A Case Study on Plankton Diversity of Flood Plain Wetland with Special Reference of Barbila *Beel*, Nalbari District, Assam

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Abstract: The great nobleman Swami Vivekananda once must have rightly said "Next only to Kashmir, Assam is the most beautiful place in India". Assam state is very much known for its breath taking scenic beauty, rarest flora and fauna. Nalbari district is one of the major part of Brahmaputra valley. Nalbari district with its tropical climate and moderate to heavy rainfall harbours many smaller and larger wetlands where different types of plankton species has been seen. Plankton comprises microscopic organisms (both plant and animals) having very limited or no power of locomotion and living free floating and suspended in open or pelagic waters. The planktons have important role on the productivity of the water body. The present paper work deals with the study on planktons of Barbila *beel* of Nalbari, Assam was carried out for a period of two years, January 2018 to December, 2019. During the study period 53 forms of phyto plankton were identified in five different sites. They belong to five classes – Cyanophyceae, Chlorophyceae, Bacillariophyceae, Euglenophyceae and Dinophyceae. During this period 38 forms of zooplankton were identified and belong to four groups – Rotifers, protozoa, cladocera and copepods.

Index Terms **- Phyto plankton, Zoo plankton, Barbila, Pelagic.**

I. INTRODUCTION

India is endowed with myriads of flood plain wetlands locally called '*beels*'. Assam has, 1,392 beels spread over more than 100,000 hectare constituting 61% water bodies of the state.

Nalbari district is situated between 26°7' N to 26°50' N and 91°8' E to 91°48' E on the north back of the river Brahmaputra. A total of 1987 hectares area is covered with wetlands consisting of mainly 4 beels such as Kapla, Ghoga, Dubaria and Barbila.

The occurrence of plankton in a particular area indicates special habitats condition and such species are known as biological or ecological indicators since they indicate some very specific conditions of the environment.

The Phytoplankton is consisting of micro and macroscopic suspended or free floating non motile or weakly motile unicellular or colonial or filamentous algae. Phytoplankton bearing photosynthetic pigments make use of the rich organic nutrients available in the ecosystem and synthesized organic matter. Thus the form the base of ecological pyramid. In beels, zooplankton play a vital role in making efficient use of dead and living organic matter. Both zoo and phytoplankton form direct food and there by sustain a substantial portion of plantiphagous fishery of *beel* resources.

II. OBJECTIVES OF THE STUDY

The following objectives have been formulated for the study-

1. To study the plankton diversity in the Barbila *beel*.
2. To study the seasonal variation of the plankton community.

III. STUDY AREA

The Barbila *beel* is located in the district of Nalbari, Assam, at the intersection 26°15'10" North parallel of latitude and 91°18'30" East meridian of longitude. It is about 95 Km away from Guwahati and about 10 Km away from Tihu Town. The *beel* covers an area of 407.0 hectare. The *beel* is surrounded by village with about 6000 families of SC, ST and OBC people whose livelihood mainly depend on the fish and other aquatic resources of the *beel*.

IV. METHODS

Plankton samples were collected at random from the water surface of five sites. The samples were collected by the filtering 50 liters of water in each site through a plankton net made of bolting silk (nylobolt no. 25). Filtered plankton samples were fixed and preserved in 4% aquous formaldehyde solution and the plankton boottles were well labeled. In the laboratory 10-20 ml of the collected samples were centrifuged about 15-20 minutes at 1000 rpm. in an electrical centrifuge. The supernatant sample was removed from the centrifuge and the volume was reduced to 8 ml. After centrifugation qualitative and quantitative estimation were done by taking samples in Sedgewick Rafter Counting cell Method. Planktons were studied under light microscope and identified following the works of Kutikova (1970), Kostle (1978), Koste and Shiel (1987, 1989, 1990), Shiel and Kostle (1992,1993), Segers (1995), De Smet (1997), Sarma and Sarma (1997, 1999, 2000) and Nogrady and Needham (1986), Battish (1992), and Jayashree Datta Munshi, S.P. Roy, J.S. Datta Munshi (2010), Sharma Sumita (2008) and Sharma B.K.

