International Journal of Fisheries and Aquatic Studies 2017; 5(4): 47-53

E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2017; 5(4): 47-53

www.fisheriesjournal.com
Received: 22-05-2017
Accepted: 24-06-2017

Ram Bhajan Mandal
Agriculture and Forestry University, Bharatpur, Nepal, Nepal

Sunila Rai
Agriculture and Forestry University, Bharatpur, Nepal, Nepal

Madhav Kumar Shrestha
Agriculture and Forestry University, Bharatpur, Nepal, Nepal

Dilip Kumar Jha
Agriculture and Forestry University, Bharatpur, Nepal, Nepal

Narayan Prasad Pandit
Agriculture and Forestry University, Bharatpur, Nepal, Nepal

Correspondence
Ram Bhajan Mandal
Agriculture and Forestry University, Bharatpur, Nepal, Nepal

Comparison of abundance of zooplankton between red bloom and non-red bloom carp ponds of Nepal

Ram Bhajan Mandal, Sunila Rai, Madhav Kumar Shrestha, Dilip Kumar Jha and Narayan Prasad Pandit

Abstract
The present study was carried out to compare abundance of zooplankton between red bloom and non-red bloom carp ponds in summer, autumn, winter and spring seasons from June 2015 to May 2016. Combined mean density of Rotifers, Cladocera and Copepods did not differ significantly ($P>0.05$) between red bloom and non-red bloom carp ponds indicated that red bloom did not affect zooplankton population. Density of Rotifers and Copepods in red bloom carp ponds were significantly ($P<0.05$) higher in summer season than non-red bloom carp ponds corresponding to euglenophytes abundance. Rotifers density was significantly ($P<0.05$) higher (253±29 cells L^{-1}) in red bloom carp ponds than non-red bloom (155±12 cells L^{-1}) carp ponds in summer season. Copepods density was found significantly ($P<0.05$) higher (1060±50 cells L^{-1}) in red bloom carp ponds than non-red bloom carp ponds (393±40 cells L^{-1}) in summer season. Zooplankton density showed a significant correlation ($P<0.05$) with TDS ($r= 0.343$) and conductivity ($r= 0.367$).

Keywords: Red bloom, Non-red bloom, Seasonal variation, Zooplankton, Conductivity

Introduction

Zooplanktons are considered as one of the most important food source to the aquatic organisms including Planktivorous fish. Nearly all fish depends on zooplankton for their food during their larval phases and some fishes continue to eat zooplankton in their entire lives (Madin *et al*., 2001, Fontaine and Revera, 1986) [23, 11]. It plays a key role in the aquatic food chains (Sharma, 1998) [32]. Zooplankton community is found to change with seasonal changes in temperature and nutrient content of water (Ahangar *et al.,* 2012, Dodson, 1992) [1, 9]. Zooplanktons have close links with the surrounding environment throughout their life cycles and they demonstrate rapid changes in their populations when disturbance occurs such as eutrophication. Therefore, they are potential indicator species for water pollution (Jakhar 2013) [17].

Red-bloom in fish ponds is a common occurrence in Nepal. In red bloom ponds, a thin film or scum covers the water surface, which gives unpleasant look, shades the lower waters, inhibit photosynthesis, deplete dissolved oxygen, brings behavioral changes in fish and sometimes results fish mortality too (Rehman, 1998; Zimba *et al*., 2004; Zimba *et al*., 2010) [29, 36-37]. It was found that Euglenophytes and *Euglena sanguinea* dominates phytoplankton community in red bloom in the ponds (Mandal *et. al*., 2016) [22]. In Nepal, such type of study has not been done in red bloom and non-red bloom carp fish ponds. Therefore, the present study was to examine abundance of zooplanktons in red bloom and non-red bloom carp ponds. The study also aims to assess the relation between water quality variables and the abundance of zooplankton.

Materials and Methods

Zooplankton and water samples were collected from ten carp ponds (5 red bloom and 5 non-red bloom ponds), each from 3 different regions (Morang in Eastern region, Chitwan in Central region and Rupandehi district in Western region) of Nepal at 6 am to 8.30 am in four different seasons (spring, autumn, summer and winter) in a year from June 2015 to May 2016.

Water quality parameters such as dissolved oxygen (DO), pH, oxidation reduction potential (ORP), temperature, conductivity, total dissolved solid (TDS) were analyzed in situ using

HI-98194 Multiparameter whereas soluble reactive phosphorus (SRP), nitrate, nitrite, ammonia nitrogen (NH_3-N) were analyzed using HI-83203-02 Multiparameter bench photometer. Total phosphorus, chlorophyll-a total Kjheldahl nitrogen (TKN) were analyzed following APHA, 1985; APHA, 2005; APHA, 2012) [4-6].

