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BIOMASS DYNAMICS OF THE MACROPHYTIC SPECIES OF KHARUNGPAT LAKE, MANIPUR, INDIA

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ABSTRACT

Biomass estimation of the macrophytic species were carried out at monthly intervals for a period two years from January 2008 to December 2009. For the present study, the lake was divided into four study sites representing as Site I, II, III and IV which are named as Panchao, Pangalpat, Kambong Leiram and Kharungpat Khong (Shamu Lanpham) respectively. Among the dominant macrophytic species, the maximum biomass was exhibited by A*lternanthera philoxeroides* with values ranging from 56.41 g m^{-2} to 183.48 g m^{-2} in the first year and 53.97 g m^{-2} to 201.45 g m^{-2} in the second year. This was followed by *Echinochloa stagnina* with values ranging from 21.75 to 162.73 g m^{-2}, *Ceratophyllum demersum* (34.65 to 155.82 g m^{-2}) *Zizania latifolia* (19.88 to 140.78 g m^{-2}), *Eichhornia crassipes* (13.08 to 94.25 g m^{-2}), *Ludwigia adscendens* (21.83 to 74.76 g m^{-2}), *Enhydra fluctuans* (4.46 73.40 g m^{-2}), *Hygroryza aristata* (15.18 to 68.46 g m^{-2}) *Hydrilla verticillata* (13.16 to 64.70 g m^{-2}), *Salvinia cucullata* (9.06 to 52.20 g m^{-2}), *Pistia stratiotes* (11.80 to 50.52 g m^{-2}) successively. The total biomass of 'other species' ranged from 16.51 to 129.24 in the first year and 18.08 to 98.83 in the second year. The total biomass of all species (combined) in the different study sites ranged from 304.01 to 989.95 g m^{-2}.

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INTRODUCTION

Biomass is the total amount of organic matter present at a given time per unit area of the earth's surface (Whittaker, 1970). The biomass is an expression of the standing crop which is referred to as the amount of living materials in a trophic level or component population. Biomass may also be expressed as the 'organism mass' in unit area, which can be expressed as living weight, dry weight, ash-free dry weight or carbon weight or calories or any other convenient unit for comparative purposes (Odum, 1971). Biomass determination is one of the most important tools for evaluation of the primary productivity. Species which accumulate more biomass and having higher production rates are found dominant in the community and hence they usually influence the overall physiognomy of the vegetation (Misra, 1989).

Studies on the biomass dynamics of the macrophytes of freshwater ecosystems in India were undertaken by different workers in different regions viz., Sahai and Sinha (1970); Kaul (1970); Ambasht (1971); Gopal *et al.,* (1978); Dhakar (1979); Shah and Abbas (1979); Billore and Vyas (1981); Seshavatharam and Venu (1982); Sharma and Pradhan (1983); Unni (1984); Saxena (1986); Vasudeva (1986); Yadava *et al.,* (1987); Shardendu and Ambasht (1991); Devi (1993); Devi (1993 a); Devi (1998); Devi (2000); Devi (2001); Devi (2002); Usha (2002); Devi (2007); Devi (2008) and Devi and Sharma (2010) etc. The present study would augment the existing database on Biomass dynamics of the aquatic macrophytes in freshwater ecosystem of the state.

Study area

Kharungpat lake is situated in Thoubal District, Manipur. The lake is located in South Western Portion of Thoubal District at a distance of about 30 km. from Imphal City. Kharungpat lake is surrounded by Ikoppat on the Northern portion, Wangjing Tentha on Eastern side, Uchiwa, Santhel and Sekmaijin on the Western side and Wabagai on the southern side. The lake is located at the intersection of 24°53'57"N – 24°60'78" N Latitude and 93°90'77" E – 93°97'37" E Longitude. The lake has an area of about 33.52 sq. km during rainy season and is located at about 781 m above the mean sea level. For the present study, the lake was divided into four study sites representing as Site I, II, III and IV which are named as Panchao, Pangalpat, Kambong Leiram and Kharungpat Khong (Shamu Lanpham) respectively. The study site map of Kharungpat lake has been presented in Fig.1.

