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Quantitative and Qualitative Analysis of Plankton in the Paddy Fields of Imphal East District, Manipur

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Abstract
Investigation on the seasonal distribution and abundance of various taxa of phyto- and zooplankton and their corresponding physico-chemical characteristics were carried out in four selected sampling sites between the latitude 25^{0}5/31.995// N to 24^{0}39/45.25// N and 94^{0}8/49.324//E to 93^{0}53/47.559//E Imphal East district. Drop count method was followed for the qualitative and quantitative analysis of both phyto and zooplankton. With about 500 phytoplankton are incredibly diverse and play a crucial role in paddy field ecosystem, they belong to different groups belonging 4 classes and 471 zooplankton genera were recorded. Zooplankton growth cycle was noticeably less than the phytoplankton abundance in the paddy fields during study period. During summer phytoplankton were recorded maximum as compare to zooplankton. Among phytoplanktonic groups, Cyanophyceae they perform photosynthesis and are crucial for nitrogen fixation was found to be dominating 16% in most of the sampling sites and followed by Bacillariophyceae (Silica cell wall) 13% during the investigation period. The pattern of differences of plankton standing crop in different sampling sites of paddy fields can be attributed to the existing physico-chemical characteristics mainly temperature, pH and hardness. Each genus has distinct adaptations for surviving in different aquatic environments. Phytoplankton is essential for supporting food web and influencing atmospheric oxygen of aquatic organism.

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INTRODUCTION

Imphal East district is mainly valley region which is mainly comprises of alluvial soil. The economy of the district is mainly agriculture based which is not a commercialized due to inadequate irrigation facilities, lack of improved farming techniques. The quality of life is linked with the quality of environment. Increasing rate of population growth had generated unprecedented pressure on the fragile natural resources base of the region consequently the economic and environmental pressure on the region was seriously threatened. The agricultural sector is the major source of income and employment generation in the region but its

potential for absorbing of growing labour force is the face of economic environmental problem and the deterioration of the resource base had a direct impact on the levels of poverty, nutrition and health. The biological compounds of a freshwater ecosystem are ruled by physico-chemical conditions (*Saksena* et al, 2008).

Phytoplankton are integral components of freshwater wetland which contribute towards the succession and dynamics of zooplankton and fish. Community structure, dominance and seasonally of phytoplankton in tropical wetlands are highly variable and are the functions of nutrient status, water level, morphometry of the underlying substrate and other regional factor. (*Gopal and Zutchi* 1998, *Zoharyi et al*., 1998 Agostinho *et al.,* 2001). Phytoplankton is the main producers of an aquatic ecosystem which control the biological productivity. The variability of phytoplankton with seasonal changes in aquatic environment is needed for the maintenance of water quality and sustainable aquaculture in Manipur. The abundance of plankton and its relation to environmental condition has become prerequisite for fish production, fish culture in paddy field, natural food productivity is increased in various ways such as artificial feeds & fertilizers (both organic and inorganic) which lead to nutrient environment in paddy fields.

Any aquatic body the primary productivity has given information relating to the amount of energy available to support the bioactivity of the system (Vollenweider, 1969). The quality and quantity of plankton vary in relation to depth, site, time and season of collection. They also differ according to biological and climatic condition. Good water quality is essential for the survival and adequate growth. Little or no studies on water quality and plankton in culture paddy field with the valley of Manipur have been done.

Therefore, this study was conducted for understanding the nutritive quality of the paddy fields water in order to assess its suitability for inland aquaculture fish.

MATERIALS AND METHODS

The experimental site & periods:

The study was conducted in 4 paddy fields viz. Lamlai, Khundrakpam, Pangei and Sawombung etc. situated in Imphal East district Manipur. Sampling was conducted over 3-month period from 15 September to 15 November 2023. The rain water is main source of water for these paddy fields. Water bodies are contaminated and paddy field are exposed to domestic and Municipal effluent.

