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Litter Fall and Decomposition of Mangrove Species (*Excoecaria agallacha)* in a Newly Emerged Island (Nayachar), West Bengal , India : w.r.f Soil Microarthropods

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Abstracts:- Mangrove leaf litter (*Excoecaria agallacha*) fall and decomposition was estimated using litter bags throughout the year at four sites of Nayachar Island. *Excoecaria agallacha* is the most common species in Nayachar Island (Latitude 21º 58' 50'' N and Longitude 88º 04' 60'' E). This species tends to occupy the inner parts of the Island. This study presents the decomposition rate for *Excoecaria agallacha* leaf litter throughout the year (Premonsoon, monsoon and post monsoon). It also quantifies physico-chemical factors along with the microarthropods population abundance throughout the decomposition process. The result showed that breakdown of leaf litter was season and microarthropods population (Acarina, Collembola, Coleoptera, Hymenoptera, Isopoda etc.) dependent.A significant (P<0.05) higher amount of mass loss, rate of decomposition, decay constant and amount of nutrient return from leaf litter(*Excoecaria agallacha*) were observed during the post monsoon period.

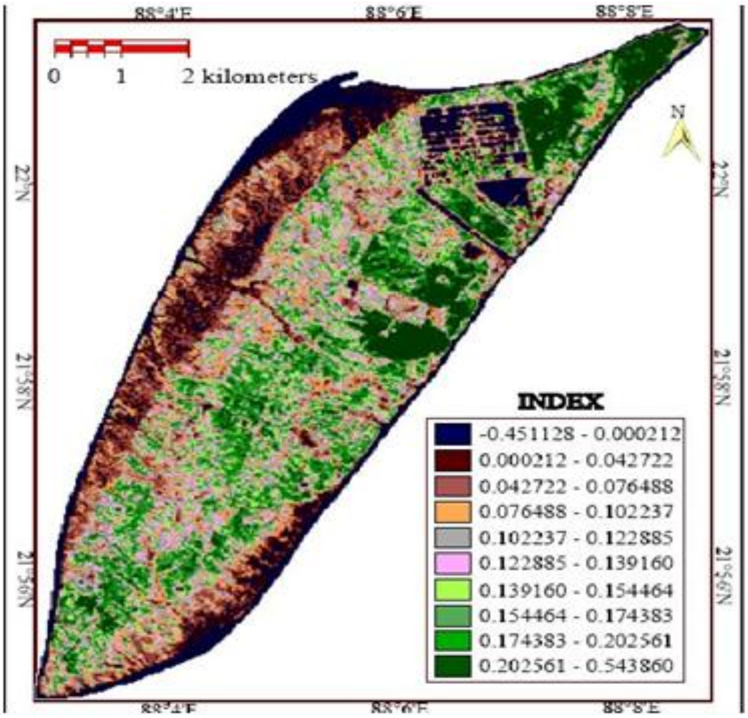
Keywords:-*Decomposition, Mangrove, Soil arthropods, Nayachar Island.*

I. INTRODUCTION

Nutrients are up taken by plants for their growth and development and portion of these nutrients is accumulated in plant body [1-2]. Conversely considerable amount of nutrients are returned to the soil embryonic phase of development has been found to be very low as the decomposition on mangrove forest are influenced by several parameters, including mangrove species(*Excoecaria agallacha)* , season and position of the stand in the supra tidal zone [3-4]. Arthropods are one of the group of soil fauna which inhabit the soil and the overlying layer of organic debris. According to Kuhnelt (1963) [5] , there was hardly an arthropodan group, which was not found in the soil. The arthropods usually referred to collectively as the soil micro arthropod fauna [5] , including Acrarina, Collembola, Protrua, Pauropoda, Diplura and Symphyla. The first two groups are the abundant faunal groups in most soil in comparison to other group (Kuhnelt (1963)[5]. The present investigation also laid emphasis on the study of the decomposition process of *Excoecaria agallacha*leave litters and the succession of different micro-arthropods population in the different phases of litter decomposition processes of Nayachar Island. This study also emphasizes that i> leaf litter decomposition rates of *Excoecaria agallocha* in pre monsoon, monsoon, and post monsoon ii> return rate of N, P and K in the soil for *Excoecaria agallacha* litter decomposition in different season.

