previtellogenic oocyte
- V = Vitellogenic oocyte
- T = Testicular follicle

Indonaiia caeruleus Plate No. 2



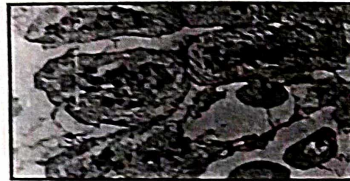
MALE GONAD

- S = Sperm
- G = Germinal Epithelium
- SG = Spermatogonium
- ST = Spermatid
- STP = Spermatid
- SC = Spermatozoite



FEMALE GONAD

- N = Nucleus
- NO = Nucleolus
- D = Degenerating oocyte
- PO = Post vitellogenic oocyte



HERMAPHRODITE GONAD

- N = Nucleus
- NO = Nucleolus
- V = Vitellogenic oocyte
- T = Testicular follicle
- SG = Spermatogonium
- IM = Immature oocyte

Lamellidens corrianus

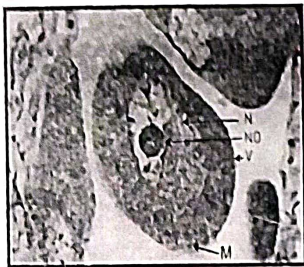
Plate No. 3





MALE GONAD

S = Sperm
SG = Spermatogonium
T = Testicular follicle



FEMALE GONAD

N = Nucleus
No = Nucleolus
M = Mature oocyte
V = vitellogenic oocyte



HERMAPHRODITE GONAD

S = Sperm
N = Nucleus
No = Nucleolus
MB = Muscle band
V = Vitellogenic oocyte
T = Testicular follicle

Lamellidens marginalis

Plate No. 4



MALE GONAD

ST = Sperm tail
SG = Spermatogonium



FEMALE GONAD

N = Nucleus
No = Nucleolus
V = Vitellogenic oocyte
D = Degenerating oocyte



HERMAPHRODITE GONAD

S = Sperm
N = Nucleus
No = Nucleolus
PO = Post vitellogenic oocyte
SG = Spermatogonium

After ecological biodiversity surveyed of Marathwada Region, It has been observed that there are four major species as *Lamellidens corrianus*, *Lamellidens marginalis*, *Parreysia corrugata* and *Indonaiia caeruleus* available in the water of Marathwada Region. After survey, two species i. e. *Lamellidens corrianus* and *Lamellidens marginalis* species were screened for further experiment. Beside these species, there is a species of Corbiculid, the *Corbicula regularis* which is very rare and it being small is not useful for the food value and its shell is also not nacreous, therefore it is not important for the aquaculture

Table 2: Percentage of Different Sexes of *L. corrianus* from the lentic and lotic habitat during November, 2004 to October, 2005. (Hundred Bivalves Screened Every Month for Each Habitat)

Sr. No.	Month and Year	Size of the bivalve	Sex			Total
			Males	Hermaphrodites	Females	
1	<i>L. corrianus</i> (Lentic habitat)	Small	198	28	162	388
		40-80 * 30-50	213	15	339	567
		Medium	108	16	121	247
		80-100 * 50-70				
		Large				
		Total	519(43.25%)	59(4.91%)	622(51.83%)	1200
2	<i>L. corrianus</i> (Lotic habitat)	Small	213	31	195	439
		40-80 * 30-50	214	22	259	495
		Medium	110	47	109	266
		80-100 * 50-70				
		Large				
		Total	537(44.75%)	100(8.33%)	563(46.92%)	1200

Graph 3. Showing The Sizewise Percentage of Male, Female and Hermaphrodities in *L. corrianus* from Lentic Habitat of Marathwada Region. (Nov. 2004 and Mar. 2005)