For plankton sampling, five liters of pond water (up to 50 cm depth) was collected using graduated bucket and filtered with plankton net (mesh size 5µm) and then preserved in 5% formaldehyde solution. Phytoplanktons were identified following Prescott (1951) [26] and Rai and Rai (2007) [26] and classified according to Guiry and Guiry (2016) [13] and population was estimated following Mandal *et al*., 2016 [22]. The Zooplankton were identified to generic level by using standard keys of Edmondson (1959) [10], Pennak (1978) [25], Reddy (1994) [28] and Dhanapathi (2000) [8]. Zooplankton were counted using Sedgwick-Rafter (S-R) cells and quantified following APHA (1976) [3] as.

No of species = C x 1000 mm^3/L x D x W x S

Where, C= Number of organisms counted, L= Length of each stripe (partition) (mm), D= Depth of each stripe (mm), W= Width of each stripe (mm), and S= Number of stripes.

Total zooplankton vs water quality (Table 1) data was analyzed by Pearson Correlation and significance was considered at 0.05 level (1-tailed). Data of water quality and zooplankton density in different seasons were compared by one way ANOVA using SPSS (version 16) followed by Duncan Multiple Range Test (DMRT) and significant level was considered at 5% ($P<0.05$). Comparison between red bloom carp ponds and non-red bloom carp ponds were done by independent simple t-test at the level of 5% ($P<0.05$).

Results

Pearson's correlation coefficients were calculated to determine a relationship between total mean zooplankton (combined Rotifer, Cladocera and Copepods in red bloom and non-red bloom carp ponds of all four season) abundance and total mean of water quality parameter in both types of carp ponds in Table 1. Total mean zooplankton population displayed correlation with 13 parameters (11 positive and 2 negative) in carp ponds (Table 1). Chlorophyll-a exhibited highest negative correlation (r = - 0.172) whereas TDS and conductivity showed positive correlation with total zooplankton population. Total mean of Zooplankton did not show significant correlation ($P<0.05$) with any of the water quality parameters except TDS (r=0.343) and conductivity (r= 0.367).

Season wise water quality parameters and phytoplankton

Season wise water quality parameters and phytoplankton in red bloom and non-red bloom carp ponds are shown in Table 2. Different groups of zooplankton in red bloom and non-red bloom carp ponds and their season wise variation in terms of density are shown in Table 3. Results showed that combined mean of water quality parameter such as pH, temperature, ORP, SRP, Nitrate, Nitrite and chlorophyll-a were not significantly different ($P>0.05$) between red bloom and non-red bloom carp ponds.

Temperature was significantly higher in summer, spring and autumn than winter season in both types of carp ponds (red bloom and non-red bloom carp pond). DO was higher in spring (3.0±0.4 mg/L) and winter (3.0±0.1 mg/L) season than summer (1.8±0.1 mg/L) and autumn (2.2±0.2) while DO in the summer was on par with autumn in red bloom carp ponds. DO was significantly higher in winter (4.7±0.2 mg/L) than summer (2.4±0.2 mg/L) season in non-red bloom. Chlorophyll-a was significantly higher in non- red bloom carp ponds in summer season (37.9±5.6 mg/L) than autumn season (21.7±2.6 mg/L). ORP was significantly higher in red bloom (139.1±6.6 mV) and non-red bloom (147.6±3.3 mV) carp ponds in autumn season than in spring season in red bloom (106.5±6.6 mV) and non-red bloom (119.2±6.8 mV) carp ponds, respectively. Total Kjeldahl nitrogen (TKN) was significantly higher in non-red bloom carp ponds in summer (1.39±0.1 mg/L) season than winter (0.82±0.1 mg/L) season while TKN in spring season was on par with autumn. The pH was significantly higher in winter season in red bloom carp pond than summer season while pH in spring was on par with autumn season. Similarly pH of non-red bloom fish pond was also significantly higher in winter (7.9±0.1) than summer season (7.3±0.0) while that of spring was on par with autumn season.

Euglenophytes was significantly higher ($P<0.05$) in summer (2490±290 cells L^{-1}), winter (2180±370 cells L^{-1}) and autumn (1950±390 cells L^{-1}), than spring (1250±220cells L^{-1}) season (Table. 2) in red bloom carp ponds. Chlorophytes was found significantly higher in summer season (1620±250 cells L^{-1}) than autumn season (650±60 cells L^{-1}) in red bloom carp ponds (Table 2). Cyanophytes was found significantly higher in non-red bloom carp ponds (980±180 cells L^{-1}) in summer season than in spring (270±30 cells L^{-1}). Bascillariophytes was significantly higher non-red bloom carp ponds (920±170 cells L^{-1}) in summer season than autumn (320±50 cells L^{-1}). In red bloom carp ponds, red color was depended on the presence of *Euglena sanguinea.*