II. MATERIAL AND METHODS

Excoecaria agallacha mangrove plants were chosen for the study of mangrove leaves decomposition. Litter decomposition rate has been determined by litterbags methods. The litterbags were made of nylon, mesh sizes (6mm^2) were used for present study [7] . Freshly fallen leaves of different mangroves plant were collected from the mangrove belt of Nayachar Island. The leaves were chopped with size (1inch) into uniform lengths then dried in air. Each nylon bags was filled with 200gm air-dried litter. A set of 4 such bags was made for each selected sites. A total of 12(4×3) bags were made in three different localities. Bags were placed at a depth 5 inch under the soil. The litter bags at the rate of decompose leaves were drawn at an intervals of 3 months for one year. Microarthropods from each litter bags were extracted by modified Tullgreen funnel [8] . The collected fauna were sorted out into different groups and identified with the help of Stereoscopic binocular microscope followed by taxonomic key. Decompose soil sample were study with the help of laboratory standard method [9] and statistical analysis done by STATISTICA , Version 7.0. The study carried out in the coastal environment of West Bengal experienced three distinct seasons mainly determined by two major meteorological parameters (temperature and rainfall) each with four months duration *viz.* Premonsoon (March-June), Monsoon (July-October), Postmonsoon (November-February) [10](*Nayachar IslandMap Source: Researchgate.net*).



III. RESULT & DISCUSSION

Exoecaria agallocha, locally named as "Gewa" an important mangrove plant specieswas selected for litter decomposition study. The successional occurrence of different microarthropodal faunal components, rate of decomposition and changes of different physicochemical parameters associated with decomposing litters have been presented below.

a. Rate of decomposition-

The rate of litter decomposition of *Exoecaria agallocha* was found to have increase gradually throughout the decomposition period and were estimated as 49%, 65%, 73%, and 80% at the end of 3rd, 6th, 9th and 12th months respectively (Fig-1).

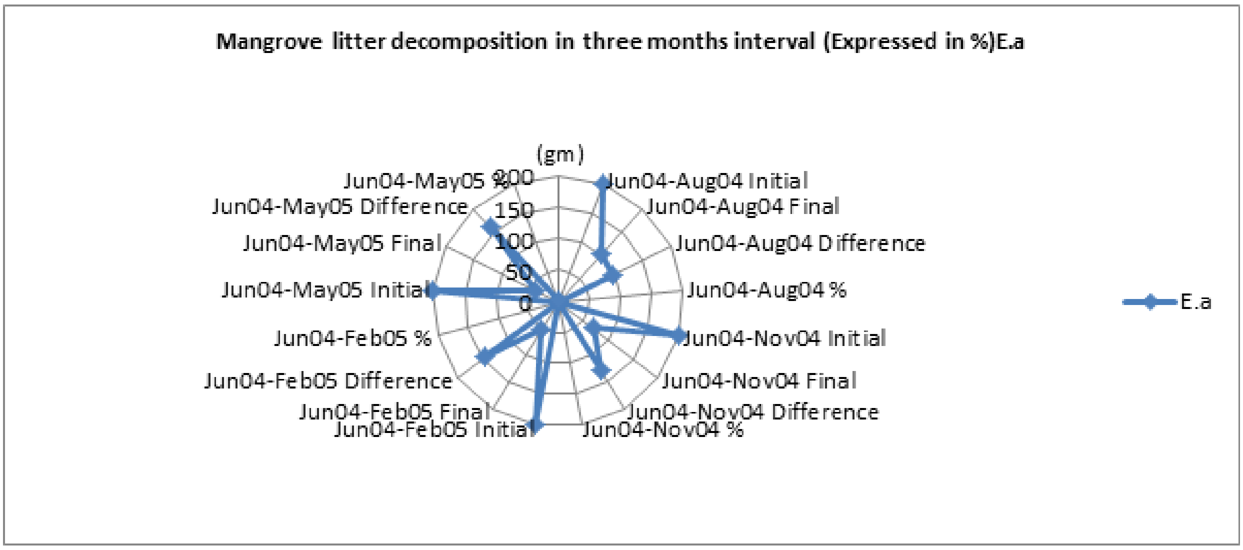


Fig -1

b. Faunal occurrence (Mean value) in different phases of decomposition

The number different faunal groups when litter bags were withdrawn after 3 months were - Acarina (5), Collembola (6) , Diptera (3), and other microarthropods (1). After 6 months of decomposition of litter, the number of different faunal groups were – Acarina (20) , Collembola (18), Coleoptera (1), Diptera (2) ,Hymenoptera (2) and other microarthropods (1) . After 9 months, when the litter bags were withdrawn, the different faunal groups which were encountered were - Acarina (7), Collembola (6) , Diptera (3), Isopoda (5), Hymenoptera (4) and other microarthropods (2) . At the end of 12 months when the litter bags were withdrawn, Acarina (5) , Collembola (7), Coleoptera (6), Diptera (4), Isopoda (7), Hymenoptera (5) and other microarthropods (2) constituted the litter faunal community (Fig-2&3)

c. Relative abundance(%)

Relative abundance of soil microarthropods revealed that after 3 months of decomposition, % of occurrence of Collembola was 40% followed by Acarina (33.33%), Diptera (20%) and other micrarthropods (6.66%). After 6 months of decomposition, % of occurrence of Acarina was 45.45% followed by Collembola (40.9%), Diptera (4.54%), Hymenoptera (4.54%), Coleoptera (2.27%) and other micoarthropods (2.27%). After 9 months of decomposition, % of occurrence of Acarina was 20.58% followed by Collembola (20.58%), Isopoda (17.70%), Coleoptera (17.64%), and Hymenoptera (11.56%) and other microarthropods (9.22%). After 12 months of decomposition, % of occurrence of Isopoda was 19.44% followed by Collembola (19.44%), Coleoptera (16.66%), Acarina (13.88%), Hymenoptera (13.88%) , Diptera (8.33%) and other microarthropods (5.55%) (Fig-2).

