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In vitro assessment of water current on growth and biometric relationship among molluscs

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ABSTRACT:

Water current plays vital role in the development of an aquatic ecosystem. It performs various activities in the aquatic media, which in turns replenish the nutrients and alter biotic conditions of the water bodies. In order to elucidate the exact role of water current on life of aquatic fauna, present investigation was carried out. Members of phylum mollusca are world wide distributed and include the commercially important group of organisms. These creatures are continuously exposed to water's rapidly altering conditions and have the ability to withstand with this challenging atmosphere. So, for the present investigation, three freshwater uninoid molluscs *Lamellidens marginalis*, *Lamellidens corrianus* and *Pyressia corrugata* were selected. These molluscs were exposed to monitor or regulate aquatic conditions. Comparative assessment among these molluscan species, showed the impact of water current on their growth, physiology and biometric relationships. Uninoid mollusc *Lamellidens corrianus* proved its dominancy at availed atmospheric conditions and hence noted ideally suitable for commercial rearing.

Keywords:
Biometric relationships, Freshwater, Malacofauna, Water current.

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INTRODUCTION

Water is a crucially important parameter for the sustenance of aquatic life. Palatability of the water majorly depends on its physicochemical properties, which maintains the water quality (Mustapha and Omotosho, 2005 and Saxena *et al.,* 2011). Water quality denotes the total health of that area (Sala *et al.*, 2000). Amongst the water resources available on the earth surface, palatable resources are confined only to the freshwater (Aggarwal and Arora, 2012). When discussing about the freshwater resources, rivers and lakes cannot be exempted (Gupta *et al.,* 2011 and Jonnalagada and Mhere, 2001). These lentic and lotic habitats contribute the major portion of the palatable water resources and found as dwelling place for variety of animals (Alam and Pathak, 2010, Mandal and Das, 2011 and Jayalakshmi *et al.,* 2011). Nowaday's, these valued resources are continuously being contaminated and resulted to deterioration, which become a serious concern for scientific community (Sudhira and Kumar, 2003 and Singh, 2007). The only reliable way to overcome this problem is the water filtration, which is a really challenging task in large scale. River has the potential to clean this unwanted contaminations by its continuously flowing water current (Adeyemo *et al.,* 2008). Water current has a key role in maintaining equilibrium physicochemical properties of the river, which in turns regulates the floral and faunal diversity of the area.

Amongst the invertebrates, molluscan fauna comprises second largest population of the world and distributed in the every possible habitats or niche except aerial habitats (Kotpal, 1973). Due to such a wide distribution and commercial value, they provide many opportunities to the researchers to analyze their biology (Stauffer, 1937, Dreyer and Castle, 1941, Laxmilatha, 2008, Peretz and Adkins, 1982 and Cubillo, 2012). Along with its key role as model, it also exhibits as bioindicator of the pollution (Gupta and Singh, 2011 and Zhou *et al.,* 2008). Hence, it has become necessary to investigate them in order to describe their correlation with the water quality. Biometric relationships are crucially important in this concern, as they are directly associated with the growth of individuals in particular atmosphere or habitat. These parameters help to determine the impact of water current along with its quality on the physiology of molluscs. Numbers of researchers have focused on the biometric relationships of the molluscs, as a tool to investigate the impact of variety of parameters on the growth and reproduction. Previously, Cataldo *et al.,* (2001) expressed the importance of mollusc's *C. flumina* as bioindicator by evaluating its biometry against the available water quality. Shriver *et al.,* (2002), described the effect of eutrophic driven changes on the growth, condition, reproductive potential and mortality of *A. irradians*. Recently, Kolliyil *et al.,* (2006) mentioned the effect of habitat alteration on the pearl oyster *P. fucata* with the help of biometry. Nevertheless, all these investigation detailed the impact of environmental parameters on the individual molluscan species, but failed to explain the exact role or impact of water current on composite molluscan community. Comparative assessment of these biometric relations among different species of molluscs has never been elucidated. Hence, by keeping in view the crucial importance of the water current, present investigation has conducted so as to consider our knowledge regarding the biometric association of the different species of molluscs living all together in the aquatic ecosystem.