Season wise abundance of Zooplankton

Combined mean of Zooplankton (combined values of four different seasons of red bloom or non-red bloom carp ponds), density of Rotifers, Cladocera and Copepods did not differ significantly ($P>0.05$) between red bloom and non-red bloom carp ponds but varied seasonally in same types of carp ponds (Table 3). Density of Rotifers was significantly higher ($P<0.05$) in red-bloom carp ponds (253±29 cells L^{-1}) than non-red bloom carp ponds (155±12 cells L^{-1}) in summer. Density of Rotifers was significantly higher in non-red bloom carp ponds in autumn season (211±10 cells L^{-1}) than spring season (165±10 cells L^{-1}). Density of Cladocera differed significantly ($P<0.05$) seasonally within red bloom and non-red bloom carp ponds. Cladocera was significantly higher in red bloom carp ponds in autumn season (794±313 cells L^{-1}) than spring season (253±28 cells L^{-1}). Similarly in non-red bloom carp ponds also its density was significantly higher in autumn season (497±118 cells L^{-1}) than spring season (226±27 cells L^{-1}) (Table 3). Copepod was found significantly higher in red bloom carp ponds in summer season (1060±50 cells L^{-1}) than in spring season (231±14 cells L^{-1}). Copepods was significantly higher in non-red bloom carp ponds in autumn season (457±90 cells L^{-1}) than spring season (215±11 cells L^{-1}) while it was statically similar with summer season.

Total mean density of zooplankton (density of Rotifer, Cladocera and Copepods of four seasons) in red bloom carp ponds was significantly higher in summer season (1780±670 cells L^{-1}) than non-red bloom carp ponds (830±60 cells L^{-1}). It was also significantly higher than of spring season (658±50 cells L^{-1}) in red bloom carp ponds. Total zooplankton in non-red bloom carp ponds was significantly higher in autumn season (1165±21 cells L^{-1}) than spring season (606±40 cells

L^{-1}) while it was statically similar with summer and winter season.

Rotifers in was significantly higher found in non-red bloom fishponds of autumn season (211±10 cells L^{-1}) than spring season (165±10 cells L^{-1}) of same types of fishponds. Cladocera was significantly different ($P<0.05$) seasonally in same types, both (red bloom and non-red bloom) fishponds. Cladocera was significantly higher in red bloom fishponds of autumn season (794±313 cells L^{-1}) than spring season (253±28 cells L^{-1}) of the same types of fishponds. Similarly in non-red bloom fishponds was also significantly higher in autumn season (497±118 cells L^{-1}) than spring season (226±27 cells L^{-1}) (Table 3). Copepods was also significantly different ($P<0.05$) seasonally in same types of fishponds. Copepods was found significantly higher found in red bloom fishponds of summer season (1060±50 cells L^{-1}) than red bloom fishponds of spring season (231±14 cells L^{-1}). Similarly Copepods was significantly higher in non-red bloom fishponds in autumn season (457±90 cells L^{-1}) than spring season (215±11 cells L^{-1}) while statically similar with summer season.

Total mean of zooplankton (total of Rotifer, Cladocera and Copepods in red bloom or non-red bloom fishponds of different season) in Table 3. Red bloom fishponds was significantly higher in summer season (1780±670 cells L^{-1}) than non-red bloom fishponds (830±60 cells L^{-1}) while seasonally it was also different from red bloom fishponds of spring season (658±50 cells L^{-1}). Total zooplankton in non-red bloom fishponds was significantly higher in autumn season (1165±21 cells L^{-1}) than spring season (606±40 cells L^{-1}) while statically similar with summer and winter season.

Table: 1 Parson correlation coefficients between total mean zooplankton abundance and water quality parameter

	Zooplankton (X 10^3cells/ L)	**Temperature (0_C)**	**Ch-a (mg/L)**	**ORP (mV)**	**pH**	**DO (mg/L)**	**SRP (mg/L)**	**NH3-N (mg/L)**	**Nitrate (mg/L)**	**Nitrite (mg/L)**	**TDS (mg/L)**	**Cond. (µS/cm**	**TKN (mg/L)**	**TP (mg/L)**
Zooplankton (X 10^3cells/ L)	1													
Temperature (0_C)	0.064	1												
Ch-a (mg/L)	-0.172	-0.134	1											
ORP (mV)	0.057	-0.138	-0.284	1										
pH	0.144	-0.149	0.273	-0.547**	1									
DO (mg/L)	0.063	.334*	0.072	0.094	-0.129	1								
SRP (mg/L)	0.127	-0.082	-0.048	-0.122	0.161	-0.082	1							
NH_3-N (mg/L)	0.224	0.349*	-0.19	-0.548**	0.415*	-0.194	0.455**	1						
Nitrate(mg/L)	-0.058	-0.075	-0.007	0.053	0.032	0.229	0.015	-0.031	1					
Nitrite (mg/L)	0.165	0.517**	0.135	0.062	0.222	-0.188	0.143	-0.024	0.196	1				
TDS (mg/L)	0.343*	0.481**	0.224	0.194	0.507**	0.364*	-0.051	0.143	-0.008	0.610**	1			
Cond. (µS/cm	0.367*	0.490**	0.227	-0.162	0.455**	0.340*	0.046	0.134	-0.013	0.606**	0.994**	1		
TKN (mg/L)	0.1	0.238	0.093	-0.493**	0.416*	0.443**	0.455**	0.529**	-0.154	0.189	0.371*	0.334*	1	
TP (mg/L)	0.185	0.349*	0.033	-0.713**	0.473*	-0.138	0.470**	0.612**	-0.012	0.037	0.223	0.184	0.768**	1