V. RESULTS

During the period of investigation the plankton population were identified in Barbila *beel* which are listed in the following tables-

Table 1: Phytoplankton Species Recorded in Barbila *beel*

Class	Sl. No.	Genera
Cyanophyceae (Blue green algae)	1	*Spirulina*
	2	*Nostoc*
	3	*Anabaena*
	4	*Oscillatoria*
	5	*Synechococeus*
	6	*Microcystis*
	7	*Lyngbya*
	8	*Amphanothece*
	9	*Rivularia*
	10	*Nodularia*
	11	*Peridinium*
	12	*Ceratium*
	13	*Microchaete*
	14	*Gomphosphacria*
	15	*Scytonema*
Chlorophyceae	16	*Closterium*
	17	*Sprirogyra*
	18	*Docidium*
	19	*Microspora*
	20	*Scendesmus*
	21	*Chlorella*
	22	*Eudorina*
	23	*Ulothrix*
	24	*Zygnema*
	25	*Volvox*
	26	*Oedogonium*
	27	*Pediastrum*
	28	*Cladophora*
	29	*Penium*
Bacillariophyceae	30	*Navicula*
	31	*Diatoma*
	32	*Achanthes*
	33	*Pinnularia*
	34	*Amphora*
	35	*Cymbella*
	36	*Neidium*
	37	*Coloneis*
	38	*Pleurosigma*
	39	*Diploneis*

	40	*Fragillaria*
	41	*Mastoglia*
	42	*Gyrosigma*
	43	*Anomoeneis*
	44	*Neidium*
	45	*Surirella*
	46	*Eunotia*
	47	*Synendra*
	48	*Calonies*
	49	*Euglena*
Euglenophyceae	50	*Phacus*
	51	*Colacoium*
	52	*Ceratium*
Dinophyceae (Dinoflage Uates)	53	*Peridinium*

During the present study 53 forms of phytoplankton were identified in five different sites. They belong to five classes-

Table 3: Number of Phytoplankton Species Recorded in Barbila *beel*

Species Name	Quantity
Cyanophyceae	15
Chlorophyceae	14
Bacillariophycease	19
Euglenophyceae	3
Dinophyceae	2