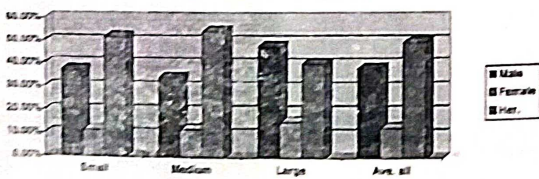
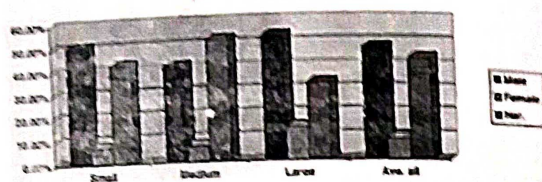


Table 3: Percentage of different sexes of *L. marginalis* from the lentic and lotic habitat during November, 2004 to October, 2005. (Hundred bivalves screened every month for each habitat)

Sr. No.	Month and Year	Size of the bivalve	Sex			Total
			Males	Hermaphrodites	Females	
1	<i>L. marginalis</i> (Lentic habitat)	Small	216	13	222	451
		40-70 * 30-50	221	18	293	532
		Medium	78	06	103	186
		70-100 * 50-70				
		Large				
		Total	545(45.41%)	37(3.08%)	618(51.5%)	1200
2	<i>L. marginalis</i> (Lotic habitat)	Small	223	30	241	497
		40-70 * 30-50	262	53	233	548
		Medium	59	08	68	135
		70-100 * 50-70				
		Large				
		Total	544(45.33%)	91(7.58%)	565(47.08%)	1200

Graph 4. Showing The Size wise Percentage of Male, Female and Hermaphrodites in *L. marginalis* from Lentic Habitate of Marathwada Region. (Nov. 2004 and Mar. 2005)



For Biochemical Composition

After Survey and Sex Composition, selective two species i. e. *Lamellidens corrianus* and *Lamellidens marginalis* species bivalves were screened for Biochemical Composition. *Lamellidens corrianus* and *Lamellidens marginalis* were brought from different localities as per their availability to the laboratory during the first week of each month. November 2004 to October 2005, *L. corrianus*, and *L. marginalis* and were screened for sex composition. Males, females and the hermaphrodites from each locality and habitat were separated. After separation of bivalves, gonads and whole body of each sex of each species were separated and dried at 80 °C in the oven. Barnes and Blackstock's method (1973) was used by extracting the lipids in Methanol: Chloroform to estimate the total lipid contents from the dry powders of gonads and whole soft body. The data prepared is given is the table 4.

RESULTS AND DISCUSSION

Ecological Biodiversity of Bivalves of Marathwada Region

After Biodiversity Survey and Sex Composition of Bivalves, *Lamellidens marginalis* and *Lamellidens corrianus* are available in most of the aquatic habitats of the Marathwada region and are also abundant in most of the cases. However, *Parreysia corrugata* and *Indonaia caeruleus* are restricted only in certain places and are very rare. *Parreysia corrugata* is found only in lentic waters. It is therefore difficult to obtain them in

Table 4: Monthly Variations Lipid Content in Gonads and Whole Soft Body of *L. corrianus* and *L. marginalis* with Reference to Their Habitat and Sex

Sr. No	Month	Habitat	Sex	<i>Lamellidens corrianus</i>		<i>Lamellidens marginalis</i>	
				Gonad %	Whole soft body %	Gonad %	Whole soft body %
1	November 2004	Lentic	Male	19.78	15.23	19.74	15.89
			Female	16.15	18.20	21.65	16.28
			Hermaphrodite	17.16	16.25	17.16	12.56
		Lotic	Male	21.32	12.26	18.32	16.23
			Female	20.63	14.56	21.48	17.21
			Hermaphrodite	27.08	12.36	18.98	16.34
2	December 2004	Lentic	Male	20.74	13.69	18.36	16.23
			Female	18.16	15.36	23.65	18.46
			Hermaphrodite	14.16	15.46	19.62	17.97
		Lotic	Male	10.03	11.36	20.00	15.64
			Female	20.61	10.23	20.60	13.14
			Hermaphrodite	22.08	9.891	17.09	14.34
3	January 2005	Lentic	Male	18.74	15.69	18.36	15.65
			Female	15.65	15.36	20.29	14.35
			Hermaphrodite	12.16	12.46	19.06	13.14
		Lotic	Male	18.15	11.26	20.16	18.95
			Female	21.51	12.36	21.89	19.65
			Hermaphrodite	19.93	11.39	19.93	18.47

(Contd...)

