

Habitat suitability analysis and monitoring of various factor for survival of model organism - crabs

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Abstract: Freshwater crabs 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. They are ecologically as well as economically significant owing to their role in nutrient recycling, water quality monitoring and small-scale fisheries. 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 the analysis of environmental factors prevailing habitat of *Barytelphusa guerini* in and near the Godavari river basin and its tributaries such as temperature of water, soil near the bank of river, analysis of pH, turbidity, hardness, conductivity and dissolved oxygen. Alteration in values of environmental parameters due to water pollution affects habitats of crab *Barytelphusa guerini* in the Godavari river and its tributaries.

Keywords: *Barytelphusa guerini*, The Godavari river, Tributary, Temperature, pH, Turbidity, Hardness, Conductivity, Dissolved Oxygen.

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 and economically significant owing to their function in recycling nutrient, monitoring water quality and small-scale fisheries. Nearly 1280 species belonging to 4 super families occurring throughout the world that sum up to 20% of identified brachyuran diversity (Cumberlidge *et al.*, 2009). A sum of 96 species belonging to 41 genera constituting 6 families till now are discovered from India (Bahir and Yeo, 2005, 2007 and Ng *et al.*, 2011).

Five species belonging to families Sesamidae, Varunidae and Hymenosomatidae are recorded from India where the members are marine or estuarine forms. 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.

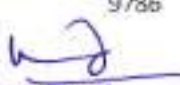
The past few decades have seen an upsurge of interest in the using freshwater crabs as ecological model for assessing impact of various environmental stress and pollutant in the rivers (Jadhav, *et al.* 2011). A number of studies have showed that various chemical pollutant and pesticides have affected 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 behavioral and various physiological studies.


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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)

Some valuable contribution has been made by Ambore (1976), Mali (2001) study the effect of the physiology and organic compounds on the the crab *Barytelphusa guerini*. Lundebye et al. (1997) *Cancer magister*, McGraw and McMahon (1998). Barde and Patil, (2003), Barde, (2009, 2010,) studied the effect of pesticides on various physiological aspects of the crab

Adaptation of freshwater crabs to different salinities altered sum of free amino acids qualitatively and quantitatively. Quantity of amino acids increased in 25% and 100% sea water where it was enhanced in females in both media. The sex and salinity of the medium affected qualitative. The concentration of amino acids in the blood regulates blood osmotic pressure and is dependent of the osmotic gradient. (Venkatachari and Keshavan, 1973).

Animals adapted to low temperatures demonstrate a elevated metabolic rate than animals adapted to high temperatures. This has been reported by various researchers (Vernberg & Vernberg, 1972). Adaptation of animals to low and high temperatures in laboratory has been confirmed by many researchers (Saroja, 1961). The effect of salinity changes on temperature tolerance have been studied less extensively. The work of Todd & Dehnell (1960) on the crabs, *Hemigrapsus nudus* and *H. oregonensis* require special mention. A number of differences in chemical composition of tissues have been connected with differences in environmental temperatures. Dean and Vernberg (1967) reported the effect of temperature adaptation on carbohydrate metabolism in decapod Crustacea.

The effect of temperature and salinity on freshwater crab, *Barytelphusa cunicularis* was studied. Experiments conducted on different temperature and salinity combinations resulted change in the upper temperature tolerance. The changes in the total water content led to variation on total protein, fat, glycogen and blood glucose after acclimation to different temperatures. (Diwan and Nagabhushanam, 1976).

The freshwater crab *Barytelphusa guerini* can with stand the gradual move to higher salinity reaching seawater enable the crab to regulate blood chlorides. Its metabolic rate demonstrates least in 50% marine water and amplifies on dilution and increased concentration of the medium. However, this increase is more pronounced in hypotonic than in hypertonic media (Venkatachari & Vasantha, 1979).

MATERIAL AND METHODS

The area of study:

The study was conducted across the Godavari river basin and its tributaries. Survey was carried out along the sides of river basin and its tributary. 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, Pune gaon having an elevation 366 meters above the sea level. Pune gaon is a village in Nanded taluka 12 km towards the east from Nanded city. Its geographical coordinates are 19° 9' 0" North and 77° 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 Dhangartaklaji were carried out.

