Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 1, 2021, Pages. 543 - 554
Received 15 December 2020; Accepted 05 January 2021.

Assessment of Population Structure and Seasonal Variation in *Barytelphusaguerini* in Rivers of Marathwada, Maharashtra, India

Ravi D.Barde, Narayan G, Nagrale, and M.M.V.Baig[1]*
Department of Zoology,S. G. B. College, Purna
[1]Department of Botany and Biotechnology, Yeshwant Mahavidyalaya, Nanded
*Corresponding author: mmvbaig@gmail.com

ABSTRACT

Freshwater crabs constitute one of the largest group of invertebrates occupying the Indian peninsula waters. The past few decades have seen an upsurge of interest in the using freshwater crabs as an ecological model for assessing impact of various environmental stress and pollutant in the rivers. The present investigation deals with the study of distribution of the species, identify specific habitat requirements, depict population levels, trends and recognize detailed risks to significant and exceptional freshwater crab.

The study included the traits in the life of the crab, body size and abundance, relative abundance, sexual ratio, distribution in relation with time during the year and size distribution, maturity of the crab ***Barytelphusaguerini***. The body size and sexual maturity differed between the localities of sampling sites.)

Keywords:
Barytelphusaguerini, Godavari river, Tributary, Population, Abundance, Distribution

Introduction

Freshwater crabs constitute one of the largest group of invertebrates occupying the Indian peninsula waters. They have recorded their presence in nearly all freshwater habitats ranging from streams emerging from mountains or highland to large rivers along with all water bodies in the land (Bahir and Yeo, 2007). Freshwater crabs are ecologically as well as economically important owing to their role in nutrient recycling, water quality monitoring and small-scale fisheries. Nearly 1280 species belonging to 4 super families' occurrs throughout the world which accounts 20% of identified brachyuran diversity (Cumberlidge*et al.*, 2009). Sums of 96 species belonging to 41 genera constituting 6 families till now are discovered from India Bahir and Yeo, 2007 and Ng *et al.*, 2011).

Five species belonging to families Sesarmidae, Varunidae and Hymenosomatidae are recorded from India where the members are marine and an estuarine form. Conversely, a few members of these families have adapted to exist in and accomplish their life cycle in freshwater habitats (Ng, 1988). These members adapted to freshwater have been designated as freshwater species where every species included in the genus *Gecarcinucidae*are fresh water.

The past few decades has seen an upsurge of interest in the using freshwater crabs as an ecological model for assessing impact of various environmental stress and pollutant in the rivers (Jadhav, *et al.*, 2011). A number of studies have showed that various chemical pollutant and pesticides have affected the population structure of the crabs in the Godavari basin (Venugopal, *et al.*, 1997). This has resulted in a steep decrease in the populations of the crabs in the region (Thankar, 1985). Freshwater crab *B. guerini* have been repeatedly investigated for behavioural and various physiological studies. The effect of various inorganic ions, drugs and antibiotics, pesticides, heavy metals, has been used by many workers to screen the various properties of this crab *B. guerini* (Deshai*et al.*, 2012).

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 1, 2021, Pages. 543 – 554
Received 15 December 2020; Accepted 05 January 2021.

This necessitate the further field surveys to study distribution of the species, identify specific habitat requirements, depict population levels, trends and recognize detailed risks to significant and exceptional freshwater crab. It is critical to the fitness of these ecosystems to consider procedures that particularly comprise the protection and sustainable utilization of local populations of crabs inhabiting the river. The ecology and patterns of allocation of the freshwater crabs are appearing as better known for the impending warnings to their enduring and continued existence (Venkateshwarlu and Sunita, 1995).

The freshwater crabs of Kerala and Tamil Nadu were reviewed on the basis of the conclusion of field survey. Nine genera and twenty-three species of gecarcinucid freshwater crabs were described. Four species earlier recorded as syntypes were identified as valid species, that includes *Lamella lamellifrons* (Alcock), *Vela pulvinata* (Alcock), *Vannitravancorica* (Henderson) and *Travancorianaconvexa* (Roux) (Bahir and Yeo, 2007).

Marshland area declination has been attributed to various environmental factors. The work included cataloging arthropod diversity and detritus subsidies induced tropic cascades disturbances. It was revealed that 143 diverse species belonging to 13 orders summing to 49,251 individuals were recorded. The detritus subsidies did not disturbed the tropic cascade significantly in the arthropod community (Mercer *et al.*, 2017).