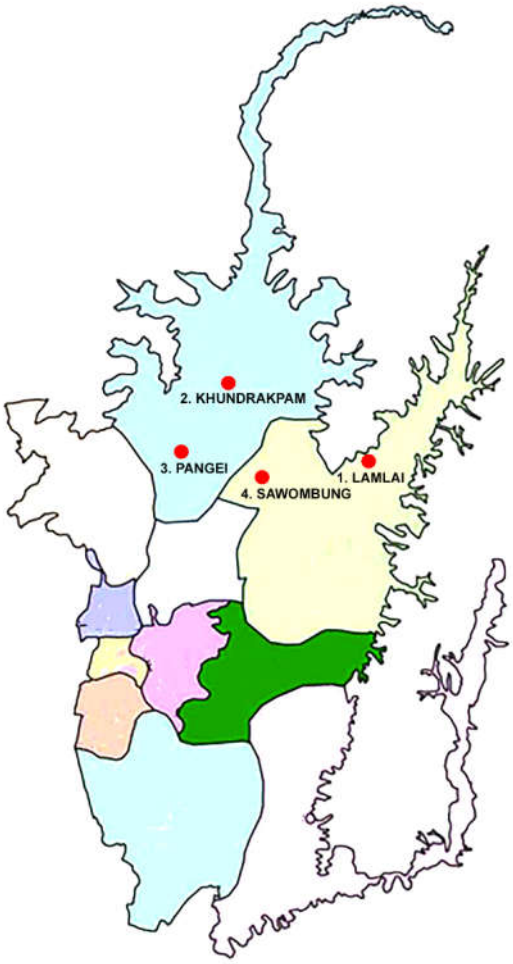

Figure 1: Sketch area of sampling site in the Imphal East District, Manipur

Phytoplankton sampling and analysis:
Plankton samples were collected using plankton net (25µm mesh size) and fixed in 4% formalin on the sites and a few drops of lugol solution were also added to prevent the cell shrinkage. The sample collected were performed thrice in one cycle, 1st collected 20 days after the plantation second collected during flowering time and 3rd sample collected ready for harvesting. Identification of plankton species were conducted under a phase contrast light microscope at 16 × 40 and 16 × 10 magnification Olympus microscope Japan with bright field and phase contrast illumination. Quantitative analyses of plankton were done on sedge wick - Rafter Counting Chamber (SR-cell). Analysis involved transfer of 1ml sub-sample from each of the samples to Sedge with Rafter counter and counting of cells within the 10 squares of the cells, chosen randomly. The counting of cells were used for compute the cell density rising Stirling (1985) formula where the plankton density was estimated by

$$N = \frac{A \times 1000 \times C}{V \times F \times L}$$

Where,
N = No. of plankton cells or units per litre of original water.
A = Total no. of plankton counted.
C = Volume of final concentrate of the sample in ml.
V = Volume of field in cubic mm.

F = No. of fields counted.
L = No. of fields counted volume in litre.

Water quality analysis
Surface water samples were collected once in a month between 10.00 and 11.00 hours for analysis of various physico-chemical parameters including temperature, transparency, hydrogen ion-concentration, total alkalinity acidity carbon dioxide, chloride, hardness, nitrate and nitrites etc. Temperature was measured on the spot using a mercury thermometer, pH was determined using a portable meter Transparency was measured using a Secchi-disc at two depths (disappearing, reappearing) using a black and white standard. Colour cold disc with 20cm diameter.

Statistical analysis:
Graphes and tables were represented in Microsoft excel. The Microsoft Excel 2007 was used to plots graphs for dissemination of the result.

RESULT AND DISCUSSION

Qualitative status of plankton community in the paddy fields of Imphal East district- 471 zooplankton and 500 of phytoplankton were identified in the paddy fields of Imphal East district (Table - 1). All most the genera were recorded in the four paddy fields of Imphal district during the study period.

