



## Temporal Variation in the Hydrobiology of Vembanad Lake at Panangad-Kumbalam Mangrove Patches of Kochi, Kerala

Mogalekar H.S.<sup>1\*</sup>, Adnankhan Golandaj<sup>2</sup>, Ansar C.P.<sup>2</sup>, Raman N.N.<sup>2</sup> and Devkate Ajinkya<sup>2</sup>

<sup>1</sup>Department of Fisheries Biology and Resource Management, Fisheries College and Research Institute, Tamil Nadu Fisheries University, Thoothukudi-628 008, Tamil Nadu, INDIA

<sup>2</sup>School of Fisheries Resource Management and Harvest Technology, Faculty of Fisheries, Kerala University of Fisheries and Ocean Studies, Panangad, Kochi – 682506, Kerala, INDIA

Available online at: [www.isca.in](http://www.isca.in), [www.isca.me](http://www.isca.me)

Received 1<sup>st</sup> November 2014, revised 16<sup>th</sup> February 2015, accepted 21<sup>st</sup> March 2015

### Abstract

The present investigation scrutinized the hydrobiological status of Vembanad Lake at Panangad-Kumbalam mangrove patches of Kochi. Distinct variations of hydrographic state and its influence on zooplankton abundance were observed. Study area revealed presence of 13 mangrove species belonging to 7 family and 9 genera. Salinity showed wide fluctuation (1.70‰ to 30.5‰). Average salinity was 19.74‰ indicated mesohaline nature. The average annual temperature was comparatively normal (28.94°C). Transparency showed lowest value during July (39.3 cm). The average pH during the study period was (7.38) on alkaline side. Dissolved oxygen was high (7.7 mg/l) during October compared March (3.9 mg/l). The average alkalinity was 95.83 mg/l. Nitrate values ranged from 2.40 µg/l to 35.90 µg/l. The phosphate value ranged between 0.90 µg/l and 9.0 µg/l with an average of 3.0 µg/l. Primary productivity showed an average of 1337.08 mg C/m<sup>3</sup>/day productive nature indicated backwater. Total number of copepods ranged from 2013 numbers/m<sup>3</sup> to 5347 numbers/m<sup>3</sup>. Total number of cladocerans ranged from 8 numbers/m<sup>3</sup> to 471 numbers/m<sup>3</sup>. Total number of rotifers ranged from 306 numbers/m<sup>3</sup> to 1263 numbers/m<sup>3</sup>. Onset of monsoon appeared to be major factor influencing the hydrography, primary productivity and zooplankton abundance in the backwater.

**Keywords:** Mangrove-vegetation, hydrography, primary productivity, zooplankton abundance, vembanad lake.

### Introduction

Vembanad Lake is second large brackishwater lake in the India encompassing mangroves, mudflats, swamps and marshes. Mangrove patches in the Vembanad Lake help in the production of detritus, organic matter, recycling nutrients and enriching the coastal water. Plankton serves as basic food for whole aquatic ecosystem. They play a vital role in the estuarine food chain and their abundance is considered as an index of fertility as the fishery resources of aquatic ecosystem mainly depend on the magnitude of phytoplankton and zooplankton production. Their production, distribution and abundance fundamentally governed by hydrography and nutrient status of aquatic ecosystem. The seasonal changes in hydrography play an important role in regulating the fauna of estuaries<sup>1</sup>. Zooplankton community is a heterogeneous assemblage of animals covering many taxonomic groups. The distribution of zooplankton in Indian estuaries has been extensively studied by several researchers<sup>2-6</sup>. Vembanad Lake is a transitional ecotone between sea and land encompassing mangroves, mudflats, swamps and marshes. These brackish water bodies are highly productive and support good fisheries as they are indispensable habitat to a variety of biologically and economically important resident and migratory aquatic fauna. Vembanad lake (9° 34' 60 N, 76° 25' 0 E) is among the most productive life-supporting coastal wetland in Kerala, spread over three districts, viz., Ernakulam, Kottayam and Alleppey having length of 96 km and surface area of 1512

km<sup>2.7</sup>. Destruction of mangroves in tropical and subtropical region leads to major loss of estuarine habitat. Extensive water and land remodeling efforts, destructive fishing methods and unprecedented growth of noxious aquatic weeds like *Salvinia* and *Eichornia* in Vembanad Lake has created an alarming situation in the area. Therefore, knowledge on the hydrobiological status of backwater ecosystem is the key to sound policy development, better decision-making.