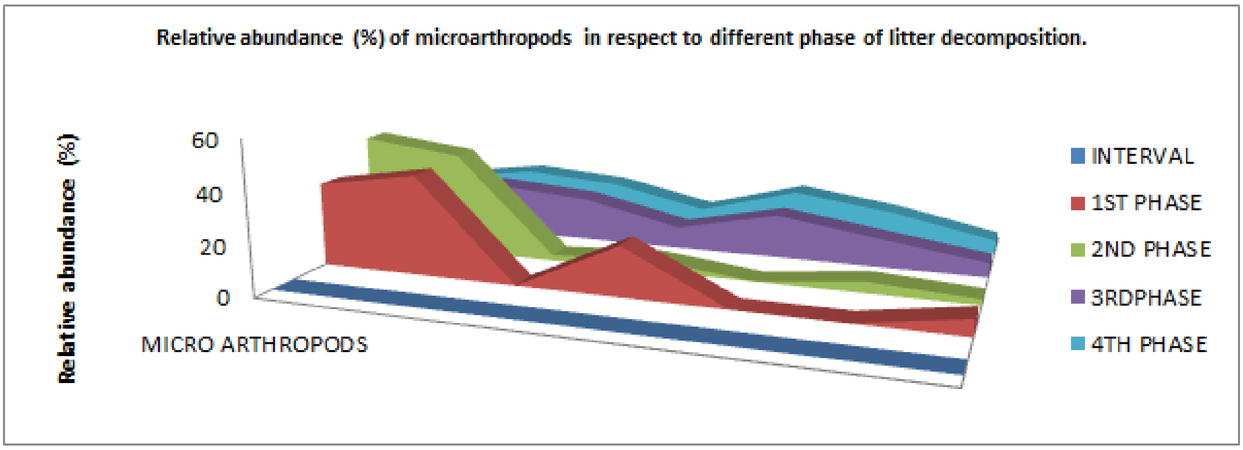


Fig-2

d. Diversity of microarthropods in different phases of decomposition

During the yearlong (12 months) studies on litter decomposition, differential appearances of different group of microarthropods at different phase of litter decomposition were noticed. During the 1st phase (Initiation to 3 months) the Collembola population was found to be maximum followed by Acarina, Diptera and other microarthropods. On the 2nd phase of decomposition (3 to 6months), gradually different groups of microarthropods *viz.* Collembola, Acarina, Diptera and other microarthropods displayed increasing trend while Coleoptera and Hymenoptera population marked its first appearance in the decomposing litter. In the 3rd phase (6 to 9 months), the population density of Acarina and Collembola showed decaling trend while the population density of Hymenoptera , Coleoptera, Isopoda and other microarthropods revealed an increasing trend. In the last phase (9 months to 12 months), population density of Acarina and Collembola totally dwindled with the maximum density of Isopoda and Hymenoptera species (Figure -3&4).