Notes: * Correlation is significant at the 0.05 level (1-tailed)

Table 2: Seasonal variation of water quality parameter and different group of Phytoplankton in red bloom and none-red bloom fishponds of four different seasons

Seasons	**Spring (M-M)**		**Summer (J -A)**		**Autumn (S -N)**		**Winter (D - F)**		**Combined mean**	
Parameter	**Red bloom pond**	**Non-Red-bloom**	**Red bloom pond**	**Non-Red-bloom**	**Red bloom pond**	**Non-Red-bloom**	**Red bloom pond**	**Non-Red-bloom**	**Red bloom pond**	**Non-Red-bloom**
Temperature (^oC)	30.0±0.9 ^{aB}	30.3±0.9 ^{aX}	31.8±0.1 ^{aA}	31.3±0.1 ^{bX}	26.5±0.6 ^{aC}	26.1±0.6 ^{aY}	18.9±0.2 ^{aD}	18.9±0.3 ^{aZ}	26.8±0.3 ^{a}	26.6±0.3 ^{a}
pH	8.1±0.1 ^{aA}	7.8±0.1^{aX}	7.6±0.1 ^{aB}	7.3±0.1 ^{aY}	7.7±0.1 ^{aAB}	7.7±0.1 ^{aXY}	8.0±0.1 ^{aA}	7.9±0.1 ^{aX}	7.9±0.1 ^{a}	7.7±0.1 ^{a}
DO (mg/L)	3.0±0.4 ^{bA}	3.9±0.4 ^{aY}	1.8±0.1 ^{bB}	2.4±0.2^{aZ}	2.3±0.2^{bAB}	3.1±0.3^{aZ}	3.0±0.1 ^{bA}	4.7±0.2^{aX}	2.5±0.1 ^{b}	3.5±0.4^{a}
ORP (mV)	106.5±6.6 ^{aB}	119.2±6.8 ^{aY}	113.6±5.7 ^{aB}	124.1±3.4 ^{aY}	139.1±6.6 ^{aA}	147.5±3.3 ^{aX}	133.6±8.4 ^{aA}	139.7±5.9^{aX}	120.3±6.0 ^{a}	132.6 ±2.8 ^{a}
NH_3-N (mg/L)	0.91±0.19 ^{aA}	0.64±0.16 ^{aX}	1.21±0.19 ^{aA}	0.42±0.06 ^{bX}	1.05±0.20 ^{aA}	0.75±0.13 ^{aX}	1.01±0.22 ^{aA}	0.76±0.17 ^{aX}	1.05±0.14 ^{a}	0.64±0.08 ^{b}
SRP (mg/L)	0.13±0.03 ^{aA}	0.19±0.06 ^{aX}	0.29±0.07 ^{aA}	0.13±0.03 ^{aX}	0.31±0.08 ^{aA}	0.34±0.08 ^{aX}	0.24±0.05 ^{aA}	0.19±0.066 ^{aX}	0.24±0.033 ^{a}	0.21±0.3 ^{a}
Nitrate (mg/L)	0.84±0.11 ^{aA}	0.91±0.21 ^{aX}	0.19±0.04 ^{aB}	0.4±0.17 ^{aX}	0.1±0.04 ^{bB}	0.49±0.16 ^{aX}	0.32±0.1 ^{aB}	0.57±0.15 ^{aX}	0.36±0.03 ^{b}	0.59±0.09 ^{a}