### Material and Methods

In present investigation an attempt has been made to discuss the zooplankton abundance in relation to hydrography of mangrove patches in the Vembanad Lake at Panangad-Kumbalam backwater for the period of 12 months from June 2012 to May 2013. Panangad-Kumbalam backwater is located at northern extremity of Vembanad wetland (Latitude 09.90990<sup>0</sup> to 09.90638<sup>0</sup> N and Longitude 76.31475<sup>0</sup> to 76.31514<sup>0</sup> E) in Ernakulam district of Kerala. Water samples were collected from four sampling points and analyzed for pH, dissolved oxygen, alkalinity, nitrate, and phosphate<sup>8</sup>. Water temperature was measured by mercury thermometer and transparency by Secchi disk. Salinity was determined by Knudsen-Mohr titration method<sup>9</sup>. Primary productivity was estimated by light and dark bottle oxygen method<sup>10</sup>. Zooplankton samples were collected using bolting silk cloth (25µ aperture) plankton net of 50 cm diameter and preserved in 4% formaldehyde for group

identification under microscope (40X)<sup>8,11</sup>. Mangrove plants available in the study area were identified up to species level<sup>12</sup>. Averages values were calculated for all water quality parameters and total number for zooplankton were recorded on monthly data obtained from four stations. Monthly average data on water parameters were analyzed employing Pearson’s correlation coefficient (r) to find out the relationship among different hydrographical parameters and zooplankton at 1% (\*\*\*) and 5% (\*) level of significance (SPSS 20v).

## Results and Discussion

Distinct variations of hydrographic state and its influence on abundance of zooplankton in the study area were observed. The average monthly data on hydrographical parameters presented in figures-1 to 12.

**Mangrove vegetation:** 13 species mangrove plants have been identified from the study area belonging to 7 family and 9 genera. In this study sites the number of mangrove species was low<sup>6,13</sup>. Khaleel<sup>13</sup> reported presence of 25 mangrove species in Kannur district of Kerala. Sarmah<sup>6</sup> reported presence of 14 mangrove species in the Puduveypu region Cochin backwater. Of 13 mangrove species recorded during present study 5 species (*Avicennia spp.*, *Rhizophora spp.*, *Excoecaria spp.*, *Acanthus spp.*, *Bruguiera spp.*) found common throughout Kerala. Dominance of *Rhizophora spp.* and *Avicennia spp.* was high (70%) during present study. *Rhizophora mucronata* and *Avicennia officianalis* are found in the proximal zones whereas, *Bruguiera species* in the middle zone. *Excoecaria species*, *Acanthus species* and *Acrostichum species* were found in the distal zone.

**Hydrographical Parameters: Salinity:** The salinity in the study area showed wide fluctuation and ranged between 1.70‰ (July 2012) and 30.5‰ (June 2012) during the study. The average salinity during the study was found to be 19.74‰. Salinity showed significant positive correlation with cladocerans ( $r=0.696^*$ ) whereas, significant negative correlation with primary productivity ( $r= -0.709^{**}$ ) and copepods ( $r=-0.646^*$ ). Varma *et al.*<sup>14</sup> also analyzed long term daily variation in salinity at a station near Panangad jetty and recorded a salinity range between 0 and 32‰. Similar observation was made by

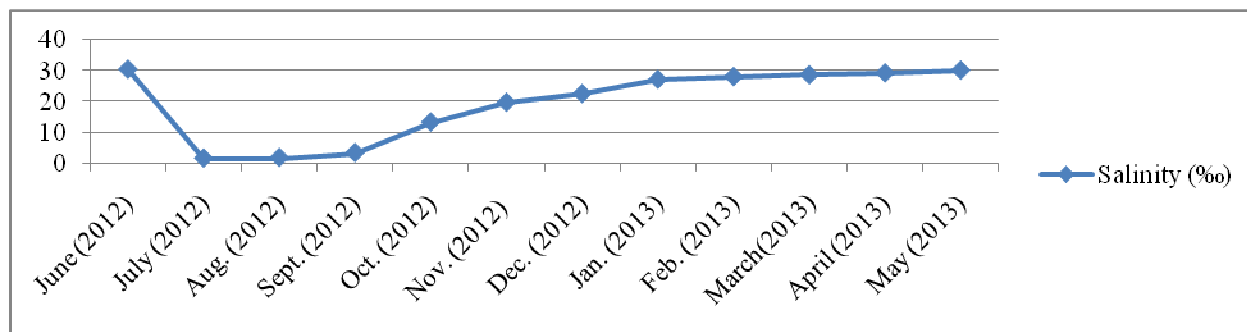
Jayasree<sup>15</sup> in a prawn filtration pond of Panagad area and reported salinity in the range of 0.05‰ to 30.63‰.