Aquatic communities in riverine systems are naturally considered to be determined by abiotic factors. Recent investigations have revealed that biological controls are able of organizing these communities in large rivers and may become more prominent as a river system. The investigation was based on long-term data set to scrutinize numerous environmental variables as potential factors of aquatic community structure in a normal riverine ecosystem. The water dwelling time was the most significant factor affecting aquatic community structure for aquatic abundance and community structure. Non-metric multidimensional scaling and correlation analysis used applied to scrutinize spatial and temporal distribution patterns in aquatic community structure. The association amid water dwelling time and taxa groups differed demonstrating that other taxa specific drivers had some effect on aquatic community structure (Burdis and Hirsch, 2017). The burrowing crab *Barytelphusacunicularis* is most abundant in Godavari river and its tributaries(Padghane*et al.*, 2018).

The past few decades has seen an upsurge of interest in the using freshwater crabs as an ecological model for assessing impact of various environmental stress and pollutant in the rivers Therefor inorder look into the population biology for conservation of this crab, the study was undertaken.

Material and Methods

The area of study:

The study was conducted across the Godavari river basin and its tributaries. Field survey was carried out along the sides of river basin and its tributaries. Observations took place for the habitat, abundance and distribution of the crabs in the Godavari river basin near Markand which is just behind Vishnupuri project, Kaleshwar, Punegaon having an elevation 366 m above the sea level. Punegaon is a village in Nanded taluka 12 Km towards the east from Nanded city. Its geographical coordinates is 19^{o} 9’0” North and 77 ^{o} 20’ 0’’East, near Amdura, *Asna* river near Shikarghat Gurudwara; left bank tributary of Godavari, Fish catching area at Babli project in Dharmabad taluka of Nanded district. Also survey of the tributary *Purna* river near DhangarTaklali were carried out.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 1, 2021, Pages. 543 – 554
Received 15 December 2020; Accepted 05 January 2021.

Sampling the Data:

*Barytelphusaguerini*chosen for this study is one of the dominant species in thisriver. The collections were carried out monthly for a period of one year, from 2013-14, 2014-15 and 2015-16. Sampling of crabs was carried out monthly, the crabs *Barytelphusaguerini*were sampled using the simple quadrate square technique. This technique consistsof using a square (wired square) with size (100 x 100 cm) and pre-determined area ($1m^2$). It was sampled randomly 10 times in each area. The reproductive males were counted. Subsequently, the area was manually excavated to an average depth of 20 using shovels and spoons.

All crabs found were caught and stored in plastic bags, which are properly labeled and kept under refrigeration until the analysis. The crabs were sexed by observing the morphology of the abdomen and asymmetry. When it was not possible to perform the sex identification, the crabs were classified as recent juveniles.

Morphometrics:

All the morphometric dimensions were recorded for each of the collected crabs. Four morphometric measurements were performed by using vernier caliper (0.01mm). For the females were measured four measurements: carapace width (CW), carapace length (CL), carapace height (CH) and abdomen width (AW). While for males other than the four measures described above for females, three further measurements were also length of the proximal (CPQ), height of the proximal (APQ) and length of the gonopodia (CG). For the indeterminate individuals, only the CL was measured (Huggings, and Munday, 1968).

Crabs were sexed according to their relative abdomen width. The crabs were sexed by observing the abdomen morphology and asymmetry of chelipodes. When it was not possible to perform the by sex identification, crabs were classified as recent juveniles. For each individual different morphometric measurements were taken. For indeterminate individuals, only the CL was measured (Hirose et al., 2012).

Sex Ratio:

The male to female ratio between river and tributary was calculated as the proportion of the number of males to the total number of females. Thus, values of mating greater than or less than 0.5 point to an inclination towards either sex in the population, respectively. The sampling done at regular time interval and within of each size class, deviations from a sex ratio of 1: 1 was determined by a binomial test.

The crabs from each stratum in each sampled location were distributed in size classes according to the best data adjustment. The smallest size class started with the smallest individual. The individuals were classified according to the following categories: demographic; recent juveniles (undifferentiated individuals); young group (individuals already sexually differentiated, but with sizes below sexual maturity); and adults (individuals greater than or equal to the size of sexual maturity). The size classes were assigned ranging from 1.0 to 10.50 mm, at intervals of 0.5 mm carapace width (Wilson and Hardy, 2002).

Population Structure:

The frequency distribution of *B. guerini* presented a total of 20 classes of with amplitude of 5 mm. The modal differences for *B. guerini* between the river and tributaries can be observed graphically. In both locations, the modal presence was observed between the classes of 10 mm to

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 1, 2021, Pages. 543 – 554
Received 15 December 2020; Accepted 05 January 2021.