The climatic conditions prevalent in the region in this region rainfall varies between 1,100 mm and 1,500 mm, that is the three climatic seasons are well defined, one season rainfall occurs in the first half of the year between the months of April to August, and Corresponds to more than 70% of

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precipitation, and a dry season occurs in the second between the months of September and March. The seasonal temperature variation is very significant,

Sampling the data

Barytelphusa guerini chosen for this study is one of the dominant species in this river. The collections were carried out monthly for a period of one year, from 2013-14, 2014-15=2015-16. Sampling of crabs was carried out monthly, the crabs *Barytelphusa guerini* were sampled using the simple quadrat square technique. This technique consists of using a square (wired square) with size (100 x 100 cm) and pre-determined area (1 m²). 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.

Environmental Parameters

The measured environmental data, air temperature, water temperature, soil temperature, salinity and percentage of organic matter, were compared between river and tributary strata and estuaries by an analysis of factorial variance (ANOVA, $\alpha = 0.05$).

At each site, location sampled from both river and tributary, the soil temperature, air temperature, and temperature nearest water source, salinity were recorded. In each site, location stratum of both river and tributary, the sediment samples were also collected. The substrate was collected monthly kept in refrigerator till analysis of organic matter content in the laboratory. The samples of sediment from each site were analyzed separately. The sample of 10 grams separated for analysis of the percentage of organic matter and the remainder used for particle size analysis.

For the organic matter content, the samples were dried for 1 hour at room temperature and then were placed in a porcelain crucibles and transferred to muffle furnace for 1 hour. Each sample was again weighed and the difference in the earlier and later weight (ash free weight) was determined. The organic matter content of the substrate in grams, which was subsequently converted to a percentage (Mantelatto and Fransozo, 1999).

Temperature of water, soil and air

Temperature was measured at the same place in the water body to ensure the data is collected from the same water body at the given time. The temperature of air was recorded by a thermophore or thermometer exposed to the air without restraint and shielded from heat and humidity (Anonymous, (2016), (DES. 2018.).

pH of water sample

The pH of the water samples was determined following Anonymous (2016). The sample was stirred continuously. The pH was measured using calibrated pH meter using electrode. The pH was also determined by pH paper.

Turbidity of water sample

The turbidity of water alters the clearness owing to the occurrence of clay or silt, suspended organic matter, phyto or zooplankton, microorganisms etc. The values are expressed in NTU (Nephelometric Turbidity Units). The turbidity was determined by turbidimetric method following standard method Anonymous (2016).

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Analysis of Dissolved Oxygen in water

Dissolved Oxygen (DO) is expressed as milligrams of oxygen gas (O₂) dissolved in one litre of water (i.e. mg/L). The amount of DO in a waterbody at a specified temperature and salinity (% saturation) gives the maximum values of DO. The DO was determined by DO sensors with temperature and salinity compensation for DO saturation value calculations (DES, 2018).

Analysis of Conductivity of Water

Conductivity of water is the water ability to conduct an electric current, an indirect measure of the quantity of chloride, nitrate, sulphate, phosphate, sodium, magnesium and calcium ions in solution. The conductivity of the water is determined by conductivity meter (DES, 2018).

Analysis of hardness of water samples

Water hardness is a quantification of the water ability to precipitate soap and is a differential and composite combination of cations and anions. They major constituent are dissolved calcium and magnesium ion in water. The hardness was determined by EDTA method Anonymous (2016).

RESULT AND DISCUSSION

The temperature of water in river and tributaries:

The environmental parameters were recorded viz. temperature of water and temperature of soil pH of water, dissolved oxygen, conductivity, and hardness. However, it was very difficult to collect the parameters of water temperature and salinity in the months of July, August and September each year as the flow of water was more and not consistent. The sampling was done at regular time interval but soon after the recession of water level. Mean values found for such variables were (Table 1).