MATERIALS AND METHODS

Mussel sampling

For the present investigation, three freshwater Uninoidae molluscs, *L. corrianus, L. marginalis* and *P. corrugata* were selected due to their importance as bioindicator and socially adapting behaviour. Mature individuals with shell length ranges between 70 mm to

90 mm for *L. corrianus*, 60 mm to 80 mm for *L. marginalis* and 40 mm to 60 mm for *P. corrugata* were collected from all along the marginal area of the river Panchganga. Total of 90 individuals i.e. 30 individuals per species were utilized for the experimental analysis.

Experimental Design

Specimens were taken to the laboratory and kept in plastic container of 50-liter size up to 48 h for acclimatization. After acclimatization, 10 individuals of each species were stored in separate containers. Out of such six containers; three containers were provided with water circulating systems i.e. with one inlet and one outlet tubes and termed as experimental groups. Aerator was provided for the proper oxygen supply to avoid the suffocation. Filters were attached to the containers to check the fecal matter. Bottom of the containers were covered with gravels or sand particles of more than 0.5 mm size to provide the natural anchoring bed for the molluscs. A continuous water current of the 3.4 ml/sec was regulated to create the exactly resembling environment of the river. For remaining three containers only exception of water circulating system was made to provide the controlled habitat. These containers were treated as control groups. Water from these three containers were routinely replaced. For the well flourishment of the reared molluscs, a routine supply of the planktonic mass was conducted. The experimentation was continued for the period of two months. In order to assess the exact impact of the water current, the experimentations were repeated thricely from January 2013 to June 2013.

Data analysis

Respiratory assessment

The respiration rate of the selected molluscan species was assessed fortnightly by using the amount of oxygen consumed by the individuals of the species, in order to notice their normal physiology as a previously described method of Resgalla *et al.,* (2006).

Hydrological parameters assessment

During the period of investigation, in order to keep checking on the water quality, hydrological parameters such as Temperature, pH, DO (Dissolved oxygen) and free CO_2 (Carbon dioxide) were assessed by using standard methodologies of APHA (2005).

Biometric relationships

In order to elucidate the exact impact of the water current on the growth, different condition indexes viz. Body Condition Index (BCI), Meat Yield Index (MYI) and Shell Component Index (SCI) were evaluated. Growth was noted as weight gain by the individual, as shell lengths growth was lowered after maturity. The BCI was calculated by applying the Davenport and Chen (1987), Rainer and Mann (1992) and Rahim *et al.,* (2012) formula. Shell Component Index (SCI) and Meat Yield Index (MYI) were evaluated by using Pekkarinen (1983) and Freeman (1974); Yildiz (2011) methods respectively. Formulae for these indexes were as follows:

$$BCI = \frac{\text{Meat dry weight}}{\text{Total weight}} \times 100$$

$$SCI = \frac{\text{Shell wet weight}}{\text{Total weight}} \times 100$$

$$MYI = \frac{\text{Meat wet weight}}{\text{Total weight}} \times 100$$

Total weight gain = Final weight – Initial weight

The data were analyzed with ANOVA by using Kruskal Wallis multiple comparison test, to determine the level of significance. The results obtained as mean of the triplicate were interpreted as an average values with mean ± S.D in graphical and tabular format.

RESULTS

During the entire period of investigation, hydrological parameters like temperature, and pH did not described any significant differences and ranged between

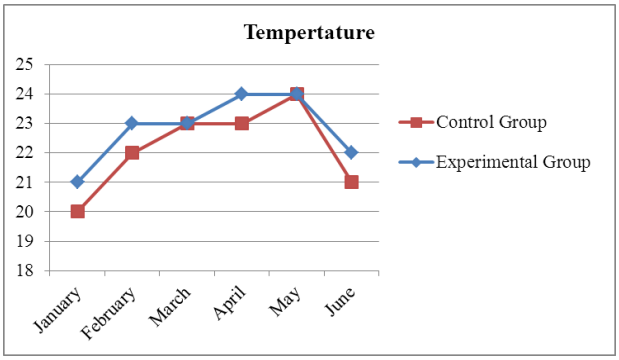

Figure 1. Temperature assessed during the study period.

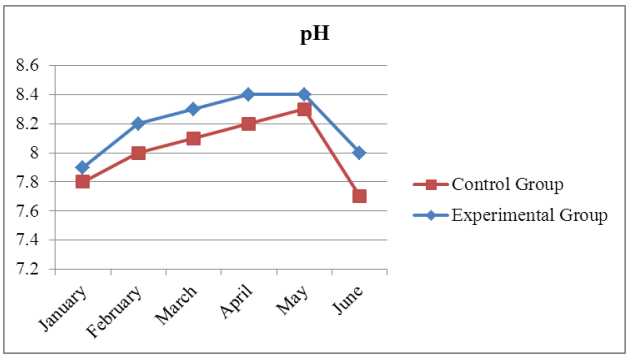

Figure 2. pH assessed during the study period.