30 mm corresponds to recent juveniles, this class being the main component seen in the both the location. The class of 30.00 mm to 105 mm composed of females and adult males. The data recorded by carapace width measurements were grouped for each the month were divided into 20 classes of 5 mm width groups respectively. The data on the 5 mm width groups were used to determine the periodic age structure as determined from the carapace width, frequency distribution (Willason, 1981).

Results

In the laboratory, the crabs were sexed by observing the morphology of the abdomen and asymmetry of the chelipods. When it was not possible to perform the sex identification, the crabs were classified as recent juveniles. For morphometric measurements were performed using a precision digital caliper (0.01 mm), for the females were measured four measurements: carapace width (LC), carapace length (CC), carapace height(AC) and abdomen width (LA).

Abundance and size of crabs

The abundance of crabs was evaluated spatio-temporally, compared by variance analysis (ANOVA, $\alpha = 0.05$), usingriver and tributaries as fixed factors. In the comparison of the size of the same statistical routine was adopted, being the size of individuals compared with variance analysis (ANOVA, $\alpha = 0.05$).

During the study period, 159 individuals of B. guerini were sampled. Of these, 38 individuals belonged to the tributary in Parbhani of the river and 45 to the tributary in Nanded of the Godavari River. Of the individuals caught in the river bank or bed, 42 belonged to the Nanded, while 34 belonged to the Parbhani. The descriptive statistics for each demographic category during study is recorded in the table 1.

Table1: Total abundance of males and females of the Godavari rivers and its tributary in Nanded and Parbhani.

Area	Location	Category	N	Size of carapace		
				Minimum (mm)	maximum (mm)	Mean ± sd (mm)
Parbhani	river	Male	13	31.7	98.5	72.4 ± 15.2
		Female	11	30.3	92.6	70.1 ± 14.6
		Juveniles	10	10.1	23.6	17.4 ± 06.0
	tributary	Male	15	30.6	87.1	61.0 ± 14.1
		Female	10	30.4	88.0	53.4 ± 13.3
		Juveniles	13	10.7	232.8	18.4 ± 05.5
Nanded	river	Male	14	30.5	102.8	64.5 ± 16.7
		Female	13	30.2	98.2	64.7 ± 17.1
		Juveniles	15	10.3	24.6	18.7 ± 05.5
	Tributary	Male	15	27.5	95.3	57.5 ± 16.9
		Female	10	89.9	30.3	51.0 ± 16.9
		Juveniles	20	10.4	24.6	19.9 ± 05.0

Sd - standard deviation

The abundance of *B. guerini* did not vary significantly between the river basin and tributary in

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 1, 2021, Pages. 543 – 554
Received 15 December 2020; Accepted 05 January 2021.

Parbhani and the river basin and tributary in Nanded with a toal tally of 159 crab were sampled. But there was a considerable difference between the samples collected from these two district river basins. Regarding the size, the individuals of *B. guerini* showed differences between tributary river bank/bed; the individual from the open river was slightly larger than those form the tributary. The abundance of crabs in the river was higher as compared to tributaries as the most crabs were collected from river basin and few crabs were collected from tributaries. More male crabs than female crabs were collected throughout the year. The juvenile population from the river as well as tributaries was similar with the male and female crabs.

Relative abundance of male and female crabs at each of the sampling localities

The measurement of carapace widths for all collected crabs was determined and they were sexually differentiated as male female and undifferentiated as juvenile crabs.The collected crabs were differentiated and recorded for relative abundance for different sampling sites. The relative abundance of crabs(male female and juvenile) was determined by combining the data collected during theeach year of the monthly data and is presented graphically.

Table2 Relative abundance of male female and juvenile crabs at each ofthe sampling localities

Parbhani						Nanded					
P river			P tributary			N river			N Tributary		
Male	Female	Juveniles	Male	Female	Juveniles	Male	Female	Juveniles	Male	Female	Juveniles
13	11	10	15	10	13	14	13	15	15	10	20
34			38			42			45		
Rel. Abundance Male: 38.23% Female: 32.35%			Rel. Abundance Male:39.47% Female:26.31%			Rel. Abundance Male: 33.33% Female:30.95%			Rel. Abundance Male: 33.33% Female:22.22%		

