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Phytal Macro & Meiofauna of Chilka Lake

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Littoral phytal macro and meiofauna of *Potamogeton pectinatus, Halophyla ovata, Gracilaria lichenoides* from Chilka Lake have been studied and compared with the littoral phytal and benthic communities of other regions. The patterns of distribution and abundance of these fauna appear to be governed by the physiognomy of the algae and the ambient characteristics of the external milieu besides the degree of epiphytation, sediment deposition and biological growth. The meiofaunal density of *Potamogeton* favourably compares with that of the level bottom communities. In contrast to the benthic communities characterised by high macro-meiofaunal ratios, the phytal have lower ratios.

Littoral sedimentary meiofaunal ecology is extensively investigated[1-4]. However, non-sedimentary meiofauna of sessile and floating algae, rock surfaces, macrofauna and organic material is least known[3]. The phytal biotope, which forms a 3rd main habitat along with the pelagical and benthic biotopes of the aquatic ecosystem[5], is almost a neglected realm. Of late, the significance and productive potentialities of phytal meiofauna in the littoral system are increasingly realised because of the ease with which the predators can find them, their high nutrient value and high turn over rates[6-7]. In sea weed regions the phytal animals contribute more than the benthic animals towards fish production[7].

The first comprehensive account of Indian Ocean phytal fauna is from the rocky littoral zone of Visakhapatnam coast[6,8-11]. Phytal faunal assemblages of Chilka lake and their relative abundances, densities and their distributional pattern are reported[12]. However, no evaluation has been made of macro and meiofauna on their individual merits in trophic structure of the phytal biocoenosis except Hicks[13] who made an attempt to fractionate phytal meiofauna with special reference to Copepoda.

In the present communication an attempt has been made to fractionate and study the phytal macro and meiofauna to know their relative numerical densities in the Chilka littoral system and to compare with the littoral benthic macro and meiofaunal communities.

Materials and Methods

The Chilka lake, lat. 19°28′ and 19°54′ N and long. 85°6′ and 85°35′ E, is a dynamic system receiving fresh water discharges from the river Daya-Mahanadi system and sea water through a narrow lake mouth that opens into the Bay of Bengal. The lake is well known for the rich fishery[14] and extensive littoral and sublittoral macrophytic vegetation subserving as a feeding and breeding ground for a variety of fauna[15].

Samples (18) of 3 weeds, viz. *Gracilaria lichenoides* from Kalijai, *Potamogeton pectinatus* and *Halophyla ovata* from Parikud, were collected from the central sector of the lake during Dec. 1978-March 1979. The methods of collection and extraction of fauna were the same as given in earlier papers[9-12]. The separation of macro and meiofauna was done by sieving the fauna through a 500 μ and 62 μm sieves respectively. The meio and macro fauna were separately preserved in 5% neutral formalin and stored in polythene bottles for further studies. The average numerical density of the fauna of different weeds is expressed in terms of 100 g of wet weight, 100 ml of displaced volume of the weed and 100 cm^2 of the bottom covered with vegetation after pooling the samples of respective weeds. The degree of sedimentation is categorised following the classification of Dahl[16].

Results

Fauna of Gracilaria lichenoides—The sediment deposited on the bushy thalli of this weed corresponded to category 1 (10 ml/liter weed). Copepods (28.33%), nematodes (16.75%), gastropods (14.07%) and ostracods (9.46%) formed the bulk of the populations (Table 1). The macrofauna was composed of 11 taxonomic groups, bivalves (68.71%) and amphipods (20.07%) being dominant components. The meiofauna was composed of 16 animal taxa. Copepods, nematodes, gastropods and ostracods were

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Table 1—Macro and Meio Fauna of Different Weeds