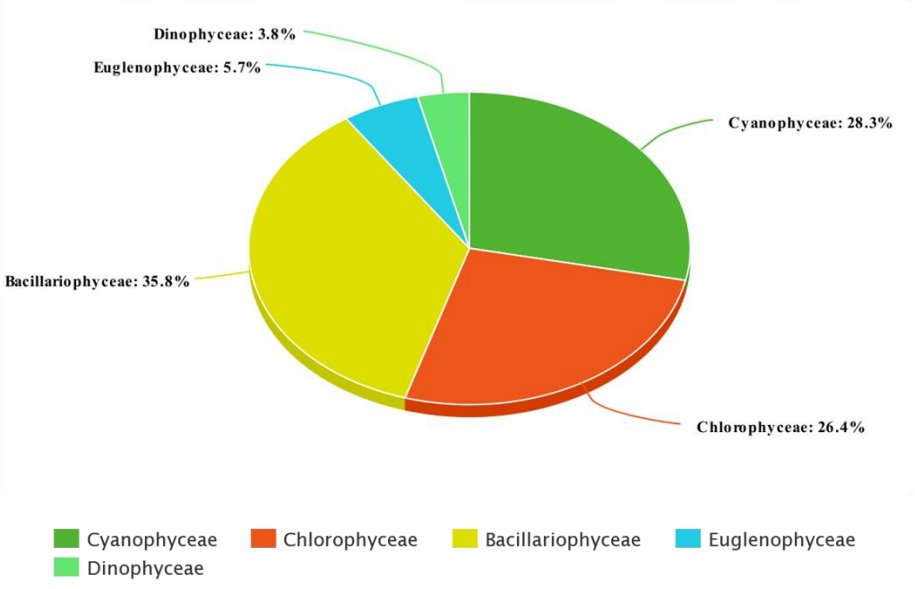

Fig 1: Pie Diagram of Phytoplankton Species in Barbila *beel*

Table 3: Zooplankton Species Recorded in Barbila *beel*

Group	Sl. No.	Genera
Rotifera	1	*Polyarthra platiptem*
	2	*Filinia bory*
	3	*Brachionus angularis*
	4	*Brachionus caudatum*
	5	*Keratella tropica*
	6	*Keratella cochlearis*
	7	*Keratella procurva*
	8	*Keratella quadrata*
	9	*Plationus patulus*
	10	*Epiphanes brachionus*
	11	*Mytilina ventralis*
	12	*Lepadella ovalis*
	13	*Lepadella patella*
	14	*Brachionus bidentatus*
	15	*Testudinella patina*
	16	*Filinia saltator*
	17	*Conochilus unicornis.*
Protozoa	18	*Difugia*
	19	*Arcella*
	20	*Centropryxis*
	21	*Euglypha*
	22	*Pandorina*
	23	*Nabela*
Cladocera	24	*Daphnia*
	25	*Moina*
	26	*Bosmina*
	27	*Ceriodaphnia*
	28	*Macrothrix*
	29	*Oxyurella*
	30	*Acroperus*
Copepods	31	*Nauplii*
	32	*Mesocyclops*
	33	*Neodiaptomus*
	34	*Cyclops muller*
	35	*Eucyclops*
	36	*Heliodiaptomus*
	37	*Tropocyclops*
	38	*Microcyclops*

During the study period 38 forms of Zooplankton were identified in five different sites. They belong to four groups.

Table 4: Number of Zooplankton Species Recorded in Barbila *beel*

Species Name	Quantity
Rotifer	17
Protozoa	6
Cladocera	7
Copedods	8

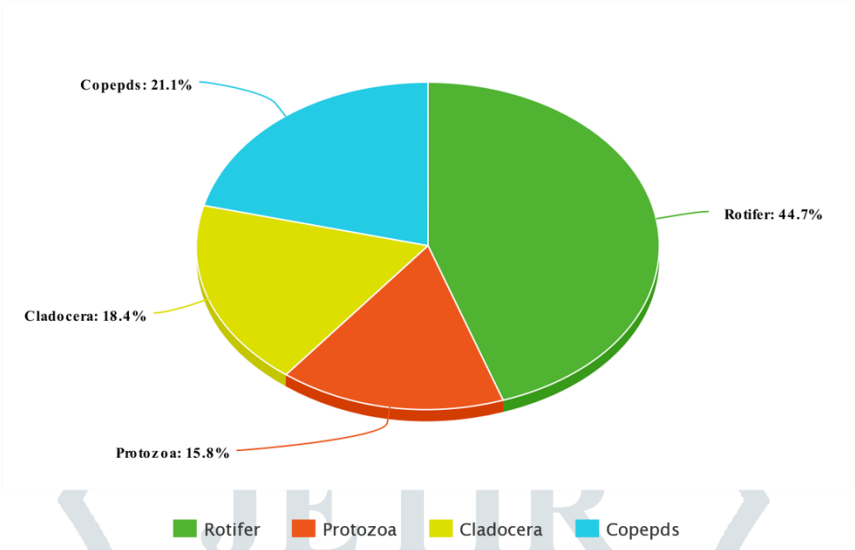

Fig 2: Pie Diagram of Zooplankton Species in Barbila *beel*

Table 5: Seasonal Variation and Percentage Composition in numerical values of different groups of Phytoplankton of Barbila *beel*