20 to 24ºC and 7.7 to 8.4 respectively (Figure 1 and 2).

Whereas highly significant variations were noticed for DO ($P < 0.0232$) and CO_2 ($P < 0.0048$), which varied between 0.7 to 2.1 mg/lit and 7 to 12 mg/lit for control as well as experimental groups (Figure 3 and 4).

Growth rate

Growth of the individual is measured by their length and weight relationship. In molluscs, after sexual maturity lengthwise increment or growths get restricted to 1 or 2 mm per year only. Hence, by keeping in view the economic importance of mature individuals for present investigation average weight gain by the individuals during the experimentation was noted as growth rate. The results obtained as mean growth rate for control and experimental groups of the individuals were summarized in the Table 1 and 2.

Highest average growth rate was remarked for *L. corrianus* along with the significant variation in case of control and experimental group whereas *L. marginalis* and *P. corrugata* were noted with moderate non-significant level of growth rates (Figure 5).

Respiratory rate

Oxygen consumption capacity i.e. respiratory rate was noted with narrow range of fluctuation in case of all the individuals. Highest respiratory activity was showed by *L. corrianus* while *P. corrugata* was observed with least level of respiratory activity. *L. marginalis* was remarked with moderate respiratory rate and showed significant variation ($P < 0.0058$) amongst compared control and experimental groups (Figure 6).

Biometric relationships

Parameters representing biometric relationships showed significant differences amongst compared molluscan species.

Table 1. Mean growth achieved by the compared molluscan species of the control group.

Weight gain in 'g' for Control group		
Lamellidens corrianus (g)	*Lamellidens marginalis* (g)	*Parreysia corrugata* (g)
5.27	6.75	2.26
3.94	3.97	3.35
0.45	4.56	1.01
8.93	5.88	1.74
1.00	5.15	2.76
8.16	2.20	1.99
20.72	4.46	4.53
4.84	3.71	3.43
2.87	2.87	2.02
4.18	6.34	2.51

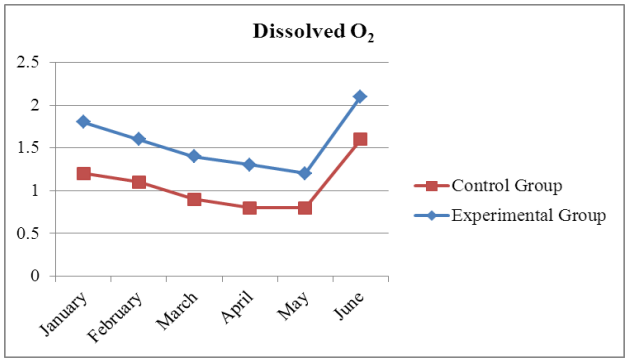

Figure 3. Dissolved Oxygen assessed during the study period.

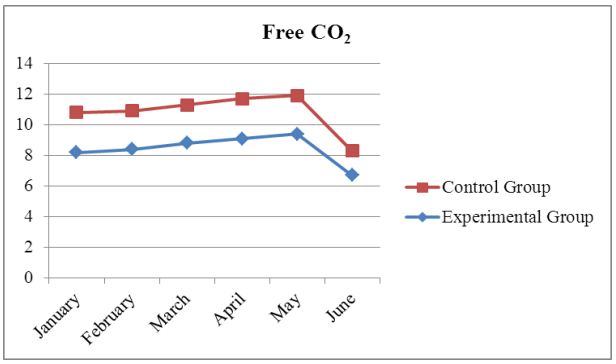

Figure 4. Free CO_2 assessed during the study period.

Table 2. Mean growth achieved by the compared molluscs of the experimental group.

Weight gain in 'g' for Experimental group		
Lamellidens corrianus (g)	*Lamellidens marginalis* (g)	*Parreysia corrugata* (g)
16.92	06.34	07.55
05.13	06.31	03.05
14.38	05.04	05.07
09.99	19.07	01.36
30.48	20.03	00.27
12.49	10.07	00.28
17.09	18.05	12.76
06.64	07.25	07.06
05.55	05.33	08.12
07.86	06.17	07.97

Body Condition Index (BCI) - Mean BCI evaluated for control and experimental group during the study was tabulated in the Table 3 and 4 respectively.