Sr. No	Month	Habitat	Sex	<i>Lamellidens corrianus</i>		<i>Lamellidens marginalis</i>	
				Gonad %	Whole soft body %	Gonad %	Whole soft body %
4	February 2005	Lentic	Male	16.74	16.59	18.96	16.23
			Female	16.65	14.25	21.56	15.32
			Hermaphrodite	11.15	18.93	19.36	14.56
		Lotic	Male	19.74	14.56	19.74	18.23
			Female	22.16	18.96	20.16	18.12
			Hermaphrodite	22.39	16.59	19.39	17.61
5	March 2005	Lentic	Male	21.22	15.46	18.36	19.86
			Female	17.26	17.98	20.25	16.32
			Hermaphrodite	18.39	16.45	18.69	13.56
		Lotic	Male	14.12	14.89	14.13	13.56
			Female	15.89	17.56	15.89	16.54
			Hermaphrodite	13.24	13.65	13.24	15.78
6	April 2005	Lentic	Male	19.57	16.69	17.58	18.45
			Female	22.16	18.68	19.89	16.21
			Hermaphrodite	20.36	15.45	19.65	14.45
		Lotic	Male	15.26	18.69	15.89	14.56
			Female	21.69	16.56	16.98	12.23
			Hermaphrodite	16.58	14.65	13.24	11.23

(Contd....)

Sr. No	Month	Habitat	Sex	<i>Lamellidens corrianus</i>		<i>Lamellidens marginalis</i>	
				Gonad %	Whole soft body %	Gonad %	Whole soft body %
7	May 2005	Lentic	Male	21.41	19.56	17.36	14.23
			Female	24.36	17.58	20.56	16.56
			Hermaphrodite	22.86	16.45	18.26	14.78
		Lotic	Male	21.19	12.36	17.19	12.23
			Female	22.96	11.98	19.96	9.89
			Hermaphrodite	17.66	13.25	17.66	11.23
8	June 2005	Lentic	Male	21.57	17.89	18.23	18.61
			Female	24.36	16.58	18.36	17.89
			Hermaphrodite	21.25	17.46	16.31	13.21
		Lotic	Male	42.39	13.24	18.39	10.25
			Female	19.44	19.85	15.44	9.45
			Hermaphrodite	20.33	18.75	13.33	11.98
9	July 2005	Lentic	Male	21.83	17.25	14.83	16.14
			Female	18.93	19.45	15.93	13.31
			Hermaphrodite	19.58	18.75	18.58	12.87
		Lotic	Male	21.23	12.36	12.23	12.32
			Female	15.33	15.24	15.33	14.15
			Hermaphrodite	14.61	16.45	13.63	13.45

(Contd....)

Sr. No	Month	Habitat	Sex	<i>Lamellidens marginalis</i>		<i>Lamellidens corrianus</i>	
				Gonad %	Whole soft body %	Gonad %	Whole soft body %
10	August 2005	Lentic	Male	17.60	18.26	17.60	18.56
			Hermaphrodite	21.23	21.24	11.23	14.25
			Female	19.46	19.45	12.46	14.12
			Male	20.86	18.12	13.86	12.24
			Hermaphrodite	19.44	14.45	14.46	14.15
			Female	15.32	14.16	15.33	15.64
11	September 2005	Lentic	Male	17.01	19.45	13.25	17.45
			Hermaphrodite	22.99	14.87	12.99	18.64
			Female	16.76	16.87	16.74	13.45
			Male	21.64	18.12	14.89	12.31
			Hermaphrodite	19.56	18.45	16.36	14.61
			Female	13.36	14.16	15.65	16.12
12	October 2005	Lentic	Male	19.31	14.56	14.83	14.26
			Hermaphrodite	18.36	19.46	13.19	13.32
			Female	18.23	17.87	14.76	16.23
			Male	19.65	16.12	18.89	15.56
			Hermaphrodite	17.61	17.45	15.36	13.26
			Female	21.56	14.16	15.65	15.46