Season	Year	Sites	Total Phytoplankton Unit/I Av.	Cyanophyceae Unit/I	(%)	Chlorophyceae Unit/I	(%)	Bacillariophyceae Unit/I	(%)	Euglenophyceae Unit/I	(%)	Dinophyceae Unit/I	(%)
Pre Monsoon (March, April, May)	2018	S-1	335	113	(33.73)	146	(43.58)	53	(15.82)	14	(4.17)	09	(2.68)
		S-2	327	99	(30.27)	140	(42.81)	65	(19.87)	12	(3.66)	11	(3.36)
		S-3	348	110	(31.60)	141	(40.51)	63	(18.10)	15	(4.31)	19	(5.45)
		S-4	348	116	(33.33)	139	(39.94)	59	(16.95)	20	(2.88)	14	(4.02)
		S-5	312	89	(28.52)	142	(45.51)	60	(19.23)	09	(2.88)	12	(3.84)
		Total	**1670 / 334.0**	**527**	**(31.56)**	**708**	**(42.39)**	**300**	**(17.96)**	**70**	**(4.19)**	**65**	**(3.89)**
Monsoon (June, July, August)	2018	S-1	358	113	(31.56)	155	(43.20)	58	(16.20)	15	(4.18)	17	(4.74)
		S-2	288	104	(36.11)	130	(45.13)	28	(9.72)	12	(4.16)	14	(4.86)
		S-3	324	119	(36.72)	132	(40.74)	45	(13.88)	15	(4.62)	13	(4.01)
		S-4	328	120	(36.58)	135	(41.15)	51	(15.54)	07	(2.13)	15	(4.57)
		S-5	261	95	(36.39)	102	(39.08)	39	(14.94)	14	(5.36)	11	(4.21)
		Total	**1559 / 311.8**	**551**	**(35.34)**	**654**	**(41.94)**	**221**	**(14.17)**	**63**	**(4.04)**	**70**	**(4.49)**
Retreating Monsoon (Sept, Oct, Nov)	2018	S-1	324	98	(30.24)	121	(37.34)	67	(20.67)	20	(6.17)	18	(5.55)
		S-2	266	85	(31.95)	93	(34.96)	60	(22.55)	17	(6.39)	11	(4.13)
		S-3	227	75	(33.03)	83	(36.56)	51	(22.46)	10	(4.40)	08	(3.52)
		S-4	266	91	(34.21)	94	(35.33)	55	(20.67)	12	(4.51)	14	(5.26)
		S-5	259	85	(32.81)	81	(31.27)	73	(28.18)	09	(3.47)	11	(4.24)
		Total	**1342 / 268.4**	**434**	**(32.33)**	**472**	**(35.17)**	**306**	**(22.80)**	**68**	**(5.06)**	**62**	**(4.61)**
Winter (Dec, Jan, Feb)	2018	S-1	280	93	(33.21)	99	(35.35)	65	(23.21)	13	(4.64)	10	(3.57)
		S-2	225	75	(33.33)	82	(36.44)	40	(17.77)	15	(6.66)	13	(5.77)
		S-3	208	71	(34.13)	70	(33.65)	45	(21.63)	10	(4.80)	12	(5.76)
		S-4	212	73	(34.43)	78	(36.79)	39	(18.39)	13	(6.13)	09	(4.24)

		S-5	201	70	(34.82)	73	(36.21)	35	(17.41)	11	(5.47)	12	(5.97)
		Total	**1126 / 225.20**	**382**	**(33.92)**	**402**	**(35.70)**	**224**	**(19.89)**	**62**	**(5.50)**	**56**	**(4.97)**

Table 6: Seasonal Variation and Percentage Composition in numerical values of different groups of Phytoplankton of Barbila *beel*

Season	**Year**	**Sites**	**Total Phytoplankton Unit/I Av.**	**Cyanophyceae Unit/I**	**(%)**	**Chlorophyceae Unit/I**	**(%)**	**Bacillariophyceae Unit/I**	**(%)**	**Euglenophyceae Unit/I**	**(%)**	**Dinophyceae Unit/I**	**(%)**
Pre Monsoon (March, April, May)	2019	S-1	346	110	(31.79)	170	(49.13)	40	(11.56)	15	(4.33)	11	(3.17)
		S-2	342	113	(33.04)	165	(48.24)	41	(11.98)	13	(3.80)	10	(2.92)
		S-3	343	117	(34.11)	160	(46.64)	43	(12.53)	12	(3.49)	11	(3.21)
		S-4	338	113	(33.43)	162	(47.92)	40	(11.83)	13	(3.84)	10	(2.95)
		S-5	306	103	(33.66)	150	(49.01)	35	(11.43)	10	(3.26)	8	(2.61)
		Total	**1675 / 335.0**	**556**	**(33.19)**	**807**	**(48.26)**	**199**	**(11.88)**	**63**	**(3.76)**	**50**	**(2.98)**
Monsoon (June, July, August)	2019	S-1	451	120	(26.60)	161	(35.69)	43	(9.53)	16	(3.54)	11	(2.43)
		S-2	293	103	(35.15)	138	(47.09)	25	(8.53)	15	(5.11)	12	(4.09)
		S-3	311	112	(36.01)	135	(43.40)	37	(11.89)	16	(5.14)	11	(3.53)
		S-4	301	89	(29.56)	145	(48.17)	39	(12.95)	15	(4.98)	13	(4.31)
		S-5	297	88	(29.62)	148	(49.83)	35	(11.78)	16	(5.38)	10	(3.36)
		Total	**1653 / 330.6**	**512**	**(30.97)**	**727**	**(43.98)**	**179**	**(10.82)**	**78**	**(4.71)**	**57**	**(3.44)**
Retreating Monsoon (Sept, Oct, Nov)	2019	S-1	367	96	(26.15)	115	(31.33)	32	(8.71)	16	(4.35)	08	(2.17)
		S-2	275	103	(37.45)	118	(42.90)	30	(10.90)	15	(5.45)	09	(3.27)
		S-3	270	88	(32.59)	119	(44.07)	35	(12.96)	17	(6.29)	11	(4.07)
		S-4	271	85	(31.36)	125	(46.12)	33	(12.17)	18	(6.65)	10	(3.69)
		S-5	252	80	(31.74)	115	(45.63)	31	(12.30)	18	(7.14)	08	(3.17)
		Total	**1435 /287.0**	**452**	**(31.49)**	**592**	**(41.25)**	**161**	**(161.21)**	**84**	**(5.85)**	**46**	**(3.20)**