**Table-1**  
**Check list of mangrove plants recorded in the Panangad Kumbalam Backwater**

Order	Family	Scientific names
Euphorbiales	Euphorbiaceae	<i>Excoecaria agallocha</i>
Lamiales	Acanthaceae	<i>Avicennia officianalis</i>
	Verbenaceae	<i>Clerodendrum inerme</i>
		<i>Premna latifolia</i>
Malpighiales	Rhizophoraceae	<i>Rhizophora mucronata</i>
		<i>Rhizophora apiculata</i>
		<i>Rhizophora conjugate</i>
		<i>Bruguiera cylindrica</i>
Myrtales	Lythraceae	<i>Sonneratia caseolaris</i>
		<i>Sonneratia alba</i>
Polypodiales	Pteridaceae	<i>Acrostichum aureum</i>
Scrophulariales	Acanthaceae	<i>Acanthus ilicifolius</i>

**Water Temperature:** The average temperature during the study period was 28.94°C. The highest temperature (30.90°C) was observed during the May 2013 and the lowest temperature (26.00°C) during September 2012. Temperature showed significant positive correlation with cladocerans ( $r = 0.663^*$ ) and negative with primary productivity ( $r = -0.770^{**}$ ) and copepods ( $r = -0.775^{**}$ ). Harikrishnan and Kurup<sup>16</sup> reported temperature was invariably low during June-July (25°C), which gradually increased from August onwards and reached highest value in March (32°C) which is much matching with the the present study. Devi<sup>4</sup> found that the water temperature of mangrove area of Panangad region, between 24°C and 30.5°C.

**Transparency:** Transparency value of the study region falls within a range of 39.30 cm (July 2012) to 97.40 cm (June 2012) with an average of 65.70 cm. Transparency showed significant negative correlation with primary productivity ( $r=-0.707^*$ ) and copepods ( $r=-0.765^{**}$ ). Sarmah<sup>6</sup> reported lower transparency values (30 cm to 47 cm) in Cochin backwater of Puduveypu region compare to present study.



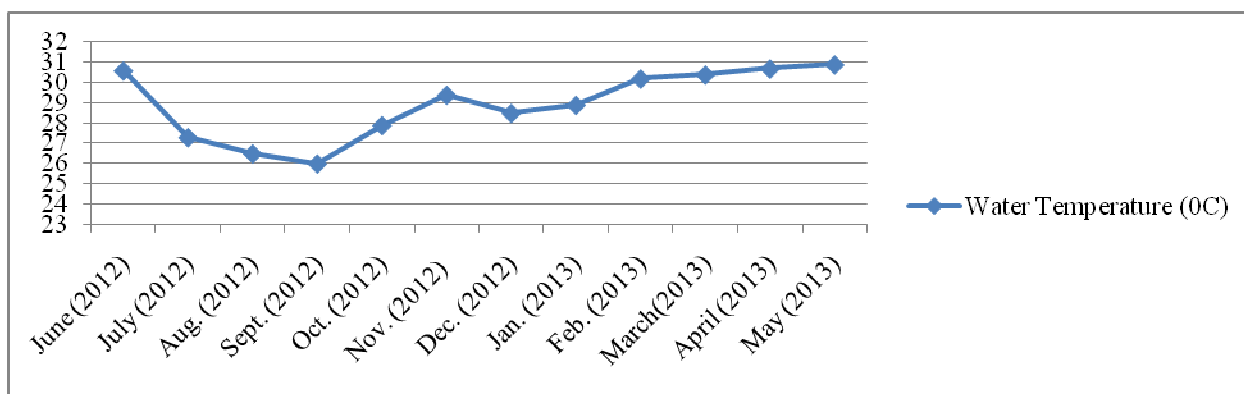
**Figure-1**  
**Monthly variation in salinity (‰)**

**pH:** The average pH during the study period was 7.38. The highest pH (8.50) was observed during June 2012, whereas the lowest pH (6.00) was observed during the July 2012. pH showed significant positive correlation with cladocerans ( $r = 0.660^*$ ) and negative correlation with primary productivity ( $r = -0.690^*$ ) and copepods ( $r = -0.706^*$ ). Similar observations were made by Devi<sup>4</sup>; Sarmah<sup>6</sup> and reported alkaline pH throughout the year in Cochin backwater.

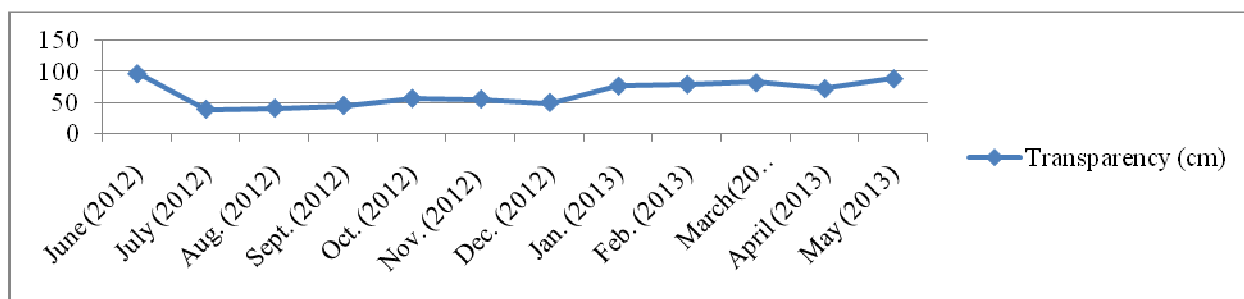
**Dissolved Oxygen:** The average dissolved oxygen value estimated during study period was 5.4 mg/l. The highest dissolved oxygen (7.7 mg/l) was observed during October 2012 and lowest 3.9 mg/l during March 2013. Dissolved oxygen showed significant positive correlation with primary