Maximum picks of average BCI was remarked for experimental group, whereas slightly altered BCI was represented by control groups. *L. corrianus* showed richest BCI, whereas non-significant moderate BCI was noted for *L. marginalis* and *P. corrugata* (Figure 7).

Shell Component Index (SCI) - Mean SCI estimated for both the groups were represented in the Table 5 and 6.

Table 3. Estimated BCI for control group individuals.

Body Condition Index of control group		
Lamellidens corrianus (g)	*Lamellidens marginalis* (g)	*Parreysia corrugata* (g)
1.453744	0.58548	2.207479
1.804176	3.364993	3.016661
1.381264	3.605256	1.258103
1.525716	2.017336	2.435835
1.250187	1.811960	1.122779
1.473294	2.422558	1.670242
1.908157	3.002183	2.223226
2.167902	1.249793	1.690028
1.340942	1.722309	1.341314
1.331899	1.655757	1.612251

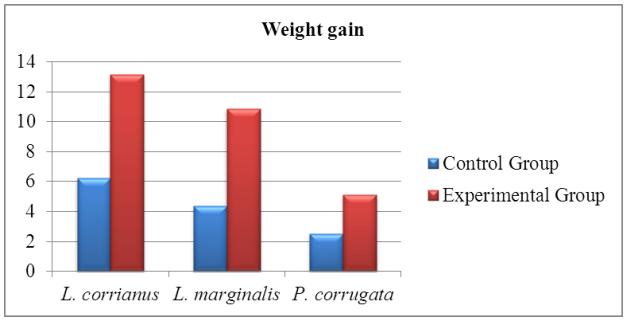

Figure 5. Growth rate noted during the investigation period.

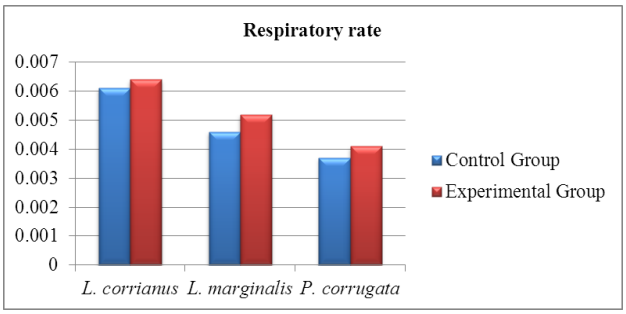

Figure 6. Oxygen consumption noted during the investigation period.

Table 4. Estimated BCI for experimental group individuals.

Body Condition Index of experimental group		
Lamellidens corrianus (g)	*Lamellidens marginalis* (g)	*Parreysia corrugata* (g)
1.717426	2.009174	1.704364
1.680832	0.947290	1.321680
1.931249	0.934551	2.641986
1.198415	4.990991	1.484685
2.906365	4.751566	1.762833
1.241548	2.089872	1.910265
1.919226	4.605892	3.580756
1.888711	2.520781	3.228804
3.062775	1.950860	3.003290
1.959476	2.877358	3.398894

Average values obtained for SCI with the help of Kruskal –Wallis test revealed significant differences ($P < 0.05$) during the investigation period. Maximum SCI was achieved by *P. corrugata*, while least was counted for *L. corrianus*. *L. marginalis* showed moderate SCI while comparing both the groups (Figure 8).

Meat Yield Index - Assessment of Meat Yield Index of the reared molluscs as mean in case of both the groups was described in the Table 7 and 8.

Average differences in the question for control and experimental groups were very highly significant ($P < 0.001$). The differences were highest oscillating around doubled for *L. marginalis* while *L. corrianus* and *P. corrugata* were noted with moderate differences (Figure 9).