MATERIALS AND METHODS

The present investigation was carried out in Kharungpat lake located in Thoubal District, Manipur. The survey and analysis of the present lake was carried out at monthly intervals for a period of two years from January, 2008 to December, 2009. For detailed study and investigation, the lake was divided into four sampling/study sites. Collections of water samples as well as the macrophytic plants samples were done on monthly regular intervals from the four study sites. Standing crop biomass was estimated by Harvest method (Odum, 1956). Macrophytic plants were sampled on monthly basis during the study. Plant samples were collected using Quadrats of 25 cm × 25 cm in dimension from the vertical core sampling sites and the cumulative data were analyzed. However for the sampling of some submerged species methods described by Ekman Dredge were used (Welch, 1948). After collection each sample was kept in polythene bags marked with wax pencil and brought to the laboratory. Plant materials were washed to remove the adhering silt, soil, mud, other plants and animal debris etc. Then the plants were sorted out as dominant species and remaining as 'other species'. Excess of water was drained using blotting papers. Fresh weights of the different species were taken by differentiating into shoot and root portions. The root portions of the submerged species are generally found to be insignificant and as such the same may be neglected (Edward and Owens, 1960; Forsberg, 1960). After taking the fresh weights, each labeled sample packed in paper bags was dried at 80°C for 48 hr. Later, dry weights of the shoot and root portions were taken separately. Thus, biomass were calculated on dry weight basis and expressed in grams per square metre (g m^{-2}).

RESULTS AND DISCUSSION

In the present investigation a total of fifty four (54) aquatic macrophytes were found distributed in the lake. The plant species recorded were grouped into different categories viz., submerged (7 species), rooted with floating leaves (6 species), free floating (8 species) and emergent (33 species) respectively. The variation in biomass values for the dominant macrophytic plant species are furnished in Table 1 and 2. The maximum ranges of biomass were recorded in *Alternanthera philoxeroides, Echinochloa stagnina, Ceratophyllum demersum, Zizania latifolia* etc. *Alternanthera philoxeroides* recorded the highest value of biomass in Sites II and IV whereas *Echinochloa stagnina* recorded peak value of biomass in Sites I and II in the first year. In the second year *Alternanthera philoxeroides* recorded maximum biomass value in Sites I, II and IV while *Echinochloa stagnina* recorded highest value of biomass in Site III.

The biomass value of *Alternanthera philoxeroides* ranged from 56.41 g m^{-2} to 183.48 g m^{-2} in the first year and 53.97 g m^{-2} to 201.45 g m^{-2} in the second year. Sharma and Devi (2002) in Loktak lake, Manipur reported comparable values of biomass (9.23 to 214.01 g m^{-2}). The present observed values are comparatively higher than those reported by various authors viz., Devi (1993 a) in Waithou lake, Manipur (53.70 g m^{-2} in the first year and 50.30 g m^{-2} in the second year), Devi (1998) in Utrapat lake, Manipur (57.12 to 93.01 g m^{-2}), Devi (2001) and Bebika and Sharma (2002) in Sanapat lake, Manipur reported biomass values ranging from 1.19 to 84.94 g m^{-2} for shoot and 0.06 to 28.54 g m^{-2} for root. Usha (2002) in Poiroupat lake reported biomass values of 139.77 g m^{-2} and 120.84 g m^{-2} in the first and second year respectively. Devi (2007) reported biomass values ranging from 32.55 to 124.35 g m^{-2} in the first year and 22.50 to 153.06 g m^{-2} in the second year from Awangsoipat lake, Manipur. The biomass values of *Alternanthera philoxeroides* reported by Devi and Sharma (2010) in Oksoipat lake, Manipur varied from 19.94 to 139.41 g m^{-2} in the first year and 21.44 to 135.79 g m^{-2} in the second year of study.