productivity ( $r = 0.864^{**}$ ), copepods ( $r = 0.814^{**}$ ) and rotifers ( $r = 0.592^*$ ); whereas, negatively correlated with cladocerans ( $r = -0.763^{**}$ ). In the earlier studies also higher values of dissolved oxygen were recorded during June to November in the Cochin estuarine system<sup>4,6</sup>.

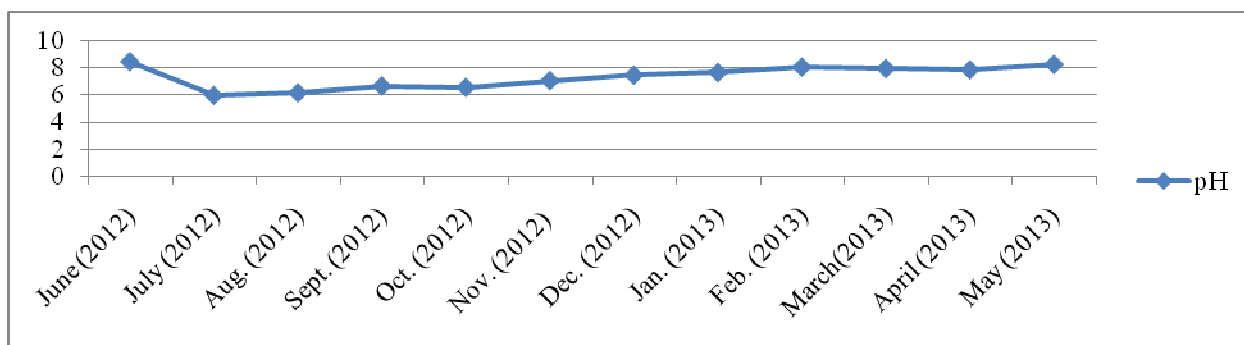
**Alkalinity:** Relatively high alkalinity was observed during June 2012 (139 mg/l), when compared to the July 2012 (38 mg/l). The average of about 95.83 mg/l. Alkalinity showed significant positive correlation with cladocerans ( $r = 0.679^*$ ) and negative correlation with primary productivity ( $r = -0.640^*$ ) and copepods ( $r = -0.734^{**}$ ). Devi<sup>4</sup> and Sarmah<sup>6</sup> also reported higher alkalinity values during summer months and started decreasing with the advent of monsoon in the Cochin backwater.