Table 1: The temperature indicating Minimum and maximum values measured in the water of the river and tributary in Nanded and Parbhani districts

	2013-14				2014-15				2015-16			
	Parbhani		Nanded		Parbhani		Nanded		Parbhani		Nanded	
Mon th	Riv er	tributa ry	rive r	tributa ry	Riv er	tributa ry	rive r	tributa ry	Riv er	tributa ry	rive r	tributa ry
Jun.	29.5	28	28.6	27.1	30.2	28.7	29.3	27.8	29.9	28.4	29	27.5
Jul.	29.1 5	27.65	28.2 5	26.75	29.8 5	28.35	28.9 5	27.45	29.5 5	28.05	28.6 5	27.15
Aug.	29.1 5	27.65	28.2 5	26.75	29.8 5	28.35	28.9 5	27.45	29.5 5	28.05	28.6 5	27.15
Sep.	27.8 5	26.35	26.9 5	25.45	28.5 5	27.05	27.6 5	26.15	28.2 5	26.75	27.3 5	25.85
Oct.	30.8	29.3	29.9	28.4	31.5	30	30.6	29.1	31.2	29.7	30.3	28.8
Nov.	27.6 5	26.15	26.7 5	25.25	28.3 5	26.85	27.4 5	25.95	28.0 5	26.55	27.1 5	25.65
Dec.	25.1 5	23.65	24.2 5	22.75	25.8 5	24.35	24.9 5	23.45	25.5 5	24.05	24.6 5	23.15
Jan.	23.9 5	22.45	23.0 5	21.55	24.6 5	23.15	23.7 5	22.25	24.3 5	22.85	23.4 5	21.95

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Feb.	26.2 5	24.75	25.3 5	23.85	26.9 5	25.45	26.0 5	24.55	26.6 5	25.15	25.7 5	24.25
Mar.	30.4 5	28.95	29.5 5	28.05	31.1 5	29.65	30.2 5	28.75	30.8 5	29.35	29.9 5	28.45
Apr.	33.6 5	32.15	32.7 5	31.25	34.3 5	32.85	33.4 5	31.95	34.0 5	32.55	33.1 5	31.65
May.	37.1 5	35.65	36.2 5	34.75	37.8 5	36.35	36.9 5	35.45	37.5 5	36.05	36.6 5	35.15

The temperature of the water during 2013-2014 at various location of study is given the table 1. The temperature was usually higher in summer months and lower in the winter months. The maximum temperature ranged between 36.2 to 38.6 °C in both the districts however there was slight variation in the river and tributaries. The minimum temperature ranged between 21.3 to 22.0°C in December 2013 – January 2014. The standard deviation with the range of variations of temperature was 4.032. The temperature of the water during 2014-2015 at various location of study is given the table 2. The temperature was usually higher in summer months and lower in the winter months. The maximum temperature ranged between 36.9 to 39.3 °C in both the districts however there was slight variation in the river and tributaries. The minimum temperature ranged between 24.4 to 22.0°C in December 2014 – January 2015. The standard deviation with the range of variations of temperature was 4.119. The temperature of the water during 2015-2016 at various location of study is given the table 3. The temperature was usually higher in summer months and lower in the winter months. The maximum temperature ranged between 36.6 to 39.0 °C in both the districts however there was slight variation in the river and tributaries. The minimum temperature ranged between 24.8 to 21.7°C in December 2014 – January 2015. The standard deviation with the range of variations of temperature was 4.214.

The temperature of soil on the banks of river and tributaries:

The environmental parameters were recorded viz. temperature of air, temperature of water and temperature of soil and salinity. However, it was very difficult to collect the parameters of soil temperature in the months of July, August and September each year as the flow of water was more and not consistent. The recording and sampling was done at regular time interval but soon after the recession of water level. Mean values found for such variables were (Table 2)

Table 2: The temperature indicating Minimum and maximum values measured of soil near the river and tributary in Nanded and Parbhani districts

Month	2013-14				2014-15				2015-16			
	Parbhani		Nanded		Parbhani		Nanded		Parbhani		Nanded	
	Riv er	tributa ry	rive r	tributa ry	Riv er	tributa ry	rive r	tributa ry	Riv er	tributa ry	rive r	tributa ry
Jun.	31.6	30.1	30.7	29.2	30.9 5	32.95	30.0 5	28.55	32	30.5	31.1	29.6
Jul.	31.1 5	29.65	30.2 5	28.75	31.8 5	33.85	30.9 5	29.45	31.5 5	30.05	30.6 5	29.15