In the present study the biomass values of *Echinochloa stagnina* ranged from 29.44 to 162.73 g m^{-2} in the first year and 21.75 to 137.75 in the second year. Devi and Sharma (2010) in Oksoipat lake, Manipur reported biomass values of 13.82 to 110.46 g m^{-2} and 23.57 to 142.14 g m^{-2} in the first and second year respectively. The biomass values of *Ceratophyllum demersum* varied from 34.65 to 128.22 g m^{-2} in the first year and 42.54 to 155.82 g m^{-2} in the second year. The present biomass values are comparable with the values reported from Gorakhpur by Sahai and Sinha (1976) with values of 161.00 g m^{-2}, Shah and Abbas (1979) in Bhagalpur (90.60 to 135.60 g m^{-2}). Devi (2007) in Awangsoipat lake, Manipur reported biomass values ranging from 20.14 to 163.56 g m^{-2} in the first year and 39.56 to 175.32 g m^{-2} in the second year which are comparable with the present findings. Devi and Sharma (2010) in Oksoipat lake, Manipur reported similarly comparable values varying from 46.88 to 155.63 g m^{-2} in the first year and 30.53 to 168.96 g m^{-2} in the second year.

The biomass values of *Zizania latifolia* ranged from 19.88 to 140.78 g m^{-2} in the first year and 25.03 to 112.67 g m^{-2} in the second year. The peak biomass values were recorded during rainy season (July and August) while the lowest values were observed during winter season (December) in the consecutive years of study period. The biomass values of *Eichhornia crassipes* varied from 13.08 to 72.21 g m^{-2} in the first year and 15.83 to 94.25 g m^{-2} in the second year. The present findings of *Eichhornia crassipes* are found to be comparable with those reported by Devi and Sharma (2010) in Oksoipat lake, Manipur with biomass values ranging from 17.87 to 64.96 g m^{-2} in the first year and 17.76 to 69.02 g m^{-2} in the second year.

Ludwigia adscendens had biomass values ranging from 23.63 to 74.76 g m^{-2} in the first year and 21.83 to 63.39 g m^{-2} in the second year. Comparable values were reported by Usha (2002) in Poiroupat lake, Manipur with biomass values ranging from 14.09 g m^{-2} to 68.77 g m^{-2} and 37.11 g m^{-2} to 89.32 g m^{-2} in the first and second year respectively. Devi (2007) in Awangsoipat lake, Manipur reported similar comparable biomass values ranging from 18.03 g m^{-2} to 66.86 g m^{-2} and 10.04 to 52.80 g m^{-2} in the two consecutive years of study. The biomass values of *Enhydra fluctuans* varied from 4.46 to 69.12 g m^{-2} in the first year and 5.10 to 73.40 g m^{-2} in the second year. *Hygroryza aristata* had biomass values ranging from 15.18 to 63.97 g m^{-2} in the first year and 17.83 to 68.46 g m^{-2} in the second year. The present findings are comparable with those reported

Table 1: Variations in the values of biomass (g m^{-2}) in kharungpat lake, manipur during the first year of study