Table 1:

Groups	Genus
Chlorophyceae	*Closterium elegane* *Volvox aureus (Ehrenberg)* *Ulothrix zonata* *Spirogyra singularis* *Chlorella vulgaris* *Chlorococcus sp.* *Ankistrodesmus sp.* *Chlorogonium sp.* *Scenedesmus sp.* *Pediastrum sp*
Bacillariophycea	*Amphora sp.* *Cymbella sp.* *Navicla seminulum* *Tabellaria sp.* *Surrirella sp.* *Pinnularia gibba* *Cyclotella sp.*
Cyanophyceae	*Anabaena affinis* *Oscillatoria linosa* *Nostoc sp.* *Melosira sp.* *Merismopedia sp.* *Aphanothece sp.*
Euglenophyceae	*Euglena viridis* *phacus sp.* *Tracelomonus sp.* *Anacystis sp.* *Gomphospaeric sp.*
Rotifers	*Branchionus calciflourus* *B. quadridentatus* *Keratella tropica*

Copepoda	*Paracyclops sp.* *Cyclops p.* *Cypris sp.* *Naupleus sp.* *Mesocyclop sp.*
Cladocera	*Dephnia, similes* *Moina sp.* *Bosmania longinostris* *Allonella nana*
Ostracoda	*Crustacean* *Prawn* *Decapoda*

Quantitative analysis of plankton community in the four paddy fields of Imphal East district namely, sampling station 1 (Lamlai) station 2 (Khundrakpam) station 3 (Pangei) station 4 (Sawombung) respectively.

The density of plankton were observed variable among the sampling sites in the paddy fields of Imphal East district. During the study period highest density of phytoplankton was observed in sampling site 3 during the month of November 2023 and less density was observed at the same sampling site 3 during the month of October as cyanophyceae. (Table - 2, 3).

Table 2: Total number and percentage of phytoplankton population in Imphal East District, 2023

Phytoplankton / Month	**September**				**October**				**November**				**Total**	**%**
Class/Station	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4		
Cyanophyceae	15	10	5	18	4	21	2	12	15	20	25	6	152	16%
Bacillariophyceae	8	8	6	10	10	12	15	10	10	15	16	10	130	13%
Chlorophyceae	13	10	12	7	8	15	10	10	10	8	15	8	126	13%
Euglenophyceae	12	7	5	13	10	5	6	3	7	10	10	4	92	10%
Total	**48**	**35**	**28**	**48**	**32**	**53**	**33**	**35**	**42**	**53**	**66**	**27**	**500**	**100**