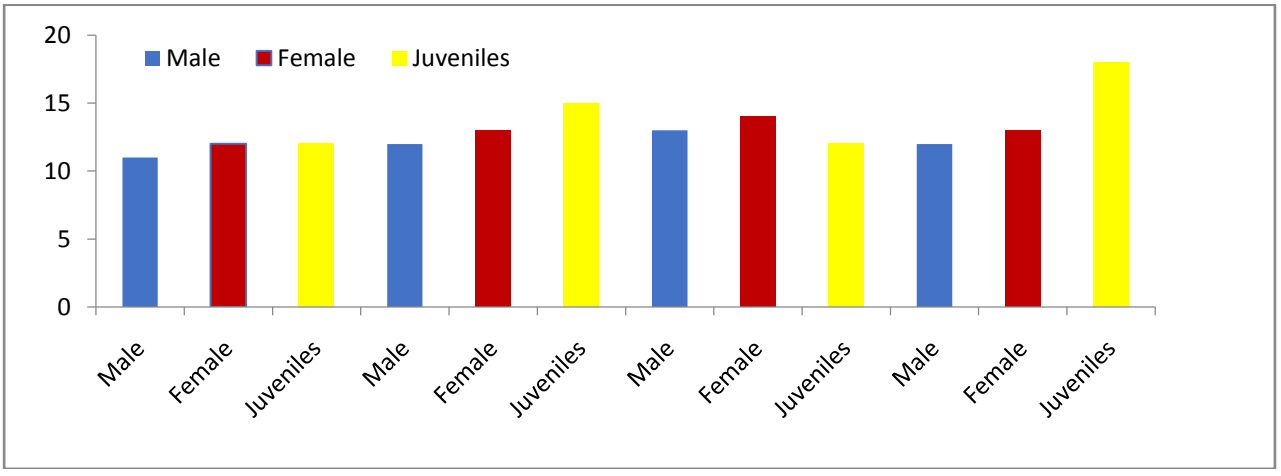

Figure 1 Relative abundance of male female and juvenile crabs at each ofthe sampling localities

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 1, 2021, Pages. 543 – 554
Received 15 December 2020; Accepted 05 January 2021.

The relative abundance among the crab population showed slight fluctuation between the numbers of crabs sampled from different localities (Table2). The numbers of crab collected from the river basin and the tributaries were at par with each other. However the number of crabs collected from Parbhani River and tributary was relatively less than that from Nanded River and tributary. The relative abundance of male crab from parbhani river basin was 38.23 and female crab was 32.35 and relative abundance of male crab from parbhani tributary was 39.47 and female crab was 26.31. The relative abundance of male crab from Nanded river basin was 33.33 and female crab was 30.95 and relative abundance of male crab from Nanded tributary was 33.33 and female crab was 22.22 (Figure 1).

Sexual ratio

The proportion between males and females between river and tributaries was estimated as the quotient between the number of males and the total number of individuals in our samples. Thus, values of sexual intercourse greater than or equal to 0.5 indicate an inclination to males or females in the population, respectively. For each sampling month and within of each size class, the deviations were tested from a sex ratio of 1: 1 using a binomial test ($\alpha = 0.05$) (Wilson and Hardy, 2002).

Table 3: Sex ratio between males and females of the Godavari River and its tributary in Nanded and Parbhani.

Area	Location	Category	N	ratio
Parbhani	river	Male	13	1:0.8
		Female	11	
		Total	24	
	tributary	Male	15	1:0.7
		Female	10	
		Total	25	
Nanded	river	Male	14	1:0.9
		Female	13	
		Total	25	
	Tributary	Male	15	1:0.7
		Female	10	
		Total	25	

The sex ratio between males and females in both on location either river basin or tributaries did not favor to any of the sex (Table 3). The river presented slight deviation in the sexual ratio for the males over tributaries for females. The sex ratio of males to femalesinParbhani river basin was 1:0.8 and in Parbhani tributary was 1:0.7. The sex ratio of males to females in Nanded river basin was 1:0.9 and in Nanded tributary was 1:0.7.

Structure of the population

The frequency distribution of *B. guerini* presented a total of 20 classes ofwith amplitude of 5 mm. The modal differencesfor*B. guerini*between the river and tributaries can be observed graphically. In both locations, the modal presence was observed between theclasses of 10 mm to 30 mm corresponds to recent juveniles, this class being the maincomponent seen in the both the location. The class of 30.00 mm to 105 mmcomposed of females and adult males. The data recorded by

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 1, 2021, Pages. 543 – 554
Received 15 December 2020; Accepted 05 January 2021.

carapace width measurements were grouped for each of the month were divided into 20 classes of 5mm width groups respectively. The data on the 5mm width groupswere used to determine the periodic age structure as determined from the carapacewidth frequency distribution.

By analyzing the location of river as well as tributaries of the Godavari river, it can be observed themodal pattern seen in spatial analysis, with the exception of a few months whereobserved the presence of recent juvenile in all the months throughout the year. In almost every month it was possible to define a modal pattern among the river as well as tributaries, where the modal class of the recent juveniles present between the classes of 10.00 to 30.00mm was followed by the class of 30.00 mm to 105 mm composed of females and adult males.