**Figure-2**  
 Monthly variation in water temperature (°C)



**Figure-3**  
 Monthly variation in transparency (cm)

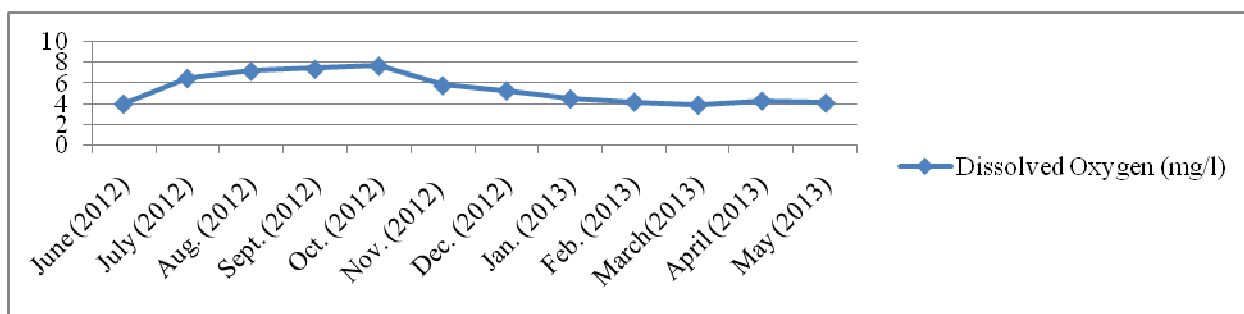


**Figure-4**  
 Monthly variation in pH

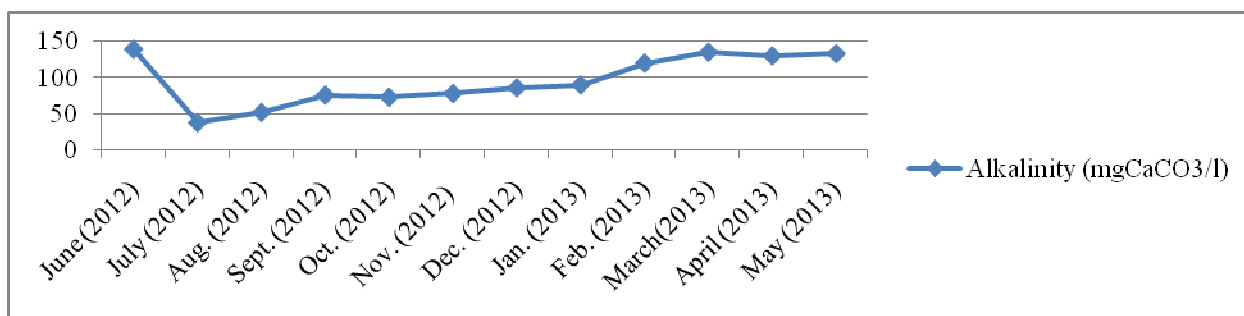
**Nitrate:** Nitrate values ranged from 2.40 µg/l (June 2012) to 35.90 µg/l (August 2012) with an average of 11.75 µg/l. Lakshmanan *et al.*<sup>17</sup> observed nitrate value in Cochin backwater the between 0 µg/l to 20.3 µg/l. Sarmah<sup>6</sup>, reported found similar nitrate range of 1.30µg/l to 18.14µg/l in Cochin backwaters.

**Phosphate:** The phosphate value ranged between 0.90 µg/l (June 2012) and 9.0 µg/l (August 2012) during the study period with an average of 3.0 µg/l. Phosphate showed significant positive correlation with nitrite-N ( $r=0.913^{**}$ ) and negatively correlated with salinity ( $r= -0.628^*$ ), temperature( $r= -0.611^*$ ), pH ( $r= -0.630^*$ ) and alkalinity ( $r= -0.660^*$ ). The phosphate value of present findings agrees with the observations made by Sarmah<sup>6</sup>.

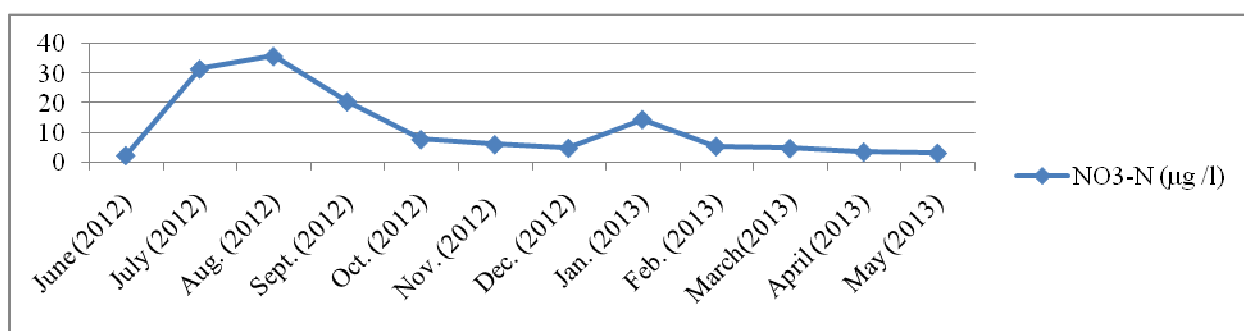
**Biological Parameters: Primary Productivity:** Average primary productivity during the study period was 1337.08 mg C/m<sup>3</sup>/day. Highest primary productivity was 3597 mg C/m<sup>3</sup>/day (September 2012) and lowest 357 mg C/m<sup>3</sup>/day (June 2012). Primary production showed a positive correlation with dissolved oxygen ( $r=0.864^{**}$ ), copepods ( $r=0.765^{**}$ ), rotifers ( $r=0.679^*$ ) and negative with salinity ( $r= -0.709^{**}$ ), temperature( $r= -0.770^{**}$ ), transparency ( $r= -0.707^*$ ), pH ( $r= -0.690^*$ ), alkalinity ( $r= -0.640^*$ ) and cladocerans ( $r= -0.716^{**}$ ). Devi<sup>4</sup> recorded a maximum value of 3300.15 mg C/ m<sup>3</sup>/ day in the Cochin backwater of Panangad region. Sarmah<sup>6</sup> observed primary production in the range of 32 mg C/m<sup>3</sup>/day to 3707 mg C/m<sup>3</sup>/day.