all the months in lentic as well as lotic habitat. *L. marginalis* and *L. corrianus* were large bivalves ranging in the gross weight from 4gm to 150gm with the flesh up to 70gms. The Minor and neglected species of the Corbiculid was also obtained from the Shankarrao Chavan Dam of Nanded and the species was *Corbicula regularis* however other species *Corbicula striatella* found in many areas of Maharashtra state was not observed in the Marathwada. The availability and abundance of freshwater bivalves was dependent on the physiological parameters of the water and availability of water and food.

The ecology of various slugs in East Lancashire, England studied by Miles, H. W., Wood, J. and Thomas, I. (1931). Water relations and parameters of molluscs were studied by various investigators Howes, N. H. and Wells, G. P. (1934), Kunkel, K. (1916), Warburg, M. R. (1965), Wells, G. P. (1944). *Arion circumscriptus* and *Deroceros reticulatum*, unrelated but native of same region, were similar in their temperature preference cold toleration and food variation; whereas *Deroceros reticulatum* and *D. laevis*, closely related but native of different regions were similar in substrate moisture preference, heat tolerance and desiccation Getz, L. L. (1959). Under normal conditions, *Helix pomatia* undergoes daily fluctuations of weight of a cyclical nature due to variation in water content, Wells, G. P. (1944). *L. marginalis* and *L. corrianus* are highly dominant in all the water bodies indicating their adaptability to any type of environment. In many regions these species were found live in the semidried mud indicating their adaptation to the aerial respiration. There are records that some bivalves use the oxygen that dissolves in the little water that is present in the mantle cavity after developing the bubbles.

Sex Composition of Selected Bivalves of Marathwada Region

The data on the occurrence of hermaphroditism in the freshwater bivalves revealed that. Amongst the *L. corrianus* screened from lentic habitat from November 2004 to October 2005, 43.25% were males, 4.91% were hermaphrodites and

51.83% were while from lotic habitat 44.75% were males, 8.33% were hermaphrodites and 46.92% were females. Amongst the *L. marginalis* screened from lentic habitat from November 2004 to October 2005, 45.41% were males, 3.08% were hermaphrodites and 51.5% were females while from lotic habitat 45.33% were males, 7.58% were hermaphrodites and 47.08% were females as mentioned in table no. 2, 3 and Graph.

Dolgov (1991) observed that the linear size of the largest individuals of *T. squamosa* was 3.5-5 times and soft body weight 100-150 times greater than that of the youngest mature ones. The population density was a thousand times less than that of the other bivalves considered. Variation of sexual structure in other bivalves in relation to size/age structure and population density (Dolgov, 1987) predicts that in the old, size/age structured population of *T. squamosa* sequential hermaphroditism may prevail. In size age composition, fictional simultaneous hermaphroditism may prevail.

Burton *et al.*, (1996) used squash preparations for microscopic determination of sex in *M. edulis*, and then substantiated the accuracy of their results by examination of histological sections. Diverse ways of reproductive strategies have come into existence in bivalves as adaptations to the environment. Primitive molluscs were dioecious and the unprotected gametes were discharged in the sea water. The adults were limited to produce and release gametes and no parental care was taken. In the latter phase of evolution, brooding of eggs in the brood pouches of gills, as a strategy for parental care was evolved.