Aug.	31.1 5	29.65	30.2 5	28.75	31.8 5	33.85	30.9 5	29.45	31.5 5	30.05	30.6 5	29.15
Sep.	29.8 5	28.35	28.9 5	27.45	30.5 5	32.55	29.6 5	28.15	30.2 5	28.75	29.3 5	27.85
Oct.	32.8 5	31.3	31.9 5	30.4	33.5 5	35.5	32.6 5	31.1	33.2 5	31.7	32.3 5	30.8
Nov.	29.6 5	28.15	28.7 5	27.25	30.3 5	32.35	29.4 5	27.95	30.0 5	28.55	29.1 5	27.65
Dec.	27.1 5	25.65	26.2 5	24.75	27.8 5	29.85	26.9 5	25.45	27.5 5	26.05	26.6 5	25.15
Jan.	25.9 5	24.45	25.0 5	23.55	26.6 5	28.65	25.7 5	24.25	26.3 5	24.85	25.4 5	23.95
Feb.	28.2 5	26.75	27.3 5	25.85	28.9 5	30.95	28.0 5	26.55	28.6 5	27.15	27.7 5	26.25
Mar.	32.4 5	30.95	31.5 5	30.05	33.1 5	35.15	32.2 5	30.75	32.8 5	31.35	31.9 5	30.45
Apr.	35.6 5	34.15	34.7 5	33.25	36.3 5	38.35	35.4 5	33.95	36.0 5	34.55	35.1 5	33.65
May.	39.1 5	37.65	38.2 5	36.75	39.8 5	41.85	38.9 5	37.45	39.5 5	38.05	38.6 5	37.15

The temperature of the soil on the banks during 2013-2014 at various location of study is given the table 4. The temperature was usually higher in summer months and lower in the winter months. The maximum temperature ranged between 38.2 to 40.6 °C in both the districts however there was slight variation in the river and tributaries. The minimum temperature ranged between 23.3 to 26.4 °C in December 2013 – January 2014. The standard deviation with the range of variations of temperature was 4.214.

The temperature of the soil on the banks during 2014-2015 at various location of study is given the table 5. The temperature was usually higher in summer months and lower in the winter months. The maximum temperature ranged between 38.9 to 43.3 °C in both the districts however there was slight variation in the river and tributaries. The minimum temperature ranged between 24.0 to 27.1 °C in December 2014 – January 2015. The standard deviation with the range of variations of temperature was 4.124.

The temperature of the soil on the banks during 2015-2016 at various location of study is given the table 6. The temperature was usually higher in summer months and lower in the winter months. The maximum temperature ranged between 38.6 to 41.0 °C in both the districts however there was slight variation in the river and tributaries. The minimum temperature ranged between 23.7 to 26.8 °C in December 2014 – January 2015. The standard deviation with the range of variations of temperature was 4.124.

Table 3: Analysis of pH of water samples from Godavari river and tributaries

pH	2013-14		2014-15		2015-16	
	Parbhani	Nanded	Parbhani	Nanded	Parbhani	Nanded

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	river	tributary	river	tributary	river	tributary	river	tributary	river	tributary	river	tributary
Jun.	8.0	7.8	8.1	8.2	8	7.6	7.5	7.6	7.8	7.5	7.8	7.8
Jul.	7.6	7.8	7.6	7.7	7.8	7.8	7.7	7.6	7.6	7.5	7.7	7.5
Aug.	7.5	7.7	7.5	7.6	8.1	7.6	7.5	7.7	7.6	7.6	7.7	7.5
Sep.	7.6	7.6	7.7	7.5	8.2	7.7	7.6	7.5	7.8	7.6	7.6	7.8
Oct.	7.8	7.5	7.8	7.8	7.8	7.6	7.6	7.8	7.8	8.1	7.9	8
Nov.	7.6	7.5	7.7	7.5	7.5	7.5	7.6	7.6	7.9	8.4	8.1	8.3
Dec.	7.6	7.6	7.7	7.5	7.8	7.7	7.7	7.6	8.1	7.9	8.2	8.4
Jan.	7.8	7.6	7.6	7.8	7.8	7.5	7.5	7.8	8.4	8.1	8.5	8.4
Feb.	7.8	8.1	7.9	8.0	7.8	7.9	8.1	8.4	8	7.8	8.1	8.2
Mar.	7.9	8.2	8.1	8.3	8.1	8.4	7.9	8.1	7.6	7.8	7.6	7.7
Apr.	8.1	7.9	8.2	8.2	7.9	8.1	8.2	8.4	7.5	7.7	7.5	7.6
May.	8.2	8.1	8.2	8.2	8	8.3	8.4	8.4	7.6	7.6	7.7	7.5

The mean pH values for all the location on river and the tributaries were very similar, with the highest mean pH at Nanded and the lowest pH value at various locations on the river as well as tributaries. The lowest pH measurement was recorded at various points on rivers as well as tributaries throughout the year whereas the highest pH value was recorded at Nanded with a value of 8.2.