**Figure-5**  
 Monthly variation in dissolved oxygen (mg/l)



**Figure-6**  
 Monthly variation in alkalinity (mgCaCO<sub>3</sub>/l)



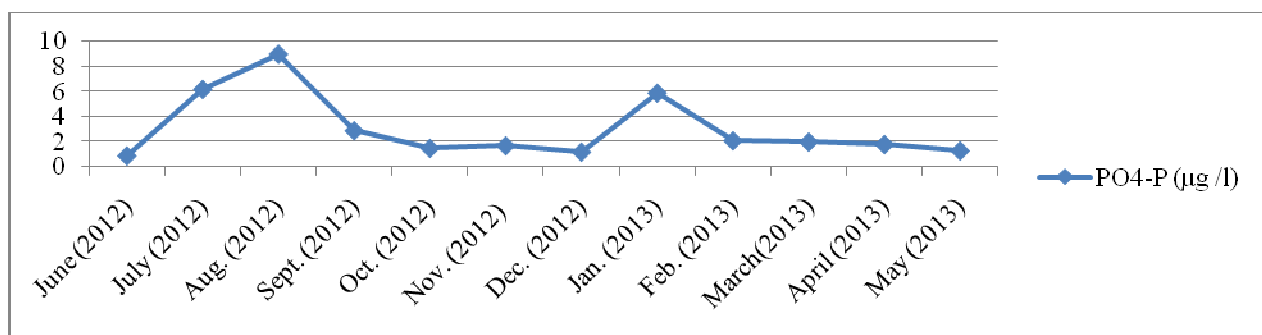
**Figure-7**  
 Monthly variation in nitrate (µg/l)

**Copepods:** Total number of copepods ranged from 2013 numbers/m<sup>3</sup> to 5347 numbers/m<sup>3</sup>. Copepods showed significant positive correlation with dissolved oxygen (r=0.814\*\*) and primary production (r=0.765\*\*); whereas, negatively correlated with salinity (r= -0.646\*), temperature (r= -0.775\*\*), transparency (r= -0.765\*\*), pH (r= -0.706\*) and alkalinity (r= -0.734\*\*). Varghese and Krishnan<sup>5</sup> observed copepods were dominated zooplankton group and share of copepods in total zooplankton varied from 27.45% to 64.04% in different stations in Cochin backwaters. Sarkar<sup>18</sup> reported 809 numbers/l of copepod in Pokkali fields of Vyttila-Ernakulam.

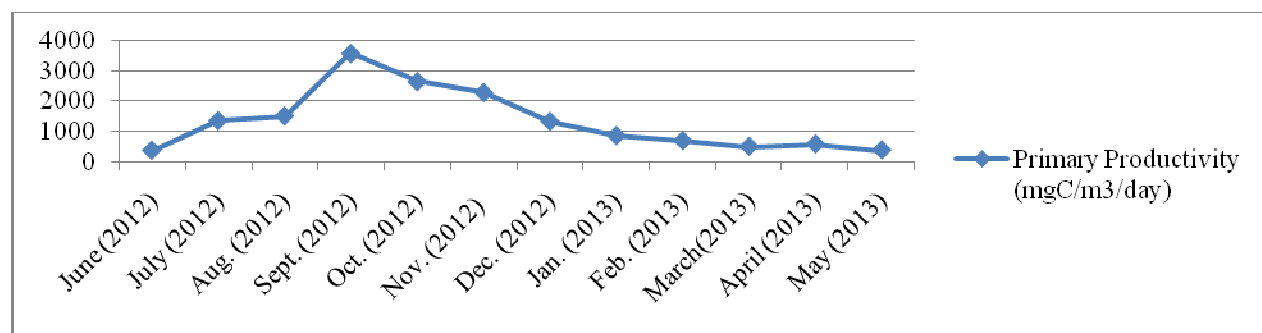
**Cladocerans:** Total number of cladocerans ranged from 8 numbers/m<sup>3</sup> (October 2012) to 471 numbers/m<sup>3</sup> (April 2013). Cladocerans showed significant positive correlation with salinity (r= 0.696\*), temperature(r= 0.663\*), pH (r= 0.660\*) and

alkalinity (r= 0.679\*); whereas, negatively correlated with dissolved oxygen (r= -0.763\*\*) and primary production (r= -0.716\*\*) and copepods (r= -0.601\*). Varghese and Krishnan<sup>5</sup> noticed maximum density of cladocerans during pre-monsoon season.