Animal group	Macro fauna			Meio fauna		
	A	B	C	A	B	C
			Gracilaria lichenoides			
Foraminifera	2	1	1	122	100	38
Nematoda	—	—	—	656	533	200
Oligochaeta	3	3	1	81	67	25
Polychaeta	10	8	3	41	33	13
Ostracoda	23	19	7	366	300	113
Copepoda	—	—	—	1098	900	338
Tanaidacea	2	1	1	57	47	18
Isopoda	31	25	10	60	50	17
Amphipoda	191	157	59	81	67	25
Nauplii	—	—	—	203	167	63
Insect larvae	2	1	1	41	33	13
Halacaridae	—	—	—	153	120	50
Acarina	3	2	1	100	90	38
Kinorhyncha	—	—	—	81	67	25
Gastropoda	26	21	8	545	447	168
Bivalvia	657	539	202	163	133	50
Total	950	777	294	3842	3154	1194
			Potamogeton pectinatus			
Foraminifera	6	3	2	838	460	288
Turbellaria	—	—	—	145	80	50
Nematodax	—	—	—	151377	83560	52225
Oligochaeta	35	19	12	1232	680	425
Polychaeta	30	17	13	1268	700	440
Ostracoda	22	12	8	3007	1660	1038
Copepoda	—	—	—	12138	6700	4188
Tanaidacea	478	264	165	13877	7660	4788
Isopoda	5	3	1	35	19	13
Amphipoda	308	170	106	1413	780	488
Nauplii	—	—	—	145	80	50
Insect larvae	11	6	4	217	120	75
Halacaridae	—	—	—	942	520	325
Acarina	3	2	1	1051	580	362
Kinorhyncha	—	—	—	471	260	163
Gastropoda	27	15	10	217	120	75
Bivalvia	6	3	2	10	6	4
Total	931	514	324	188378	103985	64997
			Halophyla ovata			
Foraminifera	7	4	2	57	33	13
Nematoda	—	—	—	7745	4544	1704
Oligochaeta	98	57	22	455	267	100
Polychaeta	52	31	12	625	367	140
Ostracoda	61	36	14	2102	1233	463
Copepoda	—	—	—	11458	6723	2521
Tanaidacea	268	157	59	739	433	163
Isopoda	11	7	3	57	33	12
Amphipoda	111	65	25	227	133	50
Nauplii	—	—	—	4943	2900	1088
Insect larvae	280	164	62	340	200	75
Halacaridae	—	—	—	852	500	190
Acarina	20	12	5	568	333	125
Kinorhyncha	—	—	—	795	467	175
Gastropoda	516	303	114	113	67	25
Bivalvia	232	136	51	34	20	10
Total	1656	972	369	31110	18253	6854

A = Nos/100g wet wt; B = Nos/100 ml displaced volume of weed; C = Nos/100 cm^2 of bottom covered with vegetation

the principal meiofaunal components of the weed as they comprised 28.31, 16.75, 14.07 and 9.46% respectively.

Fauna of Potamogeton pectinatus—The degree of sedimentation on the thickets of this weed corresponded to category 3 (30 ml/liter weed). Seventeen animal taxa were associated with this angiosperm thallus (Table 1). Nematodes (79.95%), tanaidaceans (7.58%) and copepods (6.41%) were the principal faunal components. The macrofauna was composed of 11 animal taxa dominated by tanaidaceans (50.92%), amphipods (32.72%), polychaetes (4.01%), oligochaetes (3.7%) and gastropods (3.9%). The meiofauna comprised 17 animal groups and nematodes (80.35%), tanaidaceans (7.37%) and copepods (6.44%) were the dominant assemblages.

Fauna of Halophyla ovata—The sediment deposited corresponded to category 2 (10 to 30 ml/liter weed). The fauna was composed of 16 taxonomic groups. Copepods (36.78%), nematodes (24.86%), nauplii (15.87%) and ostracods (6.75%) were the principal components. The macrofauna was composed of 11 taxonomic groups (Table 1). Gastropods (30.89%), insect larvae (16.80%), tanaidaceans (15.99%), bivalves (13.82%) and amphipods (6.78%) formed the bulk of the population. As many as 16 animal taxa were observed in the meiofauna. Copepods (36.78%), nematodes (24.86%), nauplii (15.87%) and ostracods (6.75%) formed the bulk.