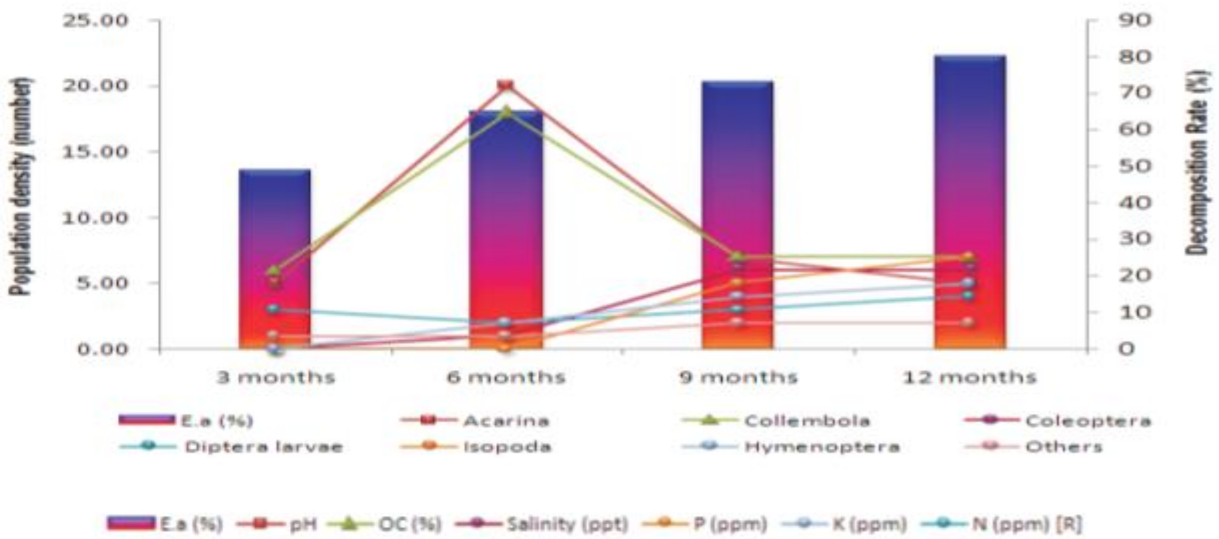


Fig -3 Density of soil microarthropods population with relation to physichochemical parameters during different phases of decomposition of *Exoecaria agallocha.*

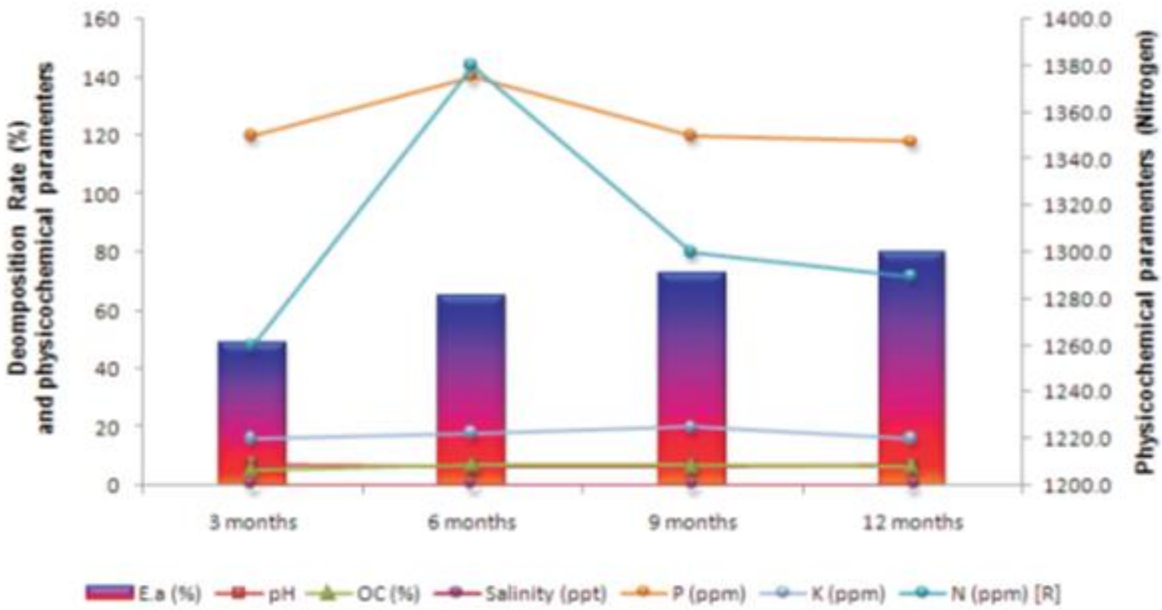


Fig -4 Different decomposition rate and with the occurrence of soil microarthropods population during different phases of decomposition of *Exoecaria agallocha.*

e. Changes in the population density of different microarthropods species during different phases of decomposition: -

Fluctuation of population density of different microarthropods showed different trend in different phases of litter decomposition. The definite population density started increasing after 6 months of decomposition of litter whereas their population density showed declining trend after 9month and continued upto 12 months of decomposition litter. This category of microarthropod included species like *Scheloribates parvus (asp2) , Scheloribates praeincisus (asp3), Oppia sp (asp6), Tectocepheus velatus (asp8), Tectocepheus sp (asp9), Allonothrus sp (asp10), Masthermannia sp (asp11), Isotomurus balteatus (csp1), Sinella sp (csp5), Calx sp(csp7), and Mesaphorura choudhuri (csp10),.*

The sharp population fluctuation of litter inhabiting microarthropod species *viz.Scheloribates thermophilus (asp1), Isotomiella minir (csp-2), Sminthurides appendiculatus (Csp-3), Entomobrya sp (Csp-4), Lepidocyrtus medis (Csp-8), Proistoma sp (Csp-9), Monomorium floricola (Hsp-2), Pheidola sp (Hsp4) and Marpissa sp (Osp-1)* where population density was started increasing after 6 months of decomposition of litter while declining population density trend was registered after 9 months of decomposition of litter and again an increasing trend of population was recorded after last phase(9 to 12 months) of decomposition of litter .