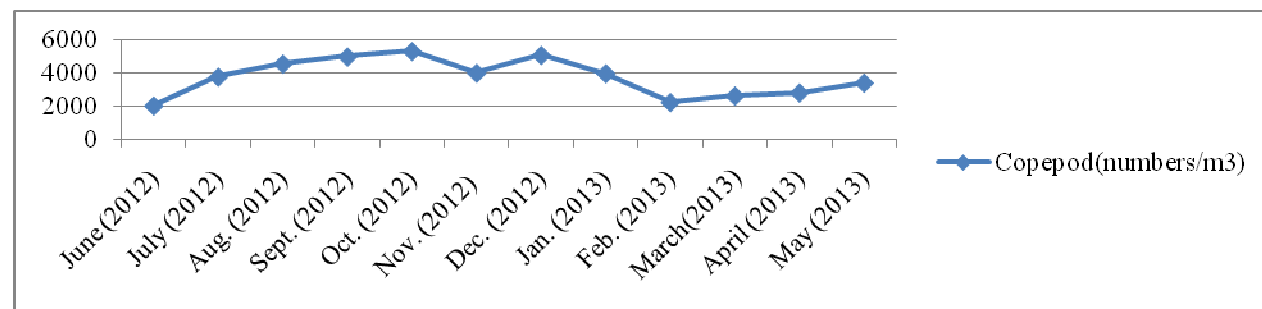
**Rotifers:** Total number of rotifers ranged from 306 numbers/m<sup>3</sup> (December 2012) to 1263 numbers/m<sup>3</sup> (September 2012). Rotifers showed significant positive correlation with dissolved oxygen (r= 0.592\*) and primary production (r= 0.679\*); whereas, negatively correlated with cladocerans(r= -0.695\*). Varghese and Krishnan<sup>5</sup> observed share of rotifers in total zooplankton varied from 6.65% to 66.50% in different stations in Cochin backwaters. Sarkar<sup>18</sup> reported 63 numbers/l of rotifer in Pokkali fields of Vyttila-Ernakulam.



**Figure-8**  
 Monthly variation in phosphate (µg/l)



**Figure-9**  
 Monthly variation in Primary Productivity (mgC/m<sup>3</sup>/day)

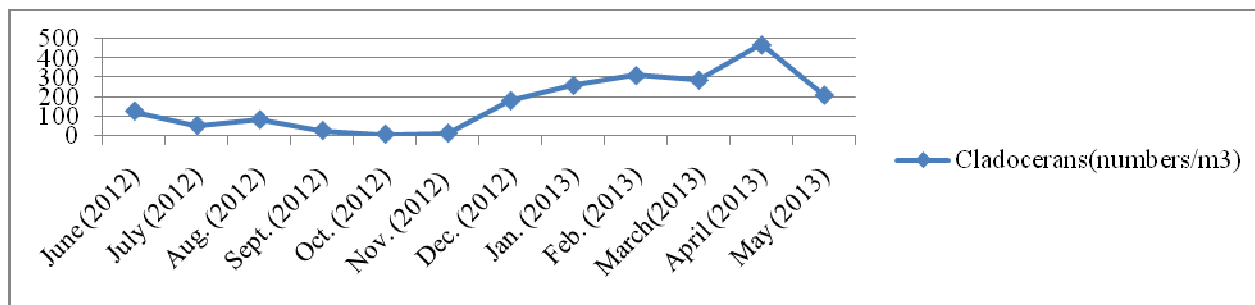


**Figure-10**  
 Monthly variation in copepods (numbers/m<sup>3</sup>)

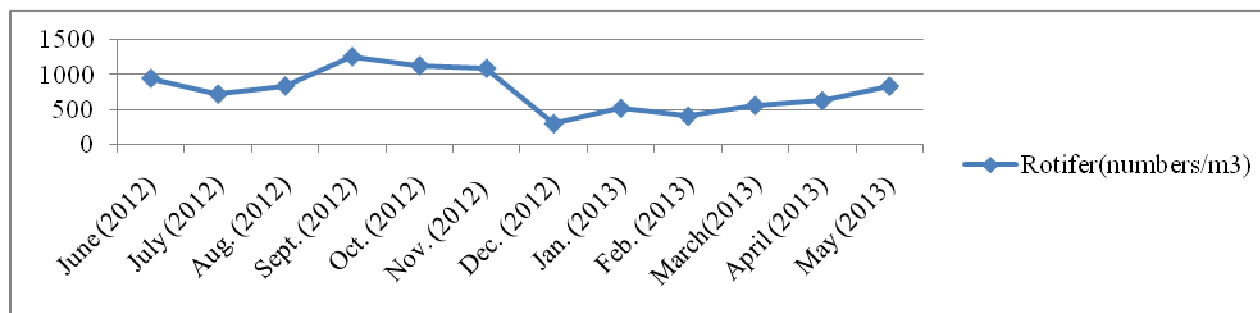
**Conclusion**

The present report on Panangad-Kumbalam mangrove patches is the first one and it indicated favorable range of

hydrobiological parameters for the normal distribution and abundance of ichthyo-diversity. Salinity and water temperature seems to have great influence on the distribution and abundance of zooplankton.