Table4: Monthly distribution in size for crabs collected in the Godavari river and its tributaries.

Size mm	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb		Mar	Apr	May
10	1		6					3				1	1
15	2	1	4	4			4		2		2	1	1
20				6	4				2		1		
25					5	6							
30		1	1	1	1		1	1				1	
35		2	2		1	1					1		1
40				2		1		1	1			1	
45	1		1				2					1	
50		1	1	1	1		1	1					
55		2	2		2	1					1		1
60				1		1		2	1			1	
65	1		2				1					1	
70		1		1	1						2		1
75	2					2		1					
80							1					1	1
85	1	1		1	1	1		1			2		
90	1		1				2		1				1
95		1		2	2	1		2	1		1	1	
100	2		1				1		2				1
105		1			1						2		

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 1, 2021, Pages. 543 – 554
Received 15 December 2020; Accepted 05 January 2021.

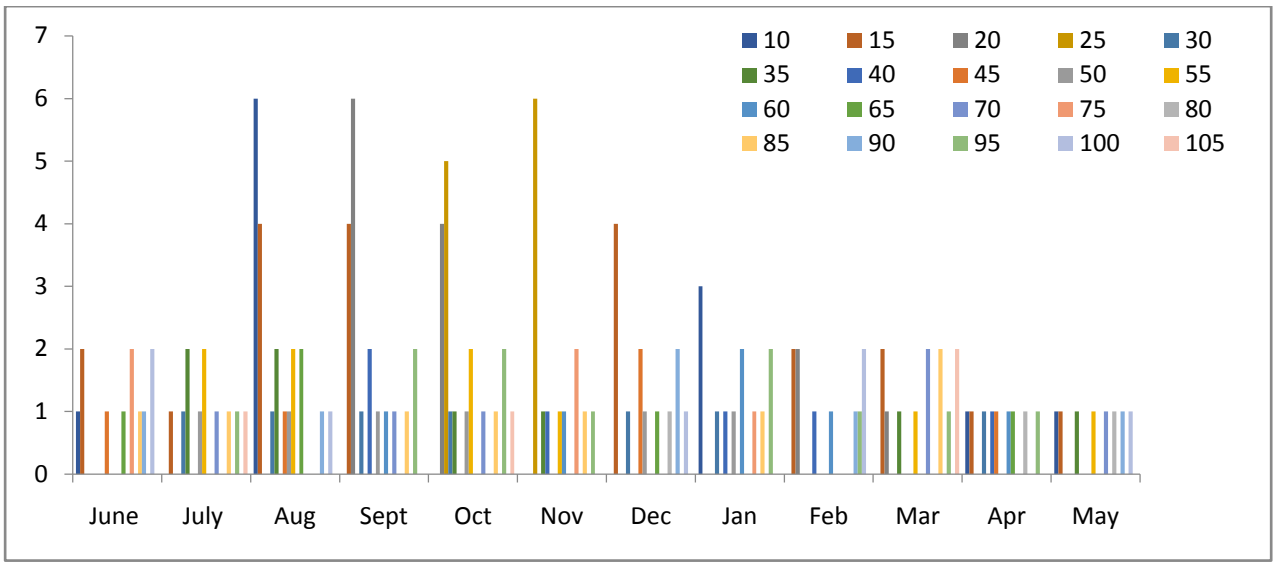

Figure2: Monthly distribution in size for crabs collected in the Godavari river and its tributaries.

The above table 4 and figure 2 shows the monthly distribution in size for crabs collected in the Godavari River and its tributaries. The data recorded by carapace width measurements were grouped for each of the month were divided into 20 classes of 5mm width groups respectively. The crab collected during each month showed an undifferentiated distribution of juvenile and adult crabs based on the size. The juveniles were collected throughout the year but the number of collected crabs was higher during August to November. The subsequent increase in age and size of the crabs collected were recorded and the distribution was random.

Table 5: Distribution of size classes for males and females' crabs collected from Godavari river and its tributaries.

Carapace size	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
Males	12	21	13	11	7	8	6	5	6	9	6	5	6	5	3	8	6	11	7	4
females	8	13	8	7	4	5	4	3	4	6	4	3	4	3	2	5	4	7	4	3

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 1, 2021, Pages. 543 – 554
Received 15 December 2020; Accepted 05 January 2021.