Nitrite (mg/L)	0.06±0.02 ^{aB}	0.03±0.01 ^{aY}	0.01±0.0 ^{aB}	0.02±0.0 ^{aY}	0.02±0.00 ^{aB}	0.03±0.0 ^{aY}	0.43±0.14 ^{aA}	0.29±0.1 ^{aX}	0.13±0.04 ^{a}	0.09±0.02 ^{a}
Ch-a (mg/L)	21.9±4.06 ^{aB}	29.44±4.44 ^{aXY}	30.76±3.35 ^{aAB}	37.98±5.6 ^{aX}	23.07±3.3 ^{aB}	21.68±2.61 ^{aY}	40.07±6.5 ^{aA}	28.42±5.3 ^{aXY}	28.95±2.05 ^{a}	29.38±2.42 ^{a}
TDS (mg/L)	160.1±18.9^{aAB}	115.4±16.2^{aX}	106.1±15.3^{aD}	85.9±11.9 ^{aX}	135.8±16.4 ^{aBC}	99.9±14.9 ^{aX}	190.2±12.1^{aA}	118.8±11.8^{bX}	148.1±14.5^{a}	105.1±13.1 ^{b}
Conductivity (µS/cm	298.7±43.3^{aAB}	232.4±33.1^{aX}	211.9±30.7 ^{aC}	169.9±24.3^{aX}	280.2±33.8^{aAB}	203.9±29.9^{aX}	378.3±24.1 ^{aA}	241.7±26.6^{bX}	292.3±31.1^{a}	211.9±27.2^{b}
TKN (mg/L)	1.45±0.15 ^{aA}	1.12±0.11 ^{aY}	1.59±0.1 ^{aA}	1.39±0.06 ^{aX}	1.24±0.13 ^{aA}	0.88±0.11 ^{bYZ}	1.62±0.25 ^{aA}	0.82±0.04 ^{bZ}	1.48±0.07 ^{a}	1.05±0.03 ^{b}
TP (mg/L)	1.01±0.16 ^{aA}	0.62±0.09 ^{aX}	0.74±0.2 ^{aA}	0.38±0.06 ^{aX}	0.76±0.17 ^{aA}	0.40±0.08 ^{aX}	0.94±0.17 ^{aA}	0.55±0.08 ^{bX}	0.86±0.12 ^{a}	0.49±0.05 ^{b}
Phytoplankton										
Euglenophytes (X10^3cells/L)	1.25±0.22 ^{aB}	0.58±0.05 ^{bX}	2.49±0.48 ^{aA}	0.29±0.04 ^{bY}	1.95±0.39 ^{aA}	0.24±0.04 ^{bY}	2.18±0.37 ^{aA}	0.56±0.07 ^{bX}	1.97±0.26 ^{a}	0.41±0.03 ^{b}
Chlorophytes (X10^3cells/L)	1.19±0.17 ^{aAB}	1.13±0.2 ^{bY}	1.62±0.25 ^{aA}	2.04±0.26 ^{aX}	0.65±0.06 ^{bC}	1.09±0.18 ^{aY}	0.97±0.14 ^{aBC}	1.25±0.17 ^{aY}	1.11±0.09 ^{a}	1.37±0.11 ^{a}
Bascillariophytes (X10^3 cells/L)	0.49±0.05 ^{aAB}	0.34±0.03 ^{bY}	0.72±0.15 ^{aA}	0.92±0.17 ^{aX}	0.37±0.05 ^{aC}	0.32±0.05 ^{aY}	0.49±0.07 ^{aAB}	0.33±0.04 ^{aY}	0.52±0.06 ^{a}	0.48±0.05 ^{a}
Cyanophytes (X (10^3cells/ L)	0.33±0.03 ^{aAB}	0.27±0.03 ^{aY}	0.43±0.1 ^{bA}	0.98±0.18 ^{aX}	0.18±0.02 ^{bB}	0.30±0.05 ^{aY}	0.27±0.03 ^{aAB}	0.32±0.04 ^{aY}	0.30±0.03 ^{b}	0.47±0.05 ^{a}