**Figure-11**  
 Monthly variation in cladocerans (numbers/m<sup>3</sup>)



**Figure-12**  
 Monthly variation in rotifers (numbers/m<sup>3</sup>)

**Table-2**  
 Correlation between hydrobiological parameters and zooplankton at Panangad Kumbalam Backwater

Water Parameters	Water Temperature	Transparency	pH	Dissolved Oxygen	Total Alkalinity	Nitrate Nitrogen	Phosphate	Primary productivity	Copepods	Cladocerans	Rotifers
Salinity	0.93**	0.89**	0.95**	-0.90**	0.89**	-0.87**	-0.62*	-0.70**	-0.64*	0.69*	-0.45
Water Temperature	1	0.87**	0.89**	-0.90**	0.88**	-0.81**	-0.61*	-0.77**	-0.77**	0.66*	-0.37
Transparency		1	0.93**	-0.85**	0.91**	-0.72**	-0.51	-0.70*	-0.76**	0.56	-0.22
pH			1	-0.91**	0.95**	-0.82**	-0.63*	-0.69**	-0.70*	0.66*	-0.38
Dissolved Oxygen				1	-0.84**	0.65*	0.40	0.86**	0.81**	-0.76**	0.59*
Total Alkalinity					1	-0.81**	-0.66*	-0.64*	-0.73**	0.67*	-0.25
Nitrate						1	0.91**	0.35	0.40	-0.44	0.18
Phosphate							1	0.07	0.25	-0.19	-0.04
Primary Productivity								1	0.76**	-0.71**	0.67*
Copepods									1	-0.60*	0.32
Cladocerans										1	-0.69*

\*\* Correlation is significant at the 0.01 level (2-tailed). \* Correlation is significant at the 0.05 level (2-tailed).

## Acknowledgements

The authors are thankful to ICAR for providing JRF.

## References

1. Menon N. N., Balachand A. N. and Menon N. R., Hydrobiology of Cochin backwater system-a review, *Hydrobiologia*, **430**, 149-183 (2000)
2. Nandan S. B. and Azis P.K.A., Zooplankton of the retting zones in the Kadinamkulam Estuary, Kerala, *Mahasagar*, **27(1)**, 59–65 (1994)
3. Qasim S.Z., Zooplankton of some major estuaries of India, *J. Indian Ocean Stud.*, **13(3)**, 439-446 (2005)
4. Devi S., Ecology of mangrove patches in the Vembanad Lake at Panangad, M.F.Sc. Thesis, Kerala Agricultural University, Thrissur, 136 (2009)
5. Varghese M. and Krishnan L., Distribution of zooplankton in selected centres of Cochin backwaters, Kerala, *J. Mar. Biol. Ass. India*, **51(2)**, 194-198 (2009)
6. Sarmah T.D., Temporal variation in the hydrography and biodiversity of Cochin backwater of Puduveypu region, M.F.Sc. Thesis, Kerala Agricultural University, Thrissur, 146 (2011)
7. Krishna K.K. and Priyadarsanan D.R., Fish and Fisheries in Vembanad Lake, CERC, ATREE, Consolidated report of Vembanad fish count-2008- 2011, 22 (2012)
8. APHA, Standard methods for the examination of water and waste water, American Public Health Association, Washington, DC, APHA-AWWA-WEF, 167 (2005)
9. Grasshoff K., Ehrhardt M. and Kremling K., Methods of Sea Water Analysis, Second Edition, Verlag Chemie, Weinheim, 419 (1983)
10. Strickland J.D.H. and Parsons T.R., A Practical Handbook of Sea Water Analysis, Third edition, Fisheries Research Board of Canada, 311 (1972)
11. Adoni A.D., Joshi G., Ghos K, Chourasia S.K., Vishya A.K., Yadav M. and Verma H.G., Work book on limnology, Pratibha Publishers, Sagar, 216 (1985)
12. Anupama C. and Sivadasan M., Mangroves of Kerala, India, *The J. of Indian. Ass. Angiosperm Taxonomy*, **14(1and2)**, 9-46 (2004)
13. Khaleel K.M., Study of the quantitative structure of true mangrove present in the mangal forests of Tellicherry, Pappiniseri and Kunhimangalam of Kannur district, *The Indian forester*, **131(1)**, (2005)
14. Varma K.K., Cherian C.J., Mrithunjayan P.S., Raman N.N. and Prabha Joseph., Characteristics of temperature and salinity fluctuations in a south Indian estuary, A study of Vemband Lake, a monsoon- influenced estuary, *Earth. Sys. Monitor*, **12**, 9-14 (2002)
15. Jayasree P.S., Structural and seasonal changes of the macrobenthic community in relation to the hydrography of a prawn filtration pond, M.F.Sc. Thesis, Kerala Agricultural University, Thrissur, 120 (2009)
16. Harikrishnan M. and Kurup B. M., Temporal and spatial distribution of male and female morphotypes of *M. rosenbergii* (deman) in Vembanad lake, *Indian J. Fish.*, **50(1)**, 11-19 (2003)
17. Lakshmanan P.T., Shynamma C.S., Balachand A.N. and Nambisan P.N.K., Distribution and variability of nutrients in Cochin backwaters, southwest coast of India, *Indian J. Mar. Sci.*, **16**, 99-102 (1987)
18. Sarkar D., Hydrobiology of Pokkali fields of Rice research station, Vyttila, Ernakulam, M.F.Sc. Thesis. KUFOS, Kochi, 169 (2013)