Discussion

The numerical distribution of the macro and meiofauna on different weeds (Table 1) points out the importance of phytal as a biotope in the littoral system. Distribution and abundance of the phytal macro and meiofauna appear to be influenced by biological as well as physical characteristics of the phytal substratum and the ambient medium[6,7,16–21]. Among the biological factors responsible for the phytal faunal make-up are the physiognomy of the algae, the number of biological hideouts or ecological niches available among the thalli besides the colour, contour and texture of the weed[8–13]. It has been observed that the degree of epiphytation and the biological growth state of alga and the amount of detritus accumulated profoundly influenced the structure and composition of the phytal faunal communities[6–13,16–22]. Epiphytation and sediment deposition not only influence the animal colonisation but also help in ameliorating the inter and intraspecific competition of the populations[6,13,23–25].

The dense thickets of *Potamogeton* infested by a variety of unicellular diatoms and multicellular algal strands and with a high degree of sediment deposition (category 3) harboured the maximum faunal density and diversity. Stoloniferous, crustose, *Halophyla* with medium epiphytation and sediment deposition (category 2) and the bushy *Gracilaria*, encrusted by *Electra pilosa* with little sediment (category 1), came next to *Potamogeton* in the order of their faunal abundances. Further, the macro and meiofaunal density distribution patterns reveal that maximum number of macro fauna (Table 1) were associated with broad leaved, stoloniferous, crustose *Halophyla* and low numbers with narrow, slender leaved *Potamogeton* and bushy cushion shaped *Gracilaria*. The broad leaved stoloniferous *Halophyla* with wider biospaces available in the thallus is well suited for macrofaunal colonisation for they can easily move amongst its thalli than in the narrow spaces available in the thickets of *Potamogeton* and *Gracilaria*. However, the maximal and minimal meiofauna densities occurring on *Potamogeton* and *Gracilaria* respectively (Table 1) closely correlated with the degree of epiphytation and sediment deposition. An examination of the faunal composition reveals that the heavily infested and silted *Potamogeton* thalli were dominated by meiofaunal nematodes and crustaceans (copepods, tanaidaceans and ostrocods) while the relatively less infested and sedimented thallus of *Halophyla* had the crustaceans as the dominant denizens followed by nematodes. The least infested and silted *Gracilaria* thalli were dominated by crustaceans (copepods 22.71%, ostracods 8.06%, amphipods 5.64% and nauplii 4.23%) and molluscs (28.71%). These results explain the bearing of the physiognomy of the algae, epiphytation and sedimentation on the distribution, abundance and composition of phytal faunal communities.

No detailed comparison of phytal macro and meiofaunal census of the present locality could be made with other localities. However, the total phytal faunal density (including macro and meiofauna) can be compared with other localities (Table 2). Total fauna per 100 g weed and per 100 cm^2 of bottom cover recorded on *Potamogeton* thalli (Table 2) finds no comparison in any other weed. The density recorded on *Gracilaria* comes almost close to that of *G. corticata* from Waltair coast[6]. The total faunal density of the *Halophyla* ranks second to that of *Spongomorpha indica*[6] off Visakhapatnam (Table 2). Total faunal densities of *Potamogeton* and *Halophyla* of Chilka lake are many times higher than those from the littoral temperate belts (Table 2). Recently from New Zealand shore, *Enteromorpha*, *Corallina*, *Zonaria*, *Xiphopera*, *Pterocladia* and *Ecklonia* phytal biotopes were studied by Hicks[13] for meiofauna with special reference to Copepoda. However, his investigations ignored the macrofauna. Among the *Corallina* weed, 13,170 meio organisms/100 cm^2 were reported by Hicks[13] which is lower than what is observed in *Potamogeton* in Chilka lake. The meiofaunal densities of *Halophyla* and *Gracilaria* of the present locality (Table 1) are also higher than those reported by Hicks[13] from New Zealand phytal biotopes except *Corallina* (Table 3). The staggering faunal densities in the present locality appears to be due to abundant detritus deposition on the phytal thalli and absence of tidal oscillations, wave beat and desiccation problems[16,17]. The sediment accumulated on the thalli acts as an incentive for the detritus feeding organisms for colonisation[6,8-12,22].