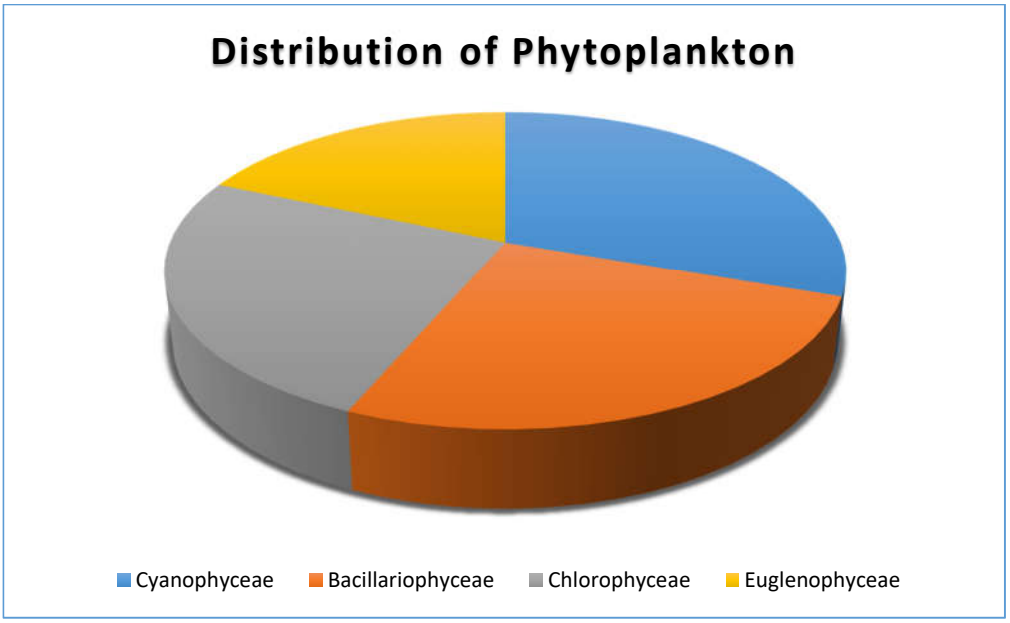

Figure 1: Distribution of phytoplankton

Table 3: Total number and percentage of zooplankton population in Imphal East District, 2023

Zooplankton Month	September				October				November				Total	%
Class/Station	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4		
Rotifera	18	15	6	10	20	10	10	6	15	16	8	10	144	30.99%
Copepoda	12	10	8	5	-	8	15	8	12	10	13	8	109	23.14%
Cladocera	22	20	18	10	-	6	10	9	8	10	8	9	130	27.60%
Ostracoda	11	8	10	6	8	10	-	5	10	-	8	10	86	18.25%
Total	**65**	**53**	**42**	**31**	**28**	**34**	**35**	**28**	**45**	**36**	**37**	**37**	**471**	**100**

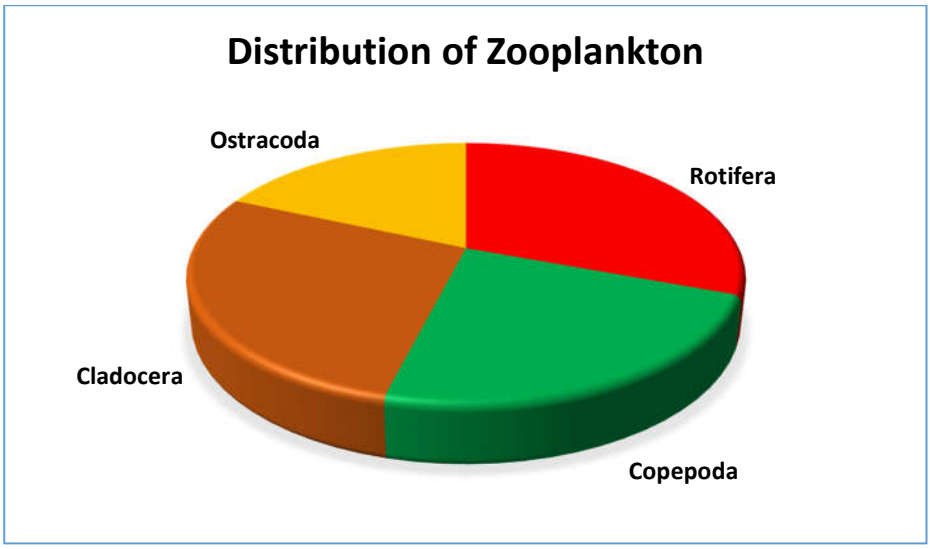

Figure 2: Distribution of Zooplankton

The four paddy fields in Imphal East District during the investigation period.

S_1 - Lamlai S_2 - Khundrakpam S_3 - Pangei S_4 - Sawombung

Table 4: Water quality (mg/L) observed in the paddy field of Imphal East District, 2023