Table 5. SCI observed during the investigation for control group individuals

SCI of Control group		
Lamellidens corrianus (g)	*Lamellidens marginalis* (g)	*Parreysia corrugata* (g)
77.71001	87.77729	83.86395
72.19069	81.12000	80.83522
87.13850	80.59058	85.80750
90.11091	87.66959	85.02491
87.36543	87.62167	86.88411
42.23457	85.68455	84.98980
86.58500	83.81993	85.75603
79.53250	86.47710	86.02370
84.37946	83.86895	85.23634
88.12045	83.73996	85.35105

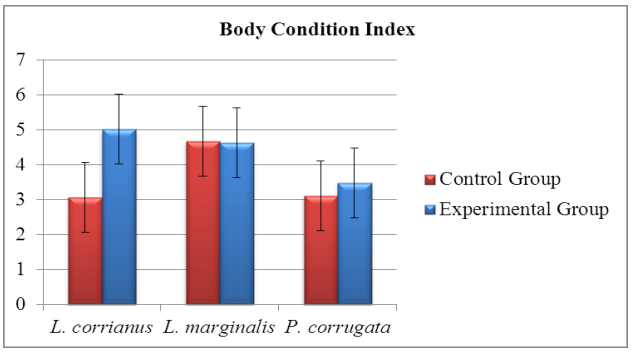

Figure 7. BCI achieved by comparing molluscan individuals during the investigation

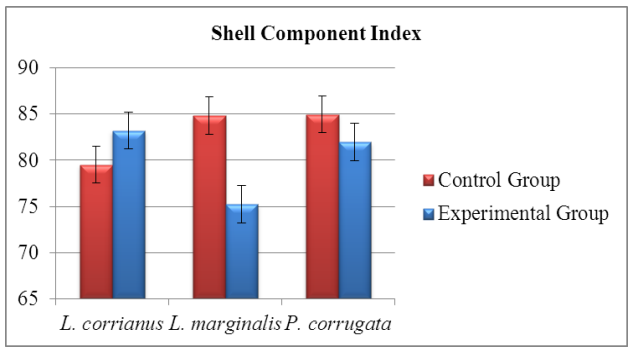

Figure 8. Shell Component Index achieved by comparing molluscan species during the investigation.

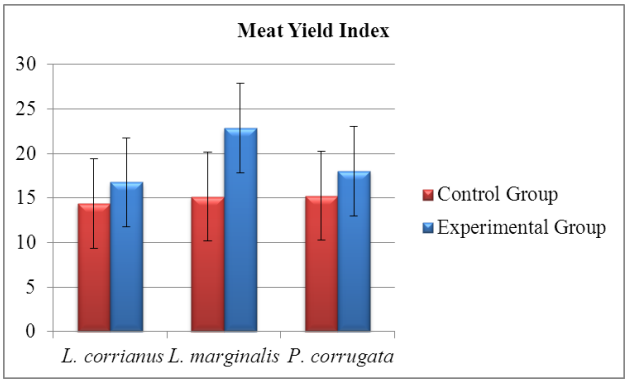

Figure 9. MYI achieved by the compared molluscan species during the investigation.

DISCUSSION

Drastically altering environmental conditions had its strong influence on the growth and reproduction of the molluscs (Bayne *et al.,* 1983, Hawkins and Bayne, 1992, Griffiths *et al.,*1987 and Seed Suchanek, 1992). Both biotic and abiotic parameters play a major role in the overall development of the molluscs (Gascoigne *et al.,* 2005 and Gibbs *et al.,* 1991). In the environment as per the nature of the habitat, the molluscs are evolved to sustain with prolific growth and reproduction (Sahi, 2006). In our experimentation, we observed that hydrological parameters have its significant impact on the molluscan development as previously mentioned by Yukihira *et al.,* (2002) for *P. margaritifera* and *P. maximum*. Oxygen was remarked as most essential parameter for the survival and normal growth of the individuals and tends to be more soluble in case of running water. Ample amount of oxygen accelerates the various physiological activities, which in turn enhances the respiratory rate of the animals (Bayne, 1967). Control group individuals showed slightly stunted respiratory rate, which may be the result of less oxygen concentration along with restricted physiological activities as mentioned by Bayne and Thompson, (1970), Gabbott, (1976) and Bayne *et al.,* (1983). It was also

Table 6. SCI observed during the investigation for experimental group individuals.

Shell Component Index of control group		
Lamellidens corrianus (g)	*Lamellidens marginalis* (g)	*Parreysia corrugata* (g)
81.30651	77.55957	83.10370
79.88342	69.57480	81.34172
84.49993	63.11569	82.78805
86.56812	77.24327	82.63982
86.11364	77.29858	82.93289
86.24293	76.76349	82.23638
83.30588	76.22295	80.62310
82.46388	76.64173	81.88153
80.36785	84.74201	81.69309
81.41228	73.16038	80.54702

Table 7. MYI representing tissues build up in the compared molluscan individuals.