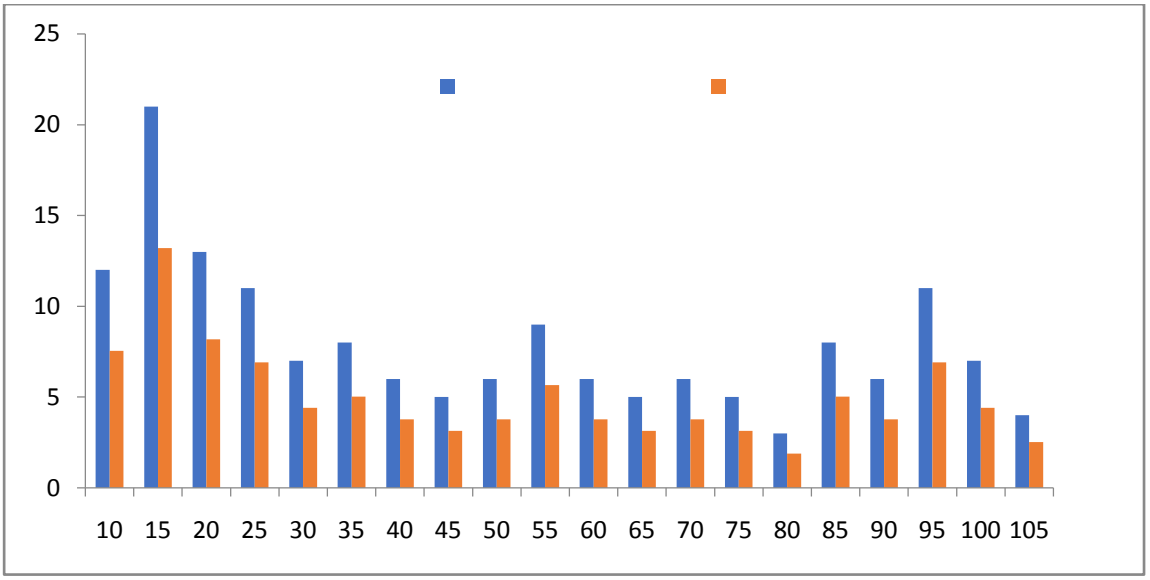

Figure 3: Distribution of size classes for males and females crabs collected from Godavari River and its tributaries.

A total of 156 individuals of crabs were collected that were differentiated sexually. Of the 156 crab sampled, 95(60.8%) were males and 61(39.1%) were females. Carapace width distributions of both sexes are shown in Figure 3. The population shows sex differences in the size frequency distributions, with males reaching larger size than females (70 -105mm and 35- 90mm CW, respectively). The females constituted relatively small size groups ranging from 45-55 and 55-65 mm CW. A few number of females exceeded 90 mm, whereas several males were larger than this size. The range size class was 90-105 mm for males and 75-9 5mm for females. The overall sex ratio (Male: female) was (1:1.1). The sex ratio of Crabs in the river and its tributaries was inclined toward males almost throughout the year and males outweighed the numbers of females in all months of the years(Table 5)

Discussion

In the present investigaton, the abundance of crab was not significantly different between the river basin and tributary in Parbhani and the river basin and tributary in Nanded. The size of the individuals of *B. guerini* showed differences between tributary river bank/bed; the individual from the open river was slightly larger than those form the tributary. The abundance of crabs in the river was higher as compared to tributaries as the most crabs were collected from river basin and few crabs were collected from tributaries. The juvenile population from the river as well as tributaries was higher to the male and female adults and similar with the male and female crabs.

Gunther (1992) suggests the existence of differential colonization between juveniles and adults because of juveniles avoid competition against the adults. Such behavior may be restricting the activity of juveniles where they can find protection from the weather and against aggressions from adult males (Croll&Mcclintock, 2000).

The highest abundance of *U. leptodactylus* was accompanied by larger body sizes, which may be associated with aggregation and consequent competition for resources in these area. Zucker (1986) suggested a relationship between crab size and increased likelihood of individuals. It is known that the size of the animals in regions with high concentrations of individuals of the same species are related to the quality of the resources acquired by individuals (Mathis, 1990).

Overall, in the present study there was little significant difference in sex ratio. However, in some months, males may be more frequently present which may be related to reproductive behavior, where the males move to open areas limiting a space to be defended for performing attracting habit to females.

The sex ratio between males and females in both on location either river basin or tributaries was the same. The river or tributaries did not present any deviation in the sexual ratio for the males over tributaries for females. The sex ratio of males to females in Nanded and Parbhani river basin and in Parbhani tributary was 1:1.1.

According to Wenner (1972), the analysis of the sex ratio for demonstrates the standard found in the natural environment, the sex ratio seemed better consistent with the anomalous pattern as a function of size, with little seasonal variation and presence of females in the larger classes, which can be explained by the tendency to post-reproductive mortality occur before males. Generally, the sex ratio is reported to be greater than 1: 1, with greater abundance of females (Masunari &Swiech-Ayoub, 2003; Castiglioni &Negreiros-Fransozo, 2006; Bedê et al., 2008).