The marked population fluctuation of litter inhabiting microarthropods*viz***.** Family Staphlinidae (Cop-2), Dytiscidae (Cop-3), Mycetophilidae (Dsp-1), *Procellionides sp (Isp-2) and Monomorium destructor (Hsp-1)* where population density started increasing after 6 months of decomposition of litter and these increasing trends was continued upto 12 months of decomposition litter .

The clear population fluctuation of litter inhabiting microarthropods species *viz. Multioppia sp (Asp7) and Lepidocyrtus sp (Csp6*) where the population density was found to be maximum during all phases of decomposition (Figure-5).

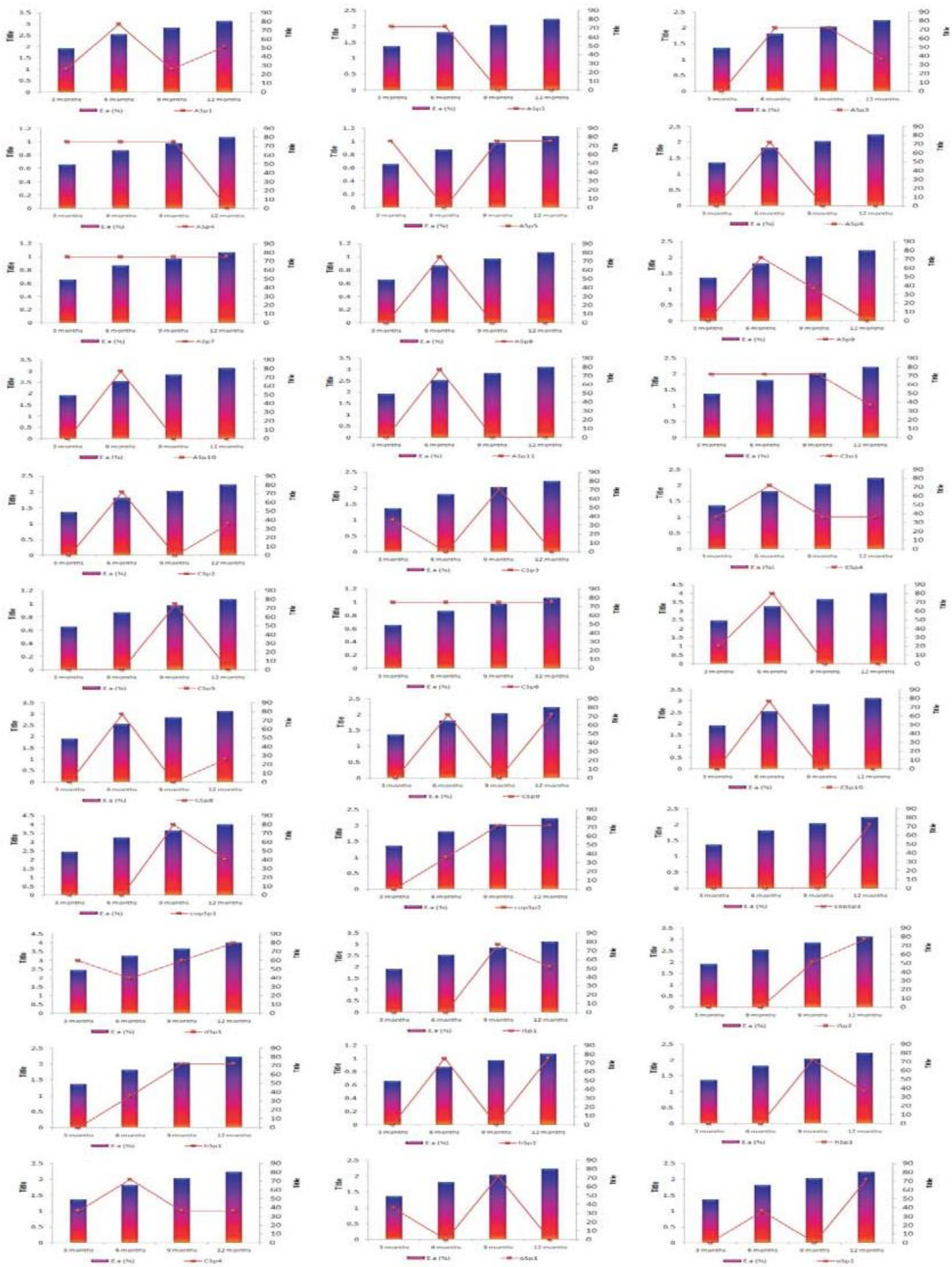


Fig .5.Trends of population fluctuation of soil microarthropods in relation to different phase of decomposition of *Exoecaria agallocha.*

Physicochemical chemical parameters during different phases of decomposition

pH : Minimum pH(6.3) was recorded after 6 months of decomposition and maximum (7.3) was recorded after 3 months of decomposition period . Organic carbon (%): **Organic carbon showed its minimum value (5.22%) after 3 months of decomposition and maximum (6.85%) was recorded after 6 months of decomposition period .**Salinity (ppt): **Salinity was**