Table 7: Seasonal Variation and Percentage Composition in numerical values of different groups of Zooplankton of Barbila *beel*

Season	**Year**	**Sites**	**Total Zooplankton Unit/I Av.**	**Copepoda Unit/I**	**(%)**	**Rotifera Unit/I**	**(%)**	**Cladocera Unit/I**	**(%)**	**Protozoa Unit/I**	**(%)**
Pre Monsoon (March, April, May)	2018	S-1	177	75	(42.37)	60	(40.81)	30	(16.94)	12	(6.77)
		S-2	186	79	(42.47)	68	(36.55)	25	(13.44)	14	(7.52)
		S-3	172	73	(42.44)	63	(36.62)	26	(15.11)	10	(5.81)
		S-4	167	76	(45.50)	55	(32.93)	23	(23.77)	13	(7.78)
		S-5	152	70	(46.05)	51	(33.55)	21	(13.81)	10	(6.57)
		Total	**854 / 170.80**	**373**	**(43.67)**	**297**	**(34.77)**	**125**	**(14.63)**	**59**	**(6.90)**
Monsoon (June, July, August)	2018	S-1	161	68	(42.23)	57	(35.40)	25	(15.52)	11	(6.83)
		S-2	159	71	(44.65)	55	(34.59)	23	(14.46)	10	(6.28)
		S-3	155	65	(41.93)	52	(33.54)	26	(16.77)	12	(7.74)
		S-4	146	63	(43.15)	51	(34.93)	22	(15.06)	10	(6.84)
		S-5	142	60	(42.25)	53	(37.32)	18	(12.67)	11	(7.74)
		Total	**763 / 152.60**	**327**	**(42.85)**	**268**	**(35.12)**	**114**	**(14.94)**	**54**	**(7.07)**
Retreating Monsoon (Sept	2018	S-1	193	75	(38.86)	78	(40.41)	30	(15.54)	10	(5.18)
		S-2	202	80	(39.60)	75	(37.12)	35	(17.32)	12	(5.94)
		S-3	189	73	(38.62)	71	(37.56)	32	(16.93)	13	(6.87)
		S-4	193	78	(40.41)	70	(36.26)	33	(17.09)	12	(6.21)
		S-5	182	70	(38.46)	73	(40.10)	31	(17.03)	08	(4.39)

, Oct, Nov)		**Total**	**959 / 191.8**	**376**	**(39.20)**	**367**	**(38.26)**	**161**	**(16.78)**	**55**	**(5.73)**
Winter (Dec, Jan, Feb)	2018	S-1	196	80	(40.81)	67	(34.18)	35	(17.85)	14	(7.14)
		S-2	189	83	(43.91)	62	(32.80)	33	(17.46)	11	(5.82)
		S-3	199	82	(41.20)	68	(34.17)	36	(18.09)	13	(6.53)
		S-4	189	87	(46.03)	63	(33.33)	31	(16.40)	08	(4.23)
		S-5	176	76	(43.18)	60	(34.09)	30	(17.04)	10	(5.68)
		Total	**949 / 189.80**	**408**	**(42.99)**	**320**	**(33.71)**	**165**	**(17.38)**	**56**	**(5.90)**