Name of Species	*Family*	*Site I*	*Site II*	*Site III*	*Site IV*
Alternanthera philoxeroides (Mart) Griseb.	Amaranthaceae	70.87-155.75	54.41-142.88	42.72-117.12	76.90-193.98
Brachiaria mutica (Forsk). Stapf.	Poaceae	7.75-47.57	-	-	-
Ceratophyllum demersum Linn.	Ceratophyllaceae	58.06-128.22	51.41-114.20	34.65-103.50	-
Ceratopteris thalictroides (Linn.)	Ceratopteridaceae	-	28.50-76.57	37.35-71.11	-
Cyperus distans Linn.f.	Cyperaceae	-	-	-	9.18-25.11
Echinochloa stagnina (Retz.) P. Beauv.	Poaceae	29.44-157.05	25.39-142.73	31.53-162.73	21.56-128.89
Eichhornia crassipes (Mart.) Solms.	Pontederiaceae	17.31-72.21	13.08-62.46	15.22-65.34	15.24-64.78
Enhydra fluctuans Lour.	Asteraceae	4.46-55.45	8.40-52.49	6.75-69.12	-
Hydrilla verticillata (Linn. F.). Royle.	Hydrocharitaceae	-	13.16-45.50	15.39-51.63	9.82-38.57
Hygroryza aristata (Retz.) Nees.	Poaceae	25.37-63.97	24.61-57.98	19.34-54.48	15.18-48.24
Ipomoea aquatica Forsk.	Convolvulaceae	-	-	6.73-24.91	-
Leersia hexandra Swartz.	Poaceae	5.48-20.56	-	-	-
Ludwigia adscendens (Linn.) Hara	Onagraceae	26.22-74.76	26.63-54.19	27.36-56.31	33.13-60.05
Marsilea quadrifoliata Linn.	Marsileaceae	-	-	-	6.43-27.19
Nymphoides cristatum (Roxb.) O. Kuntze	Menyanthaceae	-	-	4.99-23.88	-
Nymphaea pubescens Willd.	Nymphaeaceae	-	5.59-42.02	-	-
Phragmites karka (Retz.) Trin. Ex Stand.	Poaceae	12.24-27.22	-	-	-
Pistia stratiotes Linn.	Araceae	-	11.80-41.73	17.84-45.14	21.10-50.52
Pseudoraphis minuta (Mez) Pilger	Poaceae	6.53-27.53	-	-	-
Salvinia cucullata Roxb.	Salvinaceae	9.06-52.20	16.08-44.79	-	11.25-39.37
Zizania latifolia (Griseb.) Stapf.	Poaceae	34.20-140.78	30.58-119.68	22.96-108.44	19.88-104.06
Other Species		30.47-129.24	16.51-118.73	23.18-107.85	13.26-101.76
All Species (Combined)		384.28-989.95	315.20-982.32	330.39-933.06	313.36-787.60

by Devi and Sharma (2010) in Oksoipat lake, Manipur with biomass values ranging from 18.94 to 86.57 g m^{-2} in the first year and 17.44 to 64.26 g m^{-2} in the second year. .

Hydrilla verticillata had biomass values ranging from 13.16 to 51.63 g m^{-2} in the first year and 13.46 to 64.70 g m^{-2} in the second year. In the present study, the peak biomass values for the two consecutive years

Table 2: Variations in the values of biomass (g m^{-2}) in kharungpat lake, manipur during the second year of study