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found lowest (0.01 ppt) after 9 months of decomposition and that of highest (0.1ppt) was noticed after 3 months of decomposition period. Total nitrogen (ppm): **Total nitrogen showed its minimum value (1200ppm) after 12-months of decomposition and that of maximum value (1240ppm**) **was found after 6 months of decomposition.Total phosphorus (ppm):** Minimum total phosphorus (118ppm) was recorded after 12 months of decomposition and that of maximum (140 ppm) was recorded after 6 months of decomposition period.**Available potassium**: Minimum available potassium (10ppm) was estimated after 12 months of decomposition and that of maximum (14ppm) was found after 6 months of decomposition period . Figure (3,4&6)

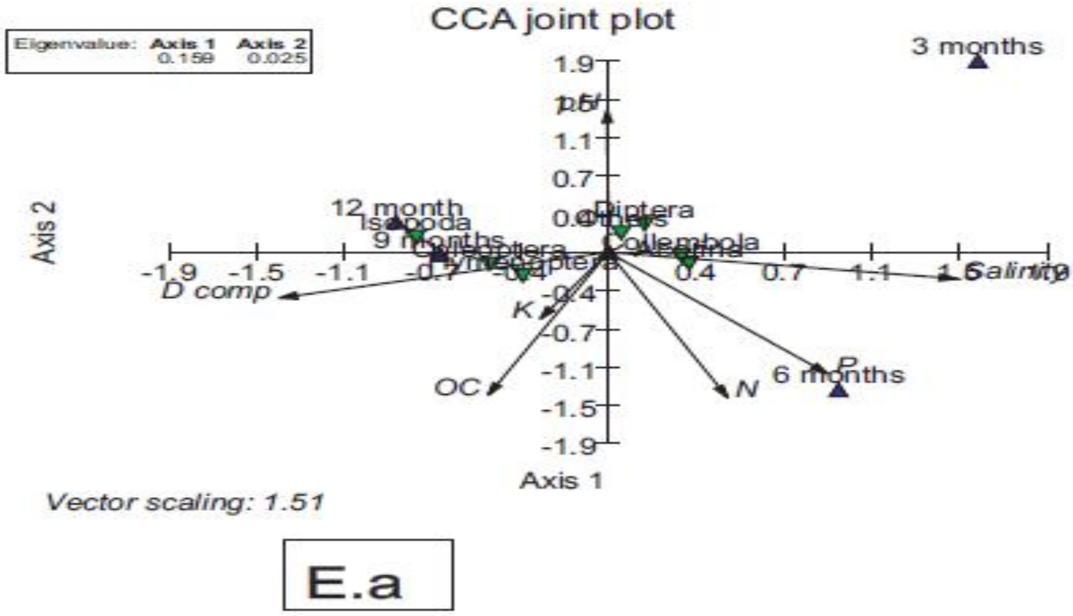

Fig- 6 Joinplot of CCA showing environmental factors of specific plants decomposition vs different groups of microarthropods along with month intervals

Different physico-chemical parameters of decomposing litters of mangrove, *Exocearia agallocha* showed different results with regard to their positive and negative relationships with soil microarthropodd. Acarina showed significant positive correlation with total nitrogen (0.965) and total phosphorus (0.993), Collembola displayed significant positive correlation with total nitrogen (0.966) and total phosphorus (0.988). Coleoptera displayed significant negative correlation with salinity (-0.991). Isopoda showed significant negative correlation with salinity (-0.973). The species *Scheloribtes praeincisus* showed significant negative correlation with pH (-0.973) and significant positive correlation with organic carbon (0.971). *Galumna flabellifera* displayed significant negative correlation with total phosphorus (-0.995).*Oppia sp* exhibited significant positive correlation with (0.995), *Tectocepheus veltus* displayed significant positive correlation with total phosphorus (0.995), *Allonothrus sp* showed significant positive correlation with total phosphorus (0.995). *Masthermannia sp* exhibited significant positive correlation with total phosphorus (0.995) *Entomobrya sp* displayed significant positive correlation with total phosphorus (0.995), *Calx sp* exhibited significant positive correlation with total phosphorus (0.975), *Mesaphorura choudhuri* showed significant positive correlation with total phosphorus (0.995), *Philoscin sp* showed significant negative correlation with salinity (-0.962). *Procellionides sp* displayed significant negative correlation with salinity (-0.962)(Table-1 &2)