Table 8: Seasonal Variation and Percentage Composition in numerical values of different groups of Zooplankton of Barbila *beel*

Season	**Year**	**Sites**	**Total Zooplankton Unit/I Av.**	**Copepoda Unit/I**	**(%)**	**Rotifera Unit/I**	**(%)**	**Cladocera Unit/I**	**(%)**	**Protozoa Unit/I**	**(%)**
Pre Monsoon (March, April, May)	2019	S-1	192	71	(36.97)	66	(34.37)	45	(23.43)	10	(5.20)
		S-2	189	69	(34.84)	65	(34.39)	42	(22.22)	13	(6.87)
		S-3	191	71	(37.17)	62	(32.46)	47	(24.60)	11	(5.75)
		S-4	188	73	(38.82)	60	(31.91)	43	(22.87)	12	(6.38)
		S-5	201	75	(37.31)	63	(31.34)	49	(24.37)	14	(6.96)
		Total	**961 / 192.2**	**359**	**(37.35)**	**316**	**(32.88)**	**226**	**(23.51)**	**60**	**(6.24)**
Monsoon (June, July, August)	2019	S-1	176	67	(38.06)	59	(33.52)	41	(23.29)	09	(5.11)
		S-2	180	65	(36.11)	61	(33.88)	42	(23.33)	12	(6.66)
		S-3	179	68	(37.98)	60	(33.51)	40	(22.34)	11	(6.14)
		S-4	176	66	(37.50)	55	(31.25)	45	(25.56)	10	(5.68)
		S-5	185	70	(37.83)	59	(31.89)	43	(23.24)	13	(7.02)
		Total	**896 / 179.2**	**336**	**(37.50)**	**294**	**(32.81)**	**211**	**(23.54)**	**55**	**(6.13)**
Retreating Monsoon (Sept, Oct, Nov)	2019	S-1	174	74	(42.52)	51	(29.31)	31	(17.81)	18	(10.34)
		S-2	190	83	(43.68)	53	(27.89)	33	(17.36)	21	(11.05)
		S-3	183	81	(44.26)	49	(26.77)	30	(16.39)	23	(12.56)
		S-4	187	78	(41.71)	57	(30.48)	35	(18.71)	17	(9.09)
		S-5	225	89	(39.55)	38	(16.88)	28	(12.44)	20	(8.88)
		Total	**959 / 191.8**	**405**	**(42.23)**	**248**	**(25.86)**	**157**	**(16.37)**	**99**	**(10.32)**

VI. ANALYSIS OF THE RESULTS

From the table 1, 53 forms of phytoplankton has been identified from the collected samples from five steps in four different reasons. They belong to 5 classes- cyanophyceae (Blue green algae, 15 species), chlorophyceae (14 species), bacillariophycease (19 species), euglenophyceae (3 species) and dinophyceae (2 species).

A total number of 15 species of cyanophyceae were recorded during the course of study. They were *Spirulina, Nostoc, Anabaena, Oscillatoria, Synechococeus, Microcystis, Lyngbya, Amphanothece, Rivularia, Nodularia, Peridinium, Ceratium, Microchaete, Gomphosphacria* and *Scytonema.* In the chlorophyceae class we have recorded total 14 number of species in Barbila *beel*, they were- *Closterium, Sprirogyra, Docidium, Microspora, Scendesmus, Chlorella, Eudorina, Ulothrix, Zygnema, Volvox, Oedogonium, Pediastrum, Cladophora* and *Penium.* There were 19 species are included in bacillariophycease, they are *–Navicula, Diatoma, Achanthes, Pinnularia, Amphora, Cymbella, Neidium, Coloneis, Pleurosigma, Diploneis, Fragillaria, Mastoglia, Gyrosigma, Anomoeneis, Neidium, Surirella, Eunotia, Synendra, Calonies* and *Euglena*. In Euglenophyceae there were only three species are identified, they were- *Phacus, Colacoium* and *Ceratium.* Also in case of Dinophyceae only one species is found identified as *Peridinium.*