[Small letter shows difference between red bloom and non-red bloom fishponds while capital letter shows seasonal differences within red bloom and non-red bloom fishponds]

Table 3: Seasonal variation and abundance of different group of zooplanktons in red bloom and none-red bloom fishponds of four different seasons

Seasons	Spring (M-M)		Summer (J -A)		Autumn (S -N)		Winter (D - F)		Combined mean	
Parameter	**Red bloom pond**	**Non-Red-bloom**	**Red bloom pond**	**Non-Red-bloom**	**Red bloom pond**	**Non-Red-bloom**	**Red bloom pond**	**Non-Red-bloom**	**Red bloom pond**	**Non-Red-bloom**
Rotifers (X 10^{3}cells/ L)	0.173±0.01^{aA}	0.165±0.01^{aY}	0.253±0.02^{aA}	0.155±0.01^{bY}	0.247±0.05^{aA}	0.211±0.01^{aX}	0.174±0.01^{aA}	0.171±0.01^{aY}	0.212±0.01^{a}	0.175±0.01^{a}
Brachionus calciflrus (X 10^{3}cells/ L)	0.125±0.01	0.125±0.01	0.195±0.02	0.102±0.01	0.152±0.03	0.144±0.01	0.137±0.01	132±0.01		
Brachionus bidentata (X 10^{3}cells/ L)	0.035±0.00	0.035±0.00	0.036±0.00	0.044±0.01	0.073±0.02	0.055±0.01	0.032±0.00	0.028±0.00		
Keratella (X 10^{3}cells/ L)	0.003±0.00	0.006±0.00	0.005±0.00	0.009±0.00	0.008±0.01	0.011±0.01	0.000	0.010±0.01		
Asplancha (X 10^{3}cells/ L)	0.004±0.00	0.000	0.009±0.01	0.000	0.011±0.01	0.000	0.003±0.00	0.001±0.00		
Polyarthra (X 10^{3}cells/ L)	0.005±0.01	0.000	0.007±0.01	0.000	0.004±0.00	0.000	0.002±0.00	0.000		
Cladocera (X 10^{3}cells/ L)	0.253±0.02^{aB}	0.226±0.02^{aY}	0.46±0.01^{aAB}	0.282±0.02^{aY}	0.794±0.31^{aA}	0.497±0.01^{aX}	0.31±0.02^{aAB}	0.335±0.01^{aXY}	0.454±0.01^{a}	0.335±0.03^{a}
Daphnia ambiqua (X 10^{3}cells/ L)	0.121±0.02	0.131±0.02	0.232±0.02	0.155±0.02	0.559±0.03	0.267±0.07	0.102±0.01	0.163±0.02		
Diaphanosoma birgei (X 10^{3}cells/ L)	0.041±0.01	0.041±0.01	0.203±0.01	0.046±0.01	0.125±0.02	0.121±0.02	0.09±0.02	0.075±0.01		
Moina sp. (X 10^{3}cells/ L)	0.051±0.01	0.027±0.01	0.009±0.00	0.074±0.02	0.029±0.01	0.03±0.01	0.077±0.02	0.058±0.02		
Bosmina sp. (X 10^{3}cells/ L)	0.015±0.01	0.007±0.00	0.004±0.00	0.001±0.00	0.049±0.02	0.067±0.03	0.017±0.01	0.015±0.01		
Chydorus sp. (X 10^{3}cells/ L)	0.023±0.01	0.02±0.01	0.003±0.00	0.006±0.00	0.005±0.00	0.006±0.01	0.011±0.01	0.006±0.01		
Ceriodaphnia sp. (X 10^{3}cells/ L)	0.003±0.00	0.00	0.009±0.01	0.00	0.027±0.01	0.006±0.01	0.008±0.01	0.012±0.01		
Sida sp. (X 10^{3}cells/ L)	0.00	0.00	0.00	0.00	0.00	0.00	0.005±0.00	0.05±0.00		
Copepods (X 10^{3}cells/ L)	0.231±0.01^{aB}	0.215±0.01^{aY}	1.06±0.05^{aA}	0.393±0.04^{bX}	0.435±0.07^{aAB}	0.457±0.09^{aX}	0.383±0.04^{aAB}	0.305±0.03^{aXY}	0.529±0.01^{a}	0.393±0.02^{a}
Mesocyclops edax (X 10^{3}cells/ L)	0.135±0.01	0.121±0.01	0.591±0.03	0.222±0.02	0.214±0.03	0.238±0.05	0.223±0.03	0.169±0.03		
Diaptomus siciloides (X 10^{3}cells/ L)	0.042±0.02	0.034±0.00	0.436±0.03	0.102±0.01	0.16±0.04	0.135±0.02	0.091±0.01	0.067±0.01		
Eubranchipus sp. (X 10^{3}cells/ L)	0.004±0.00	0.013±0.01	0.038±0.01	0.039±0.01	0.031±0.01	0.046±0.01	0.015±0.00	0.031±0.01		
Nauplius larva (X 10^{3}cells/ L)	0.05±0.01	0.047±0.01	0.017±0.01	0.031±0.01	0.029±0.02	0.039±0.01	0.055±0.01	0.038±0.01		
Total zooplankton (X 10^{3}cells/ L)	0.658±0.05aB	0.606±0.04aY	1.78±0.67aA	0.83±0.06bX	1.476±0.37aAB	1.165±0.21aX	0.867±0.07aAB	0.811±0.07aX	1.2±0.25a	0.853±0.06a

[Small letter shows difference between red bloom and non-red bloom fishponds while capital letter A, B and C shows seasonal differences within red bloom and capital letter X, Y and Z shown within non-red bloom fishponds]

Discussion

Zooplankton population in the both red bloom and non-red bloom carp ponds in three districts was comprised of Rotifers, Cladocera and Copepods corresponding to the finding of (Kumar *et al*., 2011) [21]. Red bloom did not affect combined density of Rotifer, Cladocera and Copepod because their densities did not differ significantly between red bloom and non-red bloom ponds. Density of Rotifer and Copepod was found higher in red bloom ponds than non-red bloom ponds in summer indicated phytoplankton including Euglenophytes probably served as food to them (Kozak *et al*., 2015) [20]. It was found that a mixed algal diet promotes survival, growth and development of Rotifer (Thépot *et al*., 2016) [34]. Higher abundance of Copepods might be related with high abundances of algae (Santer, 1993) [30].