The crabs collected were differentiated sexually, sex ratio, the carapace width distributions of both sexes. The population demonstrates sex divergences in the size frequency distributions where adult males having larger size than females (70 -105mm and 35- 90mm CW, respectively). The females constituted relatively small size groups ranging from 45-55 and 55-65 mm CW. A few number of females exceeded 90 mm, whereas several males were larger than this size. The range size class was 90-105 mm for males and 75-9 5mm for females. The overall sex ratio (Male: female) was (1:1.1). The sex ratio of Crabs in the river and its tributaries was inclined toward males almost throughout the year and males outweighed the numbers of females in all months of the years. Lambert & Epifanio (1982) and O'Connor (1993) observed that crabs tend to be located in areas other than specific adults. Christy (1978) suggested that behaviors of crab is affected by the surrounds and may be related to the presence of various environmental factors in the region.

The mode of distribution of adults occurred and growth of juveniles to adult may be related to secondary dispersion as a biological response function of reproductive behavior, morphological characteristics and / or environmental factors (Kraeuter, and Fegley, 19947; Powers & Peterson, 2000; Etherington & Eggleston, 2003; Reyns& Eggleston, 2004).

The conservation assessment of freshwater crabs in Maharashtra corresponds to the initial stride in the direction of the recognition of threatened species within the region. This will also direct to the improvement of a protection, preservation and conservation actions for endemic species. The constrained array of many species along with the man made harm to habitat disturbance or loss is key reasons of concern for the ever continued existence of this crab.

References

[1] Bahir, M. M., Yeo, D. C. J. (2007). The gecarcinucid freshwater crabs of sourthern India (Crustacea: Decapoda: Brachiura). *The Raffles Bulletin of Zoology*, 2007 Supplement No. 16: 309–354.

[2] BEDE, L. M.; OSHIRO, L. M. Y.; MENDES, L. M. D. & SILVA A. A. 2008. Comparison of the population structure of the species of Uca (Crustacea: Decapoda: Ocypodidae) in the mangrove of Itacuruca, Rio Janeiro, Brazil. **RevistaBrasileira de Zoologia 25**(4):601-607

[3] Burdis, R. M., Hirsch, J. K. (2017). Crustacean zooplankton dynamics in a natural

riverine lake, Upper Mississippi River. *Journal of freshwater ecology*, 2017, 32(1), 240– 258.

[4] Castiglioni, D.D.S., Fransozo, M.L.N. and Mortari, R.C., 2006. Biologiapopulacional do caranguejoviolinista Uca rapax (Smith, 1870)(Crustacea, Ocypodoidea), proveniente de umaárea de manguezaldegradadoemParaty, RJ, Brasil.

[5] Christy, J.H., 1978. Adaptive significance of reproductive cycles in the fiddler crab Uca pugilator: a hypothesis. *Science*, *199*(4327), pp.453-455.

[6] Croll, G.A. and McClintock, J.B., 2000. An evaluation of lekking behavior in the fiddler crab Uca spp. *Journal of Experimental Marine Biology and Ecology*, *254*(1), pp.109-121.

[7] Cumberlidge, N., Ng, P.K., Yeo, D.C., Magalhães, C., Campos, M.R., Alvarez, F., Naruse, T., Daniels, S.R., Esser, L.J., Attipoe, F.Y. and Clotilde-Ba, F.L., 2009. Freshwater crabs and the biodiversity crisis: importance, threats, status, and conservation challenges. *Biological Conservation*, *142*(8), pp.1665-1673.

[8] Deshai, R. B., Katore, B. P., Shinde, V. D. and Ambore, N. E. (2012). Behavioural study of female crab, *Barytelphusaguerini*under acute stress of dimethoate. *Intern. Multidiscip. Research Journal,* 2(5): 1-4.

[9] Etherington, L.L. and Eggleston, D.B., 2003. Spatial dynamics of large-scale, multistage crab (Callinectes sapidus) dispersal: determinants and consequences for recruitment. *Canadian Journal of Fisheries and Aquatic Sciences*, *60*(7), pp.873-887.

[10] Gunther, C. P. (1992). Dispersal of intertidal invertebrates: a strategy to react to disturbances of different scales. *Neth. J. Sea Res.*, 30, 45-56.

[11] Hirose, G. L., *Gregati, R. F., Fransozo, A., Fransozo M. L. N.* (2012) Morphological and morphometric comparisons of the first zoea of four species of purse crabs (Decapoda: Brachyura: Leucosiidae) from the Brazilian South Atlantic. *Zootaxa,* 3167, 17-31.