Parameters	September				October				November			
	S_1	**S_2**	**S_3**	**S_4**	**S_1**	**S_2**	**S_3**	**S_4**	**S_1**	**S_2**	**S_3**	**S_4**
Temp. 0^0C	27±1.3	24±1.5	23±1.6	22±1.3	24±1.3	26±1.6	23±1.6	22±1.6	25±1.3	24±1.2	25±1.3	22±1.4
Transp. (Cm)	3±1.2	3.6±2.1	4.5±2.2	5±1.4	5±1.4	4±1.2	4±1.6	3±1.5	3±1.5	2.5±1.3	3±1.6	4.1±1.3
pH	6.8±0.3	7±0.7	6.9±1.6	6.3±1.4	6.5±1.5	6.2±1.5	6.3±1.7	7±0.1	4±1.2	4.5±1.6	4±1.7	5±1.2
DO	5.7±1.4	6.0±1.0	6.0±1.6	6.3±1.2	7±1.0	7±1.5	6.9±1.2	6±1.3	6.8±1.0	5±1.2	5±1.3	5±1.3
CO_2	3.0±1.3	4±1.5	4.2±1.5	3±1.6	3.5±1.2	4.6±1.2	3.8±1.6	4.2±.6	5.2±1.1	5.7±1.3	6±1.7	7.2±1.5
Chloride	6.7±1.4	6.5±1.7	6±1.6	5.8±1.0	4±1.2	5±1.3	4±1.0	4.5±1.6	5±1.3	5.3±1.4	6±1.8	6±1.7
T. Alkalinity	30.0±2	31±20	29±1.6	31±1.0	29±1.6	31±2.1	32±1.0	33±0.1	33±1.2	32±1.2	31±1.6	30±1.2
Acidity	12±1.4	12±1.6	13±2.6	13.6±1.2	15±1.2	16±1.6	16±1.6	18±1.1	19±1.2	20±1.0	18±1.2	18±1.5
Hardness	45.0±1.2	45±1.0	44±1.8	49±1.4	53±1.6	50±1.2	50±1.2	53±2.6	55±1.6	54±1.8	56±1.0	58±1.9
Nitrate	0.07±0.05	0.08±0.06	0.09±0.05	0.9±0.07	0.7±0.09	0.08±0.07	0.8±0.07	0.09±0.04	0.06±0.03	0.08±0.02	0.06±0.03	0.07±0.01
Nitrite	0.02±0.01	0.06±0.02	0.08±0.02	0.09±0.02	0.08±10.03	0.09±0.03	0.09±0.03	0.08±0.03	0.08±0.03	0.09±0.03	0.08±0.02	0.08±0.02

DISCUSSION

Quantitative status of plankton community is depending on the paddy fields, season, management activities, water quality parameters etc. During the study period 500 species of phytoplankton and 471 zooplankton were identified which falls into four major groups namely- *Bacillariophyceae, Cyanophyceae, Chlorophyceas, Eugluophyceae* while *Rotiferas, Copepoda, Cladocera* & *Ostracoda.* Margelef (1964) reported that both the phytoplankton and zooplankton population are nutrient rich in waters which are more diverse in those nutrient deficient water.

The water quality data presented in (Table-4) revealed that water temperature ranged from 27^0C - 31^0C, Temperature in a key factor for the seasonal periocity of plankton as observed in the present study. Paddy fields having more than 23^0C temperature is suitable for phytoplankton reported by Bhosale, Sabale and Mulic (1994) supported the temperature of the present study.

Temperature and dissolved oxygen content have an inverse relation i.e. higher temperature, the lesser the oxygen. In tropical water at the lower plain regions the D.O content is low is critical except air breathing fish. It is also recommended that the application of light dose of fertilizers (phosphate) **algae** bloom could sustain and supply oxygen but it can also lead to depletion of oxygen further as the algae themselves could consume oxygen in darkness.