Abundance of Zooplankton had significant correlation with TDS and conductivity (Bos *et al*., 1996, Ivanova and Kazantseva, 2006; Patra, *et al*., 2011) [7, 16, 24]. Zooplankton abundances especially copepods (clanoids) found higher abundance than other groups of zooplankton was also directly related to conductivity (Soto and Rios, 2006) [33]. TDS is basically used to define the total ions in solution in the water. It could therefore be implied from the positive correlation that an increase in the total ions in solution increases the density and abundance of zooplankton (Golmarvi, *et al*., 2017) [12].

Rotifers and Copepods showed higher abundance in summer, as similar results of tropical fish ponds of warm water (Sharma and Pant, 1984; Kiran *et al.,* 2007; Ikpi *et al.,* 2013) [31, 19, 15]. In the present study, higher population of zooplanktons is positively correlated with high nutrients and temperature in summer and autumn season. Nutrient enrichment which reflected through TDS and conductivity are similar with (Ahangar *et al.,* 2012; Akoma*et al*., 2012; Khare, 2005; Hutchinson, 1967; Wetzel, 1983) [1-2, 18, 14, 35]. In the present study, Copepods and Cladocera were found to dominate the population of Rotifers in both types of ponds.

Conclusion

Present study showed that red bloom caused by *Euglena sanguinea* has no effect on zooplankton population in carp ponds. It is a good relief to carp farmers in Nepal who grows carp in a semi-intensive way on natural foods such as phytoplantktons and zooplanktons and supplemental feed. In Nepal, over 90% farmers grow carp semi-intensively in fertilized ponds. Red bloom had affected certain water quality parameters such as DO, ammonia, nitrate, TKN, total phosphorus, TDS and conductivity. Low DO and high ammonia level in red bloom ponds indicated water quality problem and needs further study to assess red bloom's effect on fish growth and production. Zooplankton population is directly or indirectly influenced by water quality and nutrients and seasons.

Acknowledgements

Authors are thankful to the farmers of Eastern, Central and Western regions of Nepal for their kind cooperation and help during the field study. We would also like to thank Department of Aquaculture and Fisheries, Agriculture and Fisheries University. We are grateful to AquaFish Innovation Lab for financial support.

References

1. Ahangar A, Saksena DN, Mir MF. Seasonal Variation in Zooplankton Community Structure of Anchar Lake, Kashmir. Universal Journal of Environmental Research and Technology. 2012; 2 (4):305-310.
2. Akoma OC, Goshu G, Imoobe TOT. Variations in Zooplankton Diversity and Abundance in Five Research Fish Ponds Ife Journal of Science. 2012; 16:81-89.
3. APHA Standard methods for examination of water and waste water. American Public Health Association Inc., New York. 1976.
4. APHA Standard methods for examination of water and waste water (16th ed). American Public Health Association**,** American Water Works Association 1015, Fifteenth street NW, Washington D.C. 1985, 1268.
5. APHA Standard methods for examination of water and waste water. American Public Health Association, Washington: Byrd Prepress Springfield. 2005.
6. APHA Standard methods for examination of water and waste water (22nd ed.), American Public Health Association, Washington. 2012.
7. Bos DG, Cumming BF, Watters CE, Smol JP. The relationship between zooplankton, conductivity and lake-water ionic composition in 111 lakes from the Interior Plateau of British Columbia, Canada**.** International Journal of Salt Lake Research. 1996; (5)**:**1-15.
8. Dhanapathi MVSSS. Taxonomic notes on the *Rotifera*, Indian Association of Aquatic Biologist, Hyderabad, Vit. 2000, 178.
9. Dodson S. Predicting crustacean zooplankton species richness. Limnology & Oceanography. 1992; 37(4):848-856.
10. Edmondson WT. Fresh water biology, Edward and Hipple (Eds), 2nd edn. John John Willy & Sons Inc., Newyork, 1959, 95-189.
11. Fontaine CT, Revera DB. The mass culture of rotifers, *Brachionus plicatalis,* for use as food stuff in aquaculture. Proc. World Mariculture Society. 1986; 11**:**211-218.
12. Golmarvi D, Kapourchali MF, Moradi AM, Fatemi M, Nadoshan RM. Influence of Physico-Chemical Factors, Zooplankton Species Biodiversity and Seasonal Abundance in Anzali International Wetland, Iran. Open Journal of Marine Science. 2017; (7):91-99.
13. Guiry MD, Guiry GM. Algae Base. World-wide electronic publication, National. University of Ireland, Galway. 2016. http://www.algaebase.org.
14. Hutchinson GE. A Treatise on Limnology. Introduction to Lake Biology and the Limnoplankton. John Wiley and Sons, Inc. New York, USA, 1967; 2:660.
15. Ikpi GU, Offem BO, Irom BO. Plankton Distribution and Diversity in Tropical Earthen Fish Ponds. Environmentand Natural Resources Research. 2013; 3(3):45-51.
16. Ivanova MB, Kazantseva TI. Effect of Water pH and Total Dissolved Solids on the Species Diversity of Pelagic Zooplankton in Lakes: A Statistical Analysis Russian Journal of Ecology. 2006; 37(4):264-270.
17. Jakhar P. Role of phytoplankton and zooplankton as health indicators of aquatic ecosystem: A review. International Journal of Innovation Research Study. 2013; 2(12):489-500.
18. Khare PK. Physico-chemical characteristics in relation to Abundance of plankton of Jagat Sagar Pond, Chattapur, India. Advances in Limnology Edited by. S.R. Mishra, (Daya Publishing House), New Delhi. 2005, 162-174.
19. Kiran BR, Puttaiah ET, Kamath D. Diversity and