[12] Huggins, A.K. and Munday, K.A., 1968. Crustacean metabolism. In *Advances in comparative physiology and biochemistry* (Vol. 3, pp. 271-378). Elsevier.

[13] Jadhav, S. S., Shinde, V. D. Sirsat, D., Katore, B. P., Ambore, N. E. (2011). Impact of Mercuric Nitrate on the Oxygen Consumption of Freshwater Crab, *Barytelphusaguerini Recent Research in Science and Technology,* 2011,3(8):50-51.

[14] Kraeuter, J.N. and Fegley, S.R., 1994. Vertical disturbance of sediments by horseshoe crabs (Limulus polyphemus) during their spawning season. *Estuaries*, *17*(1), p.288.

[15] Lambert, R. and Epifanio, C.E., 1982. A comparison of dispersal strategies in two genera of brachyuran crab in a secondary estuary. *Estuaries*, *5*(3), pp.182-188.

[16] Masunari, S. and Swiech-Ayoub, B.D.P., 2003. Relative growth in the fiddler crab Uca leptodactyla Rathbun (Crustacea Decapoda Ocypodidae). *RevistaBrasileira de Zoologia*, *20*(3), pp.487-491.

[17] Mathis, A. (1990). Territoriality in a terrestrial salamander: the influence of resource

quality and body size. Behaviour, 112 (3-4): 162-175.

[18] Mercer, N., Kaller, M. D., Stout, M. J. (2017). Diversity of arthropods in farmed wetlands in the Gulf of Mexico Coastal Plain and effects of detrital subsidies, *Journal offreshwater ecology*, 2017, 32(1): 163–178.

[19] Ng, P. K. L. (1988). The freshwater crabs of Peninsular Malaysia and Singapore, Department of Zoology, National University of Singapore, Kent Ridge, Singapore, pp. vi-viii 1-156.

[20] Ng, P. K. L., Nesemann, H. F., Sharm, G. (2011). A new freshwater species of *Neorhynchoplaxsakai*, 1938 (Crustacea, Decapoda, Hymenosomatidae) from Patna, Bihar, India. *Zootaxa*, 1871, 3063: 53-63.

[21] O'Connor, N. J. (1993). Settlement and recruitment of the fiddler crabs *Uca pugnax* and *U. pugilator*in a North Carolina, USA, salt marsh. Marine Ecology Progress Series, 93: 227-234.

[22] Padghane, S. (2018). Habitat ecology of Burrowing crab *Barytelphusacunicularis* in the tributaries of Godavari river Nanded (MS), *India Advances in Bioresearch*, 9(3), 76-80, May, 2018.

[23] Powers, S. P.; Peterson, C. H. (2000). Conditional density dependence: the flow trigger to expression of density-dependent emigration in Bay Scallops. Limnology and Oceanography, 45(3): 727-732.

[24] Reyns, N.B. and Eggleston, D.B., 2004. Environmentally-controlled, density-dependent secondary dispersal in a local estuarine crab population. *Oecologia*, *140*(2), pp.280-288.

[25] Thankar, S. S. (1985) Effect of some pollutants on edible crab *Paratelphusajacauenmontii.* Thesis submitted to Amravati University, Amaravati.

[26] Venkateshwarlu, M., Sunita, A. (1995). Impact of monocrotophos on tissue carbohydrates of the freshwater crab, Barytelphusaguerini (M. Edwards). *Ind. J.Comp. Ani. Physiol.* 13: 35-36.

[27] Venugopal, N. B. R. K., Ramesh, T., Reddy, D. S. (1997). Effect of cadmium on antioxidant enzyme activities and lipid peroxidation in a freshwater field crab, *Barytelphusaguerini. Bull. Environ. Contam. Toxicol.* 59: 132-138.

[28] Wenner, A.M., 1972. Sex ratio as a function of size in marine Crustacea. *The American Naturalist*, *106*(949), pp.321-350.

[29] Willason, S. W. (1981). Factors Influencing the distribution and coexistence of *Pachyprapsus crassipes* and*Hemigrapsusoregonensis*(Decapoda: Grapsidae) in aCalifornia salt marsh. *Marine Biology*, 64, 125-133.

[30] Wilson, K., Hardy, I. C. W. (2002). Statistical analysis of sex ratio: an introduction. In: Sex ratios: concepts and research methods, cap. 3, 48-92.

[31] Zucker, N., 1986. On courtship patterns and the size at which male fiddler crabs (genus Uca) begin to court. *Bulletin of marine science*, *38*(2), pp.384-388.