Name of Species	**Family**	**Site I**	**Site II**	**Site III**	**Site IV**
Alternanthera philoxeroides (Mart) Griseb.	Amaranthaceae	53.97-201.45	62.81-141.40	37.57-114.39	79.92-197.98
Brachiaria mutica (Forsk). Stapf.	Poaceae	4.94-45.54	-	-	-
Ceratophyllum demersum Linn.	Ceratophyllaceae	56.82-155.58	52.86-121.94	42.54-103.85	-
Ceratopteris thalictroides (Linn.)	Ceratopteridaceae	-	45.07-80.49	30.50-70.81	-
Cyperus distans Linn.f.	Cyperaceae	-	-	-	13.59-32.59
Echinochloa stagnina (Retz.) P. Beauv.	Poaceae	21.75-137.75	26.20-126.45	31.46-137.32	25.13-137.37
Eichhornia crassipes (Mart.) Solms.	Pontederiaceae	15.83-62.59	21.89-94.25	20.10-66.15	20.18-66.90
Enhydra fluctuans Lour.	Asteraceae	6.82-52.05	5.58-46.21	8.31-73.40	-
Hydrilla verticillata (Linn. F.). Royle.	Hydrocharitaceae	-	17.95-49.05	18.23-64.70	13.46-38.58
Hygroryza aristata (Retz.) Nees.	Poaceae	25.32-56.53	-	17.83-68.46	20.79-49.17
Ipomoea aquatica Forsk.	Convolvulaceae	-	-	8.89-31.80	-
Leersia hexandra Swartz.	Poaceae	5.92-9.11	-	-	-
Ludwigia adscendens (Linn.) Hara	Onagraceae	22.64-63.39	24.66-58.36	21.83-57.98	32.09-64.27
Marsilea quadrifoliata Linn.	Marsileaceae	-	-	-	18.27-39.44
Nymphoides cristatum (Roxb.) O. Kuntze	Menyanthaceae	-	-	8.82-29.61	-
Nymphaea pubescens Willd.	Nymphaeaceae	-	17.94-37.94	-	-
Phragmites karka (Retz.) Trin. Ex Stand.	Poaceae	10.43-27.02	-	-	-
Pistia stratiotes Linn.	Araceae	-	22.80-41.89	21.63-44.41	19.67-48.77
Pseudoraphis minuta (Mez) Pilger	Poaceae	11.56-30.19	-	-	-
Salvinia cucullata Roxb.	Salvinaceae	13.37-39.55	19.71-48.81	-	19.58-49.73
Zizania latifolia (Griseb.) Stapf.	Poaceae	21.71-110.88	26.93-98.32	26.19-94.26	25.25-112.67
Other Species	-	18.08-79.49	28.14-90.43	23.91-97.83	20.46-100.37
All Species (Combined)	-	310.04-986.78	323.80-947.73	304.01-947.32	313.80-848.71

Table 3: Comparison of the values of standing crop biomass of the macrophytes in different freshwater ecosystems

Ecosystem	Biomass (g^{-2})	Authors
Kharungpat Lake, Manipur	313.36 – 989.95 (1st Year) 304.01 – 986.78 (2nd Year)	Present Study
Osby Lake, Sweden	520.00	Forsberg, 1960
Freshwater ponds, Varanasi	1,250.00	Ambasht, 1971
Wetlands, Malaysia	370.00 – 520.00	Wassink, 1975
Opinicon Lake, Canada	1154.00	Crowder *et al.*, 1977
Manasbal and Anchar Lake, Kashmir	970.00 and 1010.00	Kaul, 1977
Ramgarh Reservoir	92.90 – 564.50	Gopal *et.al.*, 1978
Pichhola Lake, Udaipur	10.00 – 35.80	Billore and Vyas, 1982
Lakes of Udaipur	537.60 – 1884.09	Vyas *et.al.*, 1989
Eutrophic ponds, Michigan	196.00 – 260.00	Spencer and King, 1984 and Freeman 1989
Waikaremona lake, New Zealand	1106.00	Howard-Williams *et al.*, 1986
Shallow ponds, Varanasi	778.00	Misra, 1989
Loktak Lake, Manipur	29.13-455.97 (Non-phumdi) 363.21 – 782.63 (Phumdi)	Devi, 1993
Waithou Lake, Manipur	422.97 – 1305.70	Devi, 1993 a
Utrapat Lake, Manipur	139.18 – 579.85	Devi, 1998
Freshwater Ecosystems, Canchipur (Manipur)	55.13 – 408.40	Devi, 2000
Deux Montagnes Lake, Canada	112.20	Hudon *et al.*, 2000
Sanapat Lake, Manipur	33.19 – 229.53	Devi, 2001
Ikop lake, Manipur	16.81 – 295.62	Devi and Sharma, 2006
Poiroupat Lake, Manipur	130.07 – 512.28	Usha, 2002
Awangsoipat Lake, Manipur	164.45 – 841.00	Devi, 2007
Oksoipat Lake, Manipur	150.87 – 588.05	Devi and Sharma (2010)

were reported during rainy season (July). In consonance with the present findings Devi (1993) recorded peak biomass value for *Hydrilla verticillata* (443.08 g m^{-2}) during rainy season (July) from Loktak lake, Manipur. Similarly, Devi (2007), Mishra and Tripathi (2004) also observed peak biomass values during rainy seasons. Comparable values were also reported by Usha (2002) in Poiroupat lake, Manipur with biomass values ranging from 16.09 to 65.22 g m^{-2} and 22.23 to 67.00 g m^{-2} for the first and second year respectively.