Meat Yield Index of control group		
Lamellidens corrianus (g)	*Lamellidens marginalis* (g)	*Parreysia corrugata* (g)
22.29	12.23	16.14
27.81	18.88	19.16
12.86	19.41	14.19
12.33	12.33	14.97
12.64	12.38	13.11
13.33	14.32	15.01
13.42	16.18	14.97
13.52	13.52	15.69
03.73	16.13	14.76
11.88	16.26	14.64

justified by the less production of faecal matter and debris in case of control group organisms, whereas experimental individuals produces tremendous amount of faecal debris. Carbon dioxide revealed exactly similar trend as that of oxygen, because excess organic activities and physiological processes enhances CO_2 concentration, which was assured by the higher temperature and pH concentration of the experimental groups as previously put forth by Widdow (1973) for *M. edulis* species.

Above-mentioned abiotic and biotic conditions had its impact over the biometric relationships of the cultured molluscan species. Satisfactory growth of the individual is a multitude of favourable biotic and abiotic interactions. Experimental groups were accomplished with such delightful interactions along with ample amount of dietary, which provided maximum opportunities for the growth of individuals. Hence, showed almost doubled growth increment than that of control group individuals. Whereas in case of control group though they are provided with, satisfactory diet due to less favourable biotic and abiotic conditions the growth of the individuals, get retarded as proved by Yoo *et al.,* (1986) for *P. fucata*. These observations were supported by the evaluated condition indices. Significant differences among control and experimental group high light the role of water current along with species habitat specificity at the laboratory conditions. BCI and MYI reaches to its maximum limit in case of experimental individuals representing magnificent enhancement in the tissue weight i.e. growth, which may be because of onset of breeding season as mentioned by the Narasimham, (1988) for the species *A. rehombea*. Control individuals showed moderate growth, which may be the impact or result of stressed body physiology. SCI was significantly

Table 8. Meat Yield Index representing tissues build up in the compared molluscan individuals

Meat Yield Index of experimental group		
Lamellidens corrianus (g)	*Lamellidens marginalis* (g)	*Parreysia corrugata* (g)
18.69	22.44	16.89
20.11	30.42	18.65
15.05	17.75	17.21
13.43	22.75	17.36
13.88	22.07	17.09
13.75	23.23	17.76
16.69	23.77	19.37
17.53	23.35	18.11
19.63	15.25	18.35
18.58	26.83	19.45

altered than other condition indices, denoting comparatively doubled Shell Component Index for control individuals, whereas experimental group showed downward pattern of SCI. Overall assessment of these condition indices confirm maximum channelization or transformation of energy for the tissue or gonadal development in case of experimental groups.

A good condition value indicates accumulation of nutrients reserve to accomplish successful reproduction (Bligh and Dyar, 1984, Dare and Edwards, 1975 and Aldrich and Crowley, 1986). While comparing among the individuals of analyzed species, *L. corrianus* was found as most favourable individual to counteract with the availed atmospheric conditions at the time of rearing. It was noticed with richest growth rate and BCI representing its dominancy in experimental conditions. While in case of unfavourable atmospheric conditions its growth and BCI may slightly be hampered, but remains constant when compared with the other two species and hence denoted its ideal suitability in composite community structure. *L. marginalis* was noted as least adapted species during the experimental period due to its slower growth rate and BCI in case of both the groups, which should be the reason to have its least population and endangeredness in the natural ecosystems as stated by Cataldo and Boltovskoy, (1998) for *C. fluminea*. *P. corrugata* was evaluated as suitable species to rear in natural and artificial environments as it denotes moderate growth rate for provided experimental conditions. However, due to its smaller size than other two reared species the growth rate was comparatively similar as that of the field conditions, which was previously described by Mudigere and Seetharamaiah, (2009) for *P. corrugata* and hence mentioned as well adapted form in the composite community structure.

CONCLUSION

Water current has proved dominancy over the controlled laboratory conditions, which confirms the advantage of water current in maintenance of the aquatic animals. *In vitro* treatment enhances health and reproductive capacity of animals. Obtained results showed magnificent increment in the regeneration capacity of animals. The technique enlightens advance bioscience practices in animal culture with significant applications.

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