Hermaphroditism was also evolved as an adaptation for better reproduction. The important aspect of this adaptation is the occurrence of seasonal cycles in the reproduction of different species of bivalves. Different species which coexist in the same environment have reacted differently in having breeding periods during different seasons of a year. In case of running water, though male are available, the chances of washing out of sperms are more. In such condition animals can get adapted for hermaphroditism to reduce the loss of

gametes and to have better chances of reproduction and perpetuation of the species. The hermaphrodite gonads can have a change in the follicular composition from maleness to femaleness. Seed (1975) reported apparent asynchrony in the gonad development between the two sexes of *Mytilus edulis* with male developing at a faster rate. Sexual studies of *Perna viridis* have yielded different conclusions, Barakti and Ahmed (1974) and Rao *et al.*, (1975), both regarded *P. viridis* as a dioecious species. A functionally simultaneous hermaphrodite exhibits mature male and female gametes in gonads at the same time (Coe, 1943; Hoeh *et al.*, 1995).

A less constraining term for description of fresh water bivalve species that regularly exhibit hermaphroditism is normal hermaphrodite. The description also accommodated variance in hermaphroditic expression among populations, as with *Ulterbackia imbecillis*, (Van der Schalie, 1970; Heard, 1975) but acknowledged heremaphroditism as the normal reproductive mode of the species. The normal hermaphroditism classification recognizes that mussels may be functional hermaphrodites by the descriptive system of (Coe, 1943). The actual occurrence of hermaphroditism is facultative in normal hermaphrodite species, allocation of testicular tissue in *U. imbecillis* has been related to degrees of self-fertilization among populations (Johnston *et al.*, 1998). Hoeh *et al.*, (1995) speculated that regular occurrence of hermaphroditism in *U. imbecillis* is the result of historical hybridization with the Florida Floater, *U. peggyae* that disrupted the sex determination system of *U. imbecillis*. The incidence of occasional hermaphrodites can vary among populations of *M. margaritifera* (Van der Schalie, 1966; Smith, 1979; Bauer, 1987; Hansten *et al.*, 1997; Grande *et al.*, 2001). It was observed that hermaphroditism in *M. margaritifera* was more common among Spanish population, where population densities may be lower than in those of North America (Grande *et al.*, 2001).

Hermaphroditic occurrence varies also among populations of *M. margaritifera*. Van der Schalie (1970) found hermaphroditism in 1 of 12 specimens of *M. margaritifera* from the Yellowstone

River. Smith (1979) and Hansten *et al.*, (1997) did not find hermaphrodites in populations from New England and Finland, although 50% of specimens from a Spanish population were monoecious (Grande *et al.*, 2001). A synchronous gamete development among mussels was documented for *Diplodon chilensis* (Peredo and Parada, 1986). However gametogenic synchrony was observed among males and females of *D. gratus* (Avelar and Mendonca, 1998). Haggerty *et al.*, (1995) recorded greater number of spermatozoa per gonadal transect in early spring than numbers of oocytes per acini in purple warty backs, *Cyclonaias tuberculata* (Rafinesque, 1820). Haggerty *et al.*, (1995) noted that spawning between males and females of *Cyclonaias tuberculata* was synchronous. Possibly, the rates of spermatogenic and oogenic development may be different, with male gametes maturing faster than female gametes. Heard (1975) and Kat (1983) observed gametes in different stages of development, and inferred that differential maturity rates between spermatogenic and oogenic tissues existed. Zambare (1991) observed hermaphroditism in *Corbicula striatella* and proposed that the fertilization takes place within the gonads of hermaphrodite *C. striatella*.

Biochemical Composition of Selected Bivalves of Marathwada Region

Monthly changes in lipids content in dry powders of gonad and whole body of *Lamellidens corrianus* and *Lamellidens marginalis* as estimated from November 2004 to October 2005 are listed in table no. 4.