The mean pH values for all the location on river and the tributaries were very similar, with the highest mean pH at Nanded and the lowest pH value at various locations on the river as well as tributaries. The lowest pH measurement was recorded at various points on rivers as well as tributaries throughout the year whereas the highest pH value was recorded at various locations in both the district with a value of 8.4.

The mean pH values for all the location on river and the tributaries were very similar, with the highest mean pH at Nanded and the lowest pH value at various locations on the river as well as tributaries. The lowest pH measurement was recorded at various points on rivers as well as tributaries throughout the year whereas the highest pH value was recorded at Nanded with a value of 8.5 during November.

Table 4: Analysis of water for dissolved oxygen in samples from Godavari river and tributaries

DO in mg/l	2013-14				2014-15				2015-16			
	Parbhani		Nanded		Parbhani		Nanded		Parbhani		Nanded	
	river	tributary	river	tributary	river	tributary	river	tributary	river	tributary	river	tributary

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l	r	y	r	y	r	y	r	y	r	y	r	y
Jun.	29	30	32	29	29	34	31	36	19	17	16	15
Jul.	34	35	34	35	30	35	29	33	25	24	22	24
Aug.	31	29	32	33	32	34	32	39	36	37	35	37
Sep.	36	33	39	36	29	35	33	36	51	48	51	48
Oct.	19	17	16	15	19	25	36	51	44	49	47	48
Nov.	25	24	23	24	17	24	37	48	45	49	49	48
Dec.	36	37	35	37	16	24	35	51	52	52	53	49
Jan.	51	48	51	48	15	24	37	48	50	52	54	53
Feb.	44	49	47	48	44	45	53	50	29	30	32	29
Mar.	45	49	49	48	49	49	52	52	34	35	34	35
Apr.	52	52	53	49	47	49	53	54				
May.	50	52	54	53	48	48	49	53				

The dissolved oxygen in terms of mg/l in the Godavari River and its tributaries reflected a medium concentration. The mean DO value of water samples collected from all locations were in the range of 23 to 52 mg/l, thus indicating water suitable for living organisms. The highest mean value was recorded at Nanded during May whereas the lowest mean value was recorded at Nanded during November.

The dissolved oxygen in terms of mg/l in the Godavari River and its tributaries reflected a medium concentration. The mean DO value of water samples collected from all locations were in the range of 24 to 53 mg/l, thus indicating water suitable for living organisms. The highest mean value was recorded at Nanded during February whereas the lowest mean value was recorded at various locations in both the district.

The dissolved oxygen in terms of mg/l in the Godavari River and its tributaries reflected a medium concentration. The mean DO value of water samples collected from all locations were in the range of 22 to 54mg/l, thus indicating water suitable for living organisms. The highest mean value was recorded at Nanded during January whereas the lowest mean value was recorded at Nanded during July.

Conductivity:

Total dissolved solids are the quantity of dissolved material in water is constituted by the solubility of rocks and soils through which the water flows. The flow through limestone and gypsum contributes to calcium carbonate, and sulfate leading to high levels of total dissolved solids. The TDS can be measured by determining the conductivity of the sample. Conductivity is a measure of the ability of water to pass an electric current, affected by the presence of dissolved solids in


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the water samples. The increase in TDS leads to increase in the conductivity. Various discharges in the water streams can alter the conductivity depending on the discharge.