Variable	pH	OC	Salinity	N	P	K
Acarina	-0.7758	0.6137	0.5192	.9653*	.9933*	0.301
	p=.224	p=.386	p=.481	p=.035*	p=.007*	p=.699
Collembola	-0.7432	0.6081	0.5077	.9668*	.9887*	0.2143
	p=.257	p=.392	p=.492	p=.033*	p=.011*	p=.786
Coleoptera	-0.1922	0.4664	-.9918*	-0.1575	-0.5067	0.3534
	p=.808	p=.534	p=.008*	p=.843	p=.493	p=.647
Diptera	0.6054	-0.3083	-0.7071	-0.7171	-0.8656	-0.4264
	p=.395	p=.692	p=.293	p=.283	p=.134	p=.574
Isopoda	0.0194	0.2971	-.9733*	-0.2925	-0.6138	0.0978
	p=.981	p=.703	p=.027*	p=.708	p=.386	p=.902
Hymenoptera	-0.3288	0.6208	-0.9113	0.0807	-0.2825	0.2748
	p=.671	p=.379	p=.089	p=.919	p=.717	p=.725
Others	-0.0771	0.3528	-1	-0.2817	-0.6121	0.3015
	p=.923	p=.647	p= ---	p=.718	p=.388	p=.698

Table – 1 Correlation between physicochemical parameters and different orders of soil microarthropods appeared in different phases of decomposition of mangrove plant litter (*Exocearia agallocha)*

Variable	pH	OC	Salinity	N	P	K
ASP1	-0.5756	0.5868	0.3015	0.8664	0.8221	-0.0909
	p=.424	p=.413	p=.698	p=.134	p=.178	p=.909
ASP2	0.0771	-0.3528	1	0.2817	0.6121	-0.3015
	p=.923	p=.647	p= ---	p=.718	p=.388	p=.698
ASP3	-.9732*	.9716*	-0.3015	0.7645	0.5201	0.8182
	p=.027*	p=.028*	p=.698	p=.236	p=.480	p=.182
ASP4	-0.2916	-0.0389	0.5774	0.2277	0.4176	0.5222
	p=.708	p=.961	p=.423	p=.772	p=.582	p=.478
ASP5	0.697	-0.5424	-0.5774	-0.9434	-.9959*	-0.1741
	p=.303	p=.458	p=.423	p=.057	p=.004*	p=.826
ASP6	-0.697	0.5424	0.5774	0.9434	.9959*	0.1741
	p=.303	p=.458	p=.423	p=.057	p=.004*	p=.826
ASP8	-0.697	0.5424	0.5774	0.9434	.9959*	0.1741
	p=.303	p=.458	p=.423	p=.057	p=.004*	p=.826
ASP9	-0.9267	0.7589	0.3015	0.9344	0.8892	0.6364
	p=.073	p=.241	p=.698	p=.066	p=.111	p=.364
ASP10	-0.697	0.5424	0.5774	0.9434	.9959*	0.1741
	p=.303	p=.458	p=.423	p=.057	p=.004*	p=.826
ASP11	-0.697	0.5424	0.5774	0.9434	.9959*	0.1741
	p=.303	p=.458	p=.423	p=.057	p=.004*	p=.826
CSP1	-0.2916	-0.0389	0.5774	0.2277	0.4176	0.5222
	p=.708	p=.961	p=.423	p=.772	p=.582	p=.478
CSP2	-0.5756	0.5868	0.3015	0.8664	0.8221	-0.0909
	p=.424	p=.413	p=.698	p=.134	p=.178	p=.909