Evaluation of macro and meiofaunal densities individually reveals that the meiofauna out number the macrofaunal population as in the case of benthic communities which are well investigated[1,29]. The phytal meiofauna of Chilka Lake compares

Table 2—Comparison of Phytal Faunal Densities with Level Bottom Communities

	Location	Nos/100 ml	Nos/100 g	Nos/m^2
		Phytal		
Cladophora-Enteromorpha	Mediterranean[18]	—	—	9,00,000
Gelidium corneum	do[17]	—	2,81,800	—
Lichinea pigmea	Plymoth Laboratory, UK[21]	—	16,050	3,21,000
Potamogeton sp	Chilka Lake[12]	53,258	69,701	—
Gracilaria lichenoides	Present study	3,931	4,792	1,48,800
Halophyla ovata	do	19,225	32,766	7,22,300
Potamogeton pectinaus	do	1,04,499	1,89,309	65,32,100
Cladophora sp.	Baltic Sea[24]	—	—	12,54,400
Spongomorpha indica	Waltair coast[6]	24,019	78,808	11,34,833
Gracilaria corticata	do[6]	4,017	4,729	2,10,917
		Level bottom communities		
Mud	Danish Wadden Sea[26]	—	—	20,00,000
Mud	Bristol Channel, UK[27]	—	—	1,25,00,000
Mud	East Coast, USA[28]	—	—	9,93,00
Mud	Porto Nova[29]	—	—	38,18,360
Sand	Porto Nova[29]	—	—	19,60,128

Table 3—Comparison of Phytal and Sedimentary Meiofauna

	Location	Nos/100 ml	Nos/100 g	Nos/m²
		Phytal		
Halophyla ovata	Present study	18,253	31,110	685,400
Potamogeton Pectinatus	do	103,985	188.378	6,499,700
Graciteria lichenoides	do	3,154	3,842	119,400
Corallina officinalis	Island Bay, Wellington, NZ[13]	—	—	540,000-1,317,000
Zostera marina	Tomioka Bay, Japan[30]	—	—	669,790
		Sediment		
Sand	Waltair coast[31]	—	—	228,000
Sand	Porto Nova[29]	—	—	1,960,000
Mud	Porto Nova[29]	—	—	3,815,000
Mangrove swamp	Visakhapatnam Harbour[4]	—	—	4,280,000
Sand & Mud	Chilka Lake[32]	—	—	1,467,000

Table 4—Comparison of Macro and Meiofauna of Phytal and Sediment Biotopes

[Numbers per m²]

	Location	Macrofauna	Meiofauna	Ratios
		Phytal		
Graciteria lichenoides	Present study	29,400	119,400	1:4.06
Potamogeton pectinatus	do	32,400	6,499,700	1:200
Halophyla ovata	do	36,900	685,400	1:18.57
Halemida opentia	Andaman Islands, India*	44,416	1,268,321	1:28.6
Jania rubens	Andaman Islands*	68,320	2,144,975	1:31.4
		Sediment		
Mud	Porto Nova[29]	3,360	3,815,000	1:1135
Sand	Porto Nova[29]	128	1,960,000	1:15313

*Unpublished data

favourably with that of the level bottom communities[26-29]. In general, it appears in the intertidal zone the sand and phytal biotopes are comparable in terms of the density of the total meiobenthos[13] (Table 3).

The high meiofaunal density of *Potamogeton* which is many times higher than that of any other littoral phytal biotope investigated so far, compares favourably even with the intertidal muddy bottoms located in estuaries which in general have a higher productivity than fully marine localities (Table 3). However, the macro-meiofaunal ratios of phytal are lower than those observed in sedimentary benthos (Table 4). It appears that the relatively greater densities of macrofauna of the phytal when compared with the benthos and the vulnerability of phytal meiofauna for predation by the macro and mega organisms are responsible for the observed lower ratios. Further the structure, composition and abundance of the benthic macro and meiofaunal communities are by and large governed by the abiotic edaphic characteristics of the benthos besides inter and intraspecific relationships. In the phytal system the substratum is a living organism influenced by the ambient physico-chemical characteristics.

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