The biomass values of *Salvinia cucullata* ranged from 9.06 to 52.20 g m^{-2} in the first year and 13.37 to 49.73 g m^{-2} in the second year. The present findings are found to be comparable with those reported by Devi and Sharma (2010) in Oksoipat lake, Manipur with biomass values varying from 9.17 to 47.46 g m^{-2} in the first year and 14.99 to 67.52 g m^{-2} in the second year. In *Pistia stratiotes* biomass values ranged from 11.80 to 50.52 g m^{-2} and 19.44 to 48.76 g m^{-2} in the first year and the second year respectively. For *Brachiaria mutica* the biomass values varied from 7.75 to 47.57 g m^{-}

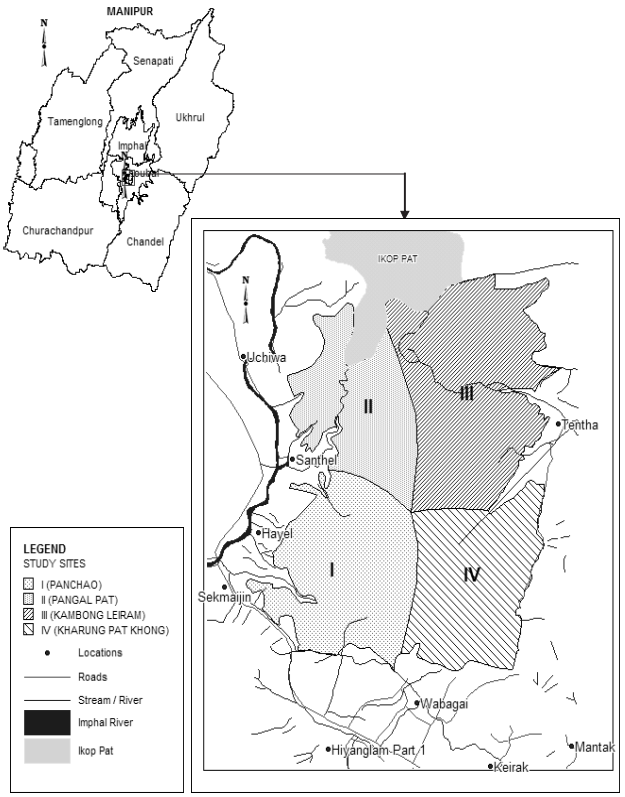

Figure 1: Map of kharungpat lake (thoubal) manipur

^{2} in the first year and 4.94 to 45.54 g m^{-2} in the second year. The biomass values of *Leersia hexandra* ranged from 5.48 to 20.56 g m^{-2} in the first year and 5.92 to 19.01 g m^{-2} in the second year and that of *Phragmites karka* ranged from 12.24 to 27.22 g m^{-2} and 10.43 to 27.02 in the first year and second year consecutively. For *Pseudoraphis minuta* the biomass values in the first year varied from 6.53 to 27.53 g m^{-2} and 11.56 to 30.19 g m^{-2} in the second year and that of *Cyperus distans* ranged from 9.18 to 25.11 g m^{-2} and 13.59 to 32.59 g m^{-2} in the first year and second year respectively. The biomass values of *Ceratopteris thalictroides* varied from 28.50 to 76.57 g m^{-2} in the first year and 30.50 to 80.49 g m^{-2} in the second year and that of *Nymphaea pubescens* from 5.59 to 42.02 g m^{-2} and 17.94 to 37.84 g m^{-2} in the first year and second year respectively. During the whole study period the biomass value of *Ipomoea aquatica* varied from 6.73 to 24.91 g m^{-2} in the first year and 8.89 to 31.80 in the second year. For *Nymphoides cristatum* the biomass values ranged from 4.99 to 23.88 g m^{-2} and 8.82 to 29.61 g m^{-2} in the first year and second year respectively. The biomass value of *Marsilia quadrifoliata* ranged from 6.43 to 26.66 g m^{-2} in the first year and 18.27 to 39.44 g m^{-2} in the second year.