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CSP3	0.0129	-0.1111	-0.3015	-0.4247	-0.453	0.6364
	p=.987	p=.889	p=.698	p=.575	p=.547	p=.364
CSP4	-0.697	0.5424	0.5774	0.9434	.9959*	0.1741
	p=.303	p=.458	p=.423	p=.057	p=.004*	p=.826
CSP5	-0.3806	0.3684	-0.5774	-0.0976	-0.2891	0.8704
	p=.619	p=.632	p=.423	p=.902	p=.711	p=.130
CSP7	-0.5288	0.3222	0.7625	0.8335	.9758*	0.046
	p=.471	p=.678	p=.238	p=.167	p=.024*	p=.954
CSP8	-0.6361	0.589	0.4082	0.9201	0.9086	0
	p=.364	p=.411	p=.592	p=.080	p=.091	p=1.00
CSP9	-0.351	0.5034	0	0.6198	0.5008	-0.3015
	p=.649	p=.497	p=1.00	p=.380	p=.499	p=.698
CSP10	-0.697	0.5424	0.5774	0.9434	.9959*	0.1741
	p=.303	p=.458	p=.423	p=.057	p=.004*	p=.826
COPSP1	-0.2452	0.4051	-0.9045	-0.2208	-0.5201	0.6364
	p=.755	p=.595	p=.095	p=.779	p=.480	p=.364
COPSP2	-0.4569	0.7087	-0.9045	0.1529	-0.2181	0.4545
	p=.543	p=.291	p=.095	p=.847	p=.782	p=.545
COPSP3	0.2916	0.0389	-0.5774	-0.2277	-0.4176	-0.5222
	p=.708	p=.961	p=.423	p=.772	p=.582	p=.478
DSP1	0.6054	-0.3083	-0.7071	-0.7171	-0.8656	-0.4264
	p=.395	p=.692	p=.293	p=.283	p=.134	p=.574
ISP1	-0.1862	0.3944	-.9623*	-0.2494	-0.5675	0.5222
	p=.814	p=.606	p=.038*	p=.751	p=.432	p=.478
ISP2	0.0379	0.2845	-.9623*	-0.2928	-0.6104	0.058
	p=.962	p=.715	p=.038*	p=.707	p=.390	p=.942
HSP1	-0.4569	0.7087	-0.9045	0.1529	-0.2181	0.4545
	p=.543	p=.291	p=.095	p=.847	p=.782	p=.545
HSP2	-0.351	0.5034	0	0.6198	0.5008	-0.3015
	p=.649	p=.497	p=1.00	p=.380	p=.499	p=.698
HSP3	-0.2452	0.4051	-0.9045	-0.2208	-0.5201	0.6364
	p=.755	p=.595	p=.095	p=.779	p=.480	p=.364
CSP4	-0.697	0.5424	0.5774	0.9434	.9959*	0.1741
	p=.303	p=.458	p=.423	p=.057	p=.004*	p=.826
OSP1	0.0129	-0.1111	-0.3015	-0.4247	-0.453	0.6364
	p=.987	p=.889	p=.698	p=.575	p=.547	p=.364
OSP2	-0.0594	0.3239	-0.3015	0.2548	0.0839	-0.4545
	p=.941	p=.676	p=.698	p=.745	p=.916	p=.545

Table-2:- Correlation between physicochemical parameters and different species of soil microarthropods appeared in different phases of decomposition of mangrove plant litter (*Exocearia agallocha)*

IV. DISCUSSION

Ecologically, mangrove acts as a habitat for feeding, nursering spawning ground ofvarious aquatic biotas[10] Mangrove vegetation plays an important role and supplier of organic matter derived from litter fall and litter decomposition. The purposes of this research was obtain the productivity of mangrove vegetation by analysing the litter fall, decomposition coefficient, and percentage of litter decomposed(*Exocearia agallocha)* in the Nayachar Island, East Midnapore Coast, West Bengal India. The study of microhabitat development and successional changes in soil organism communities during the break down and decomposition or organic materials in the soil could provide useful information towards an understanding of the large system. Successional occurrence of the soil microflora on leaves has been demonstrated in a number of studies [11-12] but there have been few investigations of the soil fauna associated with decomposing leaf litter. The present study attempted to analysis soil microarthropods population extracted from mangrove litters under the process of decomposition over an interval period of 3 months throughout one year to investigate the successional development of soil microarthropods population, structure and tropic relationships of soil microarthropods communities of *Exocearia agallocha litter* during different phases of decomposition**.**Leaf breakdown is defined as weight loss due to physical fragmentation (Caused by abiotic factors), animal feeding, microbial activity and leaching [13-14] reported that during decomposition processes, biological attack was most important, as a large variety of micro flora and fauna were involved in it .To understand the mechanism of this process, it was therefore necessary to evaluate the role of the important groups of organisms, their succession and their natural influences, [15] recognized the importance of soil animals in transforming plant remains into humus. Leaf breakdown plays a key role in ecosystem function, species richness of leaf litter may be important in determining the nature of relationships between biodiversity and ecosystem properties [16]. The initial rapid weight loss rate were most likely due to the fast release of non-structural carbohydrates such as sugars and starches (dissolved organic materials) easily utilised by microbes [17-18] which subsequently colonised and initiated the breakdown of leaf material . Soil microarthropods like Collembola ,Acarina, Coleoptera ,Amphipods, nematodes, turbellarians, isopods were found to colonies in decomposed litterbags. Some of the soil microarthropods were the dominant group suggesting that they were relatively more important in enhancing litter breakdown.

The present work incorporated the study of enclosed selected mangrove ***(Exocearia agallocha)*** litter in nylon mesh bags and an attempt to relate the activity of soil microarthropods over the season to the loss of litter weight during different phases of decomposition. The most of the abundant organisms in dry funnel extracts of decompose selected mangrove plant litter have been Collembola and Acarina and in most studies they are referred to as litter microathropods [19-21]. However, most of the other groups as included in the present study in addition to these two, came under the broad definition of this. The present investigation incorporated a detailed study of these microarthropods in relation to selected mangrove litter decomposition as the 6-mm^2 mesh size of the nylon bags were used.

Maximum decomposition was recorded in 12 months and that of minimum was estimated during 3 months of decomposition periods. Maximum faunal occurrence was observed during 6 months of decomposition phase(post monsoon) whereas minimum faunal components were noted during 3 months decomposition