Piretti *et al.*, (1987) made investigation on seasonal variations of sterols and fatty acids in *Venus gallina* and *Scapharca inequivalvis* (Bruguiere). Total lipid contents of *Crassostrea gigas*, *Mytilus edulis*, *Ruditapes philippinarum* and *Cerastoderma edule* were estimated by Deslous-Paoli *et al.*, (1988) and of *Macoma balthica* by Wenne and Styczynska (1987) and Polak *et al.*, (1987). Toshima *et al.*, (1988) studied anatomical distribution of sterols and fatty acids in the bivalve, *Mactra*

chilensis. A review of lipids in marine invertebrates including bivalves was given by Giese (1966) and Voogt (1983). Nagabhushanam and Lomte (1972) in *Parreysia corrugate* and Jadhav and Lomte (1982) in *Lamellidens corrianus* found accumulation of fat in developing gonads.

Similarly in *Meretrix meretrix* (Nagabhushanam and Deshamukh, 1974) fat accumulates in developing gonads and reduces during spawning. The seasonal changes in lipid content of *Mytilus edulis*, the lipid level is generally higher in females than the males due to its accumulation in eggs (Lubet and Longcamp, 1969). In the Mediterranean waters, *Mytilus edulis* spawns repeatedly during the spring and early summer, and between each successive period the gonad is reconstituted. The lipid levels fall rapidly after spawning and then increase again as the gametes mature. In the model of summer during non reproductive period, the level of triglycerides and phospholipids remain low (Lubet and Longcamp, 1969), whereas during winter higher fat levels occur due to increased lipid reserves in the developing eggs. Nagabhushanam and Mane (1975) in *Katelysia opima* reported that lipid level of the whole body showed correlation with maturation and spawning of the mussels, increasing to peak level in mature mussels and decreased during spawning. Foot and mantle have low lipid level in *Parreysia corrugata* (Nagabhushanam and Lomte, 1972), high in gonad, highest in gravid and decreased after spawning.

Giese *et al.*, (1967) observed relatively stable fat content for most of the year in *Tivela* except the small in gonad where lipid reaches the peak value of mature condition. John (1980) in *Anadara rhombea* found 32.1% to 16.4% lipid in hepatopancreas, 29.8% to 21% lipids in gonad while 20.5% to 17.4% lipids in foot. Nagabhushanam and Deshamukh (1974) in *Meretrix meretrix* found maximum in digestive gland (9.29%), Moderate in foot, gonads and rest of the body (2.0% to 3.5%) while very less in mantle (1.97%) and adductor muscles (1.42%) Jadhav and Lomte (1982) in *Lamellidens corrianus* observed high

fat level in gonad (4.61% to 6.74%), Low in mantle (2.23% to 3.62%) and moderate in mid gut gland (3.73% to 5.62%), foot (2.26 to 4.17%), adductor muscles (2.27% to 3.64%) and gill (2.29% to 3.86%).

CONCLUSION

Finally concluded that, the present investigation provides us basic knowledge regarding the availability of the bivalves from Marathwada Region. This investigation also observed that the percentage of hermaphrodites is less in large size bivalves of both species. The percentage of hermaphrodites was more in the lotic habitats than lentic habitats. Biochemical Estimation of bivalves, In *Lamellidens corrianus* average percentage of lipids in the dry powder showed maximum lipids in gonad (27.08 %) as well as minimum in gonad (10.03 %) depending on the maturation stage of gonad while in whole body maximum lipids were (19.85%) and minimum lipid (9.89 %). In *Lamellidens marginalis* average percentage of lipids in the dry powder showed maximum lipids in gonad (23.65 %) as well as minimum in gonad (12.23 %) depending on the maturation stage of gonad while in whole body maximum lipids were (19.46 %) and minimum lipid (9.45 %). This executed research is ecologically important, especially for understanding the ecological biodiversity of bivalves from different habitats of Marathwada Region.

Briefly, this investigation provides us potential of edible and economical importance of bivalves to aquaculture. It provides information for the selection of breeding sites of Marathwada region. It also provides information regarding the nutritive value of edible bivalves with respect to breeding period and breeding environment. This study shows basic knowledge regarding more potent habitat for breeding of bivalves. This research work is useful in agriculture to culture the bivalves for food and for pearl culture to boost the agro based industry.

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