Table 5: Analysis of Water Conductivity of water samples from Godavari River and tributaries

Conductivity at 25°C in $\mu\text{S}/\text{m}$	2013-14				2014-15				2015-16			
	Parbhani		Nanded		Parbhani		Nanded		Parbhani		Nanded	
	riv er	tributa ry	riv er	tributa ry	riv er	tributa ry	riv er	tributa ry	riv er	tributa ry	riv er	tributa ry
Jun.	118	120	112	121	118	80	81	84	154	160	170	162-
Jul.	79	84	81	83-	120	84	80	81	191	183	190	185
Aug.	81	79	82	84	112	81	82	85	200	205	198	194
Sep.	84	81	85	84	121	83-	84	84	210	212	217	222
Oct.	154	160	170	162-	154	191	200	210	221	220	236	235
Nov.	191	183	190	185	160	183	205	212	241	243	260	265
Dec.	200	205	198	194	170	190	198	217	273	272	266	267
Jan.	210	212	217	222	162	185	194	222	284	285	259	265
Feb.	221	220	236	235	221	241	273	284	118	120	112	121
Mar.	241	243	260	265	220	243	272	284	79	84	81	83-
Apr.	273	272	266	267	236	260	266	259	81	79	82	84
May.	284	287	259	265	235	265	267	265	84	81	85	84

The conductivity of river and tributaries water samples in the study ranges from $79\mu\text{S}/\text{cm}$ to $287\mu\text{S}/\text{cm}$. There was a variation in the values of conductivity in the river as well as the tributaries in the both districts of Nanded and Parbhani. The highest mean conductivity level was measured during May in Parbhani with a mean value of $287\mu\text{S}/\text{cm}$ whereas the lowest was recorded in August with a mean value of $79\mu\text{S}/\text{cm}$ in Parbhani. Similar values were obtained for different locations.

The conductivity of river and tributaries water samples in the study ranges from $80\mu\text{S}/\text{cm}$ to $287\mu\text{S}/\text{cm}$. There was a variation in the values of conductivity in the river as well as the tributaries in the both districts of Nanded and Parbhani. The highest mean conductivity level was measured during February and march in Nanded with a mean value of $284\mu\text{S}/\text{cm}$ whereas the lowest was recorded in June and July with a mean value of $80\mu\text{S}/\text{cm}$ in Nanded and Parbhani.

The conductivity of river and tributaries water samples in the study ranges from $79\mu\text{S}/\text{cm}$ to $285\mu\text{S}/\text{cm}$. There was a variation in the values of conductivity in the river as well as the tributaries in the both districts of Nanded and Parbhani. The highest mean conductivity level was measured during January in Parbhani with a mean value of $284\mu\text{S}/\text{cm}$ whereas the lowest was recorded in June and July with a mean value of $79\mu\text{S}/\text{cm}$ in Parbhani. Similar values were obtained for different locations.

Table 6: Analysis of hardness of water samples from Godavari river and tributaries

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Hardness As CaCO ₃ in mg/l	2013-14				2014-15				2015-16			
	Parbhani		Nanded		Parbhani		Nanded		Parbhani		Nanded	
	river	tributary	river	tributary	river	tributary	river	tributary	river	tributary	river	tributary
Jun.	52	53	54	52	52	53	47	44	45	46	46	45
Jul.	53	52	52	53	53	52	52	44	49	48	49	49
Aug.	47	52	48	47	54	52	48	43	49	48	48	49
Sep.	44	44	43	44	52	53	47	44	47	47	46	47
Oct.	44	42	42	44	45	49	49	47	44	42	42	44
Nov.	42	41	42	42	46	48	48	47	42	41	42	42
Dec.	39	38	39	39	46	49	48	46	39	38	39	39
Jan.	43	43	42	43	45	49	49	47	43	43	42	43
Feb.	45	46	46	45	44	42	39	43	52	53	55	52
Mar.	49	48	49	49	42	41	37	43	53	52	52	53
Apr.	49	48	48	49	42	42	39	42	47	52	48	47
May.	47	47	46	47	44	42	39	43	44	44	43	44

The hardness in terms of CaCO₃ values in the Godavari River and its tributaries reflected a low calcium concentration. The mean hardness value of water samples collected from all locations were above in the range of 38 to 54 mg CaCO₃/l, thus indicating soft water suitable for living organisms. The highest mean value was recorded at Nanded during June whereas the lowest mean value was recorded at Parbhani during December.