From the table 3 we have showed the various types of zooplankton species. In that table, a total number of 38 forms were identified in five different sites and they were belonging to four groups. The rotifera groups exhibited the rich diversity among the zooplankton and poor diversity in protozoa. In the rotifer group we have identified 17 species and they were- *Polyarthra platiptem, Filinia bory, Brachionus angularis, Brachionus caudatum, Keratella tropica, Keratella cochlearis, Keratella procurva, Keratella quadrata, Plationus patulus, Epiphanes brachionus, Mytilina ventralis, Lepadella ovalis, Lepadella patella, Brachionus bidentatus, Testudinella patina, Filinia saltator* and *Conochilus unicornis.* In case of protozoa group we have identified 6 different species and they were listed below as – *Difugia, Arcella, Centropryxis, Euglypha, Pandorina* and *Nabela*. In cladocera groups we have found 7 species and they were *Daphnia, Moina, Bosmina, Ceriodaphnia, Macrothrix, Oxyurella* and *Acroperus*. In case of copepods groups there are 8 species, they were- *Nauplii, Mesocyclops, Neodiaptomus, Cyclops muller, Eucyclops, Heliodiaptomus, Tropocyclops* and *Microcyclops*.

The average number/unit per liter of phytoplankton population in site 1, 2, 3, 4 and 5 during the pre-monsoon periods of the first and second year of observation was 1670/334 and 1675/335 u/l respectively. During the monsoon seasons of the first and second year of observation the phytoplankton population was 1559/311 and 1653/330 u/l respectively. The average numbers/unit per liter of phytoplankton population in the site 1, 2, 3, 4 and 5 during the retreating monsoon seasons was 1342/268 and 1435/287 u/l respectively during the first and second years of observation. During the winter season of the first year of observation the phytoplankton population was 1126/25. The highest population was found in pre-monsoon seasons of second year and followed by the pre-monsoon season of first year. The lowest population is found in winter season.

The average number/unit per liter of zooplankton population in site 1, 2, 3, 4 and 5 during the pre-monsoon periods of the first and second year observation was 854/170 and 961/192 u/l respectively. From the observation it was found that the population of zooplankton in pre monsoon season were more in the first year and followed by the second year. During the monsoon seasons of the first and second year of observation, the zoo plankton population was 763/152 and 896/179 respectively. The average numbers/unit per liter of zooplankton population in the five sites during the retreating seasons was 959/191 and 959/191 respectively. During the two years observation it was found that the average population of zooplankton in retreating monsoon was same. During the winter season of the first year observation the zooplankton population was 947/189. The number of zooplankton counted in different seasons was more in the second year than the first year.

VII. CONCLUSION

The plankton community play an important part in determining the productivity of ecosystem of flood plain wetland. The abundance of plankton are also dependent on the environment of the *beel*. It is well known fact that a number of physic-chemical factors govern the growth and abundance of plankton population.

The present study revealed that the seasonal variation in plankton population is seen in different sites. Seasonal variation is suggested that the favorable period of plankton in Barbila *beel* were from April to October when nutrients accumulations from fresh water run off due to monsoon rainfall. The abundance of the plankton population indicate the productivity of water body of the *beel*.

REFERENCES

[1] Battish, S. K. (1992). Freshwater zooplankton of India. Oxford & IBH Publishing Company.
[2] J.S. Datta Munshi,Jayashree Datta Munshi,S.P. Roy (2010). Manual of Fresh Water Biota, Narendra Publishing House, New Delhi
[3] Edmondson, W. T. (1959). Methods and Equiment in Freshwater biology 2nd ed. John Willey and Sons. Inc., NewYork, 1202.
[4] Sharma, S., & Sharma, B. K. (2008). Zooplankton diversity in floodplain lakes of Assam. Zoological Survey of India.
[5] Needham, J. G., & Needham, P. R. (1972). A Guide to the Study of Fresh-water Biology: rev. and Enl. Holden-Day.
[6] Kutikova, L. A. (1970). The rotifer fauna of the USSR. Fauna SSSR 104. Academia Nauk (in Russian).