During the whole study period, the total biomass of all species (combined) in the different study sites ranged from 313.36 to 989.95 g m^{-2} and 304.01 to 986.78 g m^{-2} in the first year and second year respectively. The present findings are found to be higher than those reported by earlier workers viz., Forsberg (1960) in Osby Lake,Sweden (620 g m^{-2}); Wassink (1975) in some wetlands in Malaysia (370.0 to 520.0 g m^{-2}); Billore and Vyas (1982) in Pichhola lake, Udaipur (10.0 to 35.80 g m^{-2}); Spencer and King (1984) and Freeman (1989) in Eutrophic ponds, Michigan (196 to 260 g m^{-2}); Devi (1998) in Utrapat lake, Manipur (139.18 to 579.85 g m^{-2}); Devi (2000) in Freshwater Ecosystems of Canchipur, Manipur (36.09 to 408.40 g m^{-2}); Devi (2001) and Bebika and Sharma (2002) in Sanapat lake, Manipur (34.53 to 238.28 g m^{-2}); Devi (2002) in Ikop lake, Manipur (16.81 to 295.62 g m^{-2}); Usha (2002) in Poiroupat lake, Manipur (130.07 to 512.28 g m^{-2}); Devi and Sharma (2010) in Oksoipat lake, Manipur (150.87 to 588.05 g m^{-2}).

The present findings of total biomass of all species (combined) are found to be comparable with those reported by different authors viz., Kaul (1977) in Manasbal and Anchar lake, Kashmir observing 970 g m^{-2} and 1010 g m^{-2} respectively; Devi (2007) in Awangsoipat lake, Manipur (164.45 to 841.00 g m^{-2}); Devi. (1993) in Loktak lake, Manipur (363.21 to 782.63 g m^{-2}). The present values of the total biomass for all species (combined) have been found to be lower as compared with the values reported by a number of workers viz., Ambasht (1971) in Freshwater ponds, Varanasi (1250 g m^{-2}); Crowder *et al.,* (1977) in Lake Opinicon, Canada (1154.00 g m^{-2}); Howard-Williams *et al.,* (1986) in Waikaremona lake, New Zealand (1106 g m^{-2}); Vyas *et al.,* (1989) in five lakes of Udaipur (537.6 to 1884.09 g m^{-2}) and Devi (1993 a) in Waithou lake, Manipur (422.97 to 1173.01). The present lake falls within the average global biomass values for the lakes and streams of the world which varied from 0.02 to 0.1 kg m^{-2} (Lieth 1973; Whittaker and Likens, 1973). Biomass data for lakes in different parts of the world has also been given by Sculthrope (1967) in which the biomass values ranged from 0.07 to 680 g m^{-2} in temperate lakes, 50 to 1000 g m^{-2} in lakes of New Zealand and 630 to 4640 g m^{-2} in reed swamps of Minnesota (U.S.A). The present finding of biomass values falls within the values recorded from New Zealand lakes but higher than those values of the temperate lakes. Comparative accounts of the biomass of the macrophytes in different Freshwater Ecosystems are presented in Table 3.

CONCLUSION

It is observed from the present investigation that the magnitude of biomass for the dominant macrophytic plant species of Kharungpat lake varied considerably during the entire study period. The recorded values were found to be comparable to other lakes of Manipur, as well as other wetlands of India and abroad. The high values of biomass observed in the different study sites indicate the hyper tropic status of the lake. It is high time to look into the problems of the lake caused due to overexploitations by the people for different activities. It would be important to take up possible remedial measures on priority basis in order to prevent

the lake from further eutrophication. It is also pertinent to take up management and conservation steps to save the lake from further deterioration and possible extinction.

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