seasonal fluctuation of zooplankton in fish pond of Bhadra fish farm, Karnataka. Zoos' Print Journal. 2007; 22(12):2935-2936.
20. Kozak A, Gołdyn R, Dondajewska K. Phytoplankton Composition and Abundance in Restored Maltański Reservoir under the Influence of Physico-Chemical Variables and Zooplankton Grazing Pressure. PLoS ONE. 2015; 10(4**):**e0124738.
21. Kumar P, Wanganeo A, Wanganeo R, Sonaullah F. Seasonal Variations in Zooplankton Diversity of Railway Pond, Sasaram, Bihar International Journal of Environmental Sciences. 2011; 2(2):1007-1016.
22. Mandal RB, S. Rai MK. Shrestha DK Jha, Pandit NP, Rai SK. Water quality and red bloom algae of fish ponds in three different regions of Nepal. Our Nature. 2016; 14(1):71-77. DOI: http://dx.doi.org/10.3126/on.v14i1.16443.
23. Madin LP, Horgan EF, Steinberg DK. Zooplankton at the Bermuda Atlantic Time series Study (BATS) station: diel, seasonal and international variation in biomass. Deep Sea Research. 2001; 11(48):2063-2082.
24. Patra A, Santra KB, Manna CK. Ecology and diversity of zooplankton in relation to physico-chemical characteristics of water of Santragachi Jheel, West Bengal, India, Journal of Wetlands Ecology. 2011; (5):20-39.
25. Pennak RW. Freshwater invertebrate of United States, 2nd edn. John Wiley and Son, Newyork. 1978, 303.
26. Prescott GW. Algae of the western great lakes area. WM.C. Brown Publishers, Dubuque, Iowa. 1951, 977.
27. Rai SK, Rai RK. Some euglenophycean algae from Biratnagar, Nepal. Our Nature. 2007; 5: 60-66.
28. Reddy YR. Copepod, cladocera, diaptomidous guide to the identification of micro invertebrate of the continental water of the world, SPB Publisher, The Hague, Netherland. 1994, 5.
29. Rehman SU. A red bloom of *Euglena shafiqii*, a new species, in Dal Lake, Srinagar, Kashmir. Water Air and Soil Pollution. 1998; 108:69-82.
30. Santer B. Potential importance of algae in the diet of adult *Cyclops vicinus*. Fresh water Biology. 1993; 30:269-278.
31. Sharma PC, Pant MC. Abundance and community structure of limnetic Zooplankton in kumayun lake, India Hydrobiology. 1984; 69:91-110.
32. Sharma BK. In faunal diversity of India (Eds. J. R. B. Alfred, A. K. Das and Sanyal, A. K. Zoological Survey of India, Environmental Centre: 57-70, Willy & Sons Inc., Newyork. 1998, 95-189.
33. Soto D, Rios PDL. Influence of trophic status and conductivity on zooplankton composition in lakes and ponds of Torres del Paine National Park (Chile), Biologia, Bratislava. 2006; 61/5:541-546.
34. Thépot V, Mangott A, Pirozzi L. Rotifers enriched with a mixed algal diet promote survival, growthand development of barramundi larvae, *Lates calcarifer* (Bloch), Aquaculture Reports. 2016; 3:147-58.
35. Wetzel RG. Limnology. Second Edition. Saunders College Publishing, Philadelphia. 1983, 860.
36. Zimba, PV, Rowan M, Triemer RE. Identification of euglenoid algae that produce ichthyotoxin (s). Journal of Fish Diseases. 2004; 27:115-117.
37. Zimba PV, Moeller PD, Beauchesne K, Lane HE, Triemer RE. Identification of euglenophycin- A toxin found in certain euglenoids. Toxicon. 2010; 55(1):100-104. Doi 0.1016/j.toxicon.2009.07.004.