The hardness in terms of CaCO₃ values in the Godavari River and its tributaries reflected a low calcium concentration. The mean hardness value of water samples collected from all locations were above in the range of 37 to 54 mg CaCO₃/l, thus indicating soft water suitable for living organisms. The highest mean value was recorded at Parbhani during August whereas the lowest mean value was recorded at Nanded during March.

The hardness in terms of CaCO₃ values in the Godavari River and its tributaries reflected a low calcium concentration. The mean hardness value of water samples collected from all locations were above in the range of 38 to 55mg CaCO₃/l, thus indicating soft water suitable for living organisms. The highest mean value was recorded at Nanded during February whereas the lowest mean value was recorded at Parbhani during December.

It is known that *Barytelphusa guerini* occupy habitat in the basin of river Godavari and its tributaries according to their physiological capacities, and that the temperature, pH, DO, conductivity and hardness, are the main factors influencing the distribution of *Barytelphusa guerini*. The similarity of these variables among various factor studied throughout the year influenced the *Uca* species (Frusher et al, 1994)

The temperature of the water during the study period at various location of study was usually higher in summer and lower in the winter. The temperature ranged between 21.7°C to 39.0 °C in both the districts however there was slight variation in the Godavari and its tributaries. The temperature of the soil on

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the banks at various location of study was usually higher in summer months and lowers in the winter months and ranged between 26.8 ° to 41.0 °C in both the districts however there was slight variation in the river and tributaries.

Breeding is normally recurring in sea crabs and concurrence with lunar or semi-lunar rhythms peaking near the spring tides. In the tropics reproduction may occur year-round as in Jamaican mangrove crabs (Warner, 1967). Reproduction is seasonal, dependent and based on variation in rainfall. Mating is though planned as a regular event in the majority of terrestrial and aquatic crabs. In general, crabs mate just after reaching sexual adulthood. Morphological and physiological factors often prevent premature copulation. The physiological stages of the crab at the time of mating differs among species and within the species and sexes (Cumberlidge, 2009).

The mean pH values for all the location on river and the tributaries were very similar, with the highest mean pH at Nanded and the lowest pH value at various locations on the river as well as tributaries. The lowest pH measurement was recorded at various points on rivers as well as in the tributaries throughout the year was 7.4 whereas the highest pH value was 8.5.

Chemical speciation of the metals was varied by using different pH and salinity conditions ranging from combinations between pH 7.0 and 8.5 and salinity from 560 and 140 mM of NaCl. With these conditions, the results showed that heavy metal accumulation in gill tissue. These variations in pH and salinity data revealed complex pH and salinity interactions (Laporte et al., 1997). However, neutral pH favored the normal functioning of the crabs (Pavasovic et al., 2004).

The dissolved oxygen in terms of mg/l in the Godavari-River and its tributaries reflected a medium concentration and was in the range of 22 to 54 mg/l, thus indicating water suitable for living organisms. Many species of decapod crustaceans inhabit the niche with variable supply of oxygen. Physiological system improves the capability of these crustaceans to deal with sensitive incident of low oxygen tension. *Lithodes santolla* demonstrated survival in significant oxygen tension between 4 and 9 kPa, indicating that this crab species is more sensitive to DO than other crustacean species (Paschke et al., 2010).

The conductivity of river and tributaries water samples in the study ranges from 80µs/cm to 287µs/cm however variation in the values of conductivity in the river as well as the tributaries in the both districts of Nanded and Parbhani was evident. The highest mean conductivity level was measured during February and march in Nanded with a mean value of 284µs/cm whereas the lowest was recorded in June and July with a mean value of 80µs/cm in Nanded and Parbhani. This is due to the monsoon rains where rain water dilutes the dissolved salts in river water. This also affects the hardness in terms of CaCO₃ values were in the range of 38 to 55mg CaCO₃/l, thus indicating soft water suitable for living organisms.

The rate of respiration in Blue crab falls through the early stage of decrease in salinity at a correlated to the rate of salinity decrease. This acclimatization indicates that the crab of capable of metabolic adjustment over a period. The respiratory reaction of *T. haemastoma* to salinity is reliable with its partial degree regulation, whereas the reaction of *C. sapidus* is well-matched with its capability to control extracellular fluid with osmotic and ionic composition (Soucek and Kennedy, 2005).

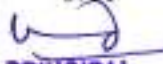
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