Turbidity of the water in paddy fields is very high. The feature in this context is the water depth which is not high the light cutting through the paddy stems can penetrate and maintain high productivity. The carps and air breathing fishes tolerate high turbidity. The present study recorded 2cm during September at station No. 2 during the month of September and recorded as 8cm during the month of October at station No. 3. The analogous was supported by Mishra etal (1998). The ecological condition of paddy fields is characterized by shallow water (5-25cm) with rich phytoplankton and shallow water of paddy fields are rich in nutrient and minerals. The

minerals and nutrients come through the fertilizers applied by the rice farmer. Water is usually neutral during the study period (Table - 4) both phyto and zooplankton develop in the field (Table -1)

pH-value ranges near to neutral and revealed that the medium productive in nature for plankton community. During present study pH was slightly alkaline during summer and pre-monsoon which may be due to dumping of garbage and inflow of sewage water in the paddy fields. The present data is within the Indian standard value (6.5 to 8.5) BIS, 1992.

The main source of carbon dioxide is the greater decomposition of organic matter and respiration of plants and animals (Jafari and Gunale, 2006). The present investigation recorded low range of carbon dioxide between 1-5 mg/L at sampling site 1 and 4 as minima and maxima. The lower value of free carbon dioxide increase the value of dissolved oxygen, increase dissolved oxygen is related to the decrease in temperature (Table - 4).

Increasing value of dissolved oxygen is due to the influence of water runoff from monsoon rain. Lower value was recorded as 4mg/L and maximum value was record as 8mg/L which is satisfactory for the survival and growth of aquatic organisms. The present data was supported by (Rao, et al 1993). The total alkalinity recorded during investigation period at the range of 28 to 32 mg/L. data was supported by (Singh, 1993). Maximum value was recorded during the monsoon at stage and minimum value was observed during the month of November. Nitrates are highly oxidized form of nitrogen compounds present in natural water because they are the product of aerobic decomposition of organic nitrogenous matter. The highest concentration of nitrate is an indicator of organic pollution and eutrophication. Wetzel (1983) stated that nitrate was generated by heterotrophic microbes as a primary end product of decomposition of oxygenic matter either directly from protein or organic compound. The present work recorded ranged from 0.04 to 0.09mg/L of nitrate and 0.02 to 0.09 of nitrites. The higher value was recorded 0.09 in the month of September and lower value were records in the month of October at sampling site 2 and 3. The increase in value of nitrate and nitrite in water is due to manmade domestic activities of fertilizers in paddy fields. The present data was resembled with Zutch and Khan (1998).

During the investigation period paddy fields are also seen dipteran larvae especially *Chironomids* larva which make use of the minerals and nutrients particularly nitrogenous materials unused and fish like carps feed on the *Chironomid* larva, make use unrapped energy source in the natural cycle. It is also pointed out that algae make use of nutrient and sunlight available are also useful in pisciculture, for fishes like *Tilapia mossambica* and *Trichogaster pectoralis* feed on lagae. The excrements of the fish are also recycled part going to the paddy plants.

The disadvantages of the paddy fields for fish was also observed during studied period for fish that low depth of water and stagnant water. The low depth water increased light penetration and consequent high production of phytoplankton and algae in shallow water.

Stagnant water is made possible only to extent by addition and retention of fertilizers applied, in this case of fishes by adoption of polyculture technique of right choice of fish species. So that recycling of nutrient is ensured.

Both fertilizers and biocide (insecticide, fungicides) are used extensively in high yielding rice production leading to green revolution in several developing countries in South East Asia there are also areas where fish culture in paddy fields are well established. There appears little compromise between modern technology in rice production. The ecology of paddy fields is highly influenced by these modern developments. High amount of chemicals injurious to fish in the paddy fields. Some of the death were also observed in station 3 and 4.

CONCLUSION

A detailed description of the dynamics of plankton within the paddy field has not been given in the studied since the samples cover only a period of 3 months. Hence there is a need to carry out successive studies to look deeply at the dynamics of the plankton groups within the

paddy fields for fish culture. Sampled over several years in order to fully characterize, the variations both due to water quality and variability in climatic conditions. This information will be useful for the future research as a foundation study towards the characterization of these dynamic works within the paddy field for the improvement of economic condition in the state through paddy cum fish culture since plankton food for fish is available and favoured with physico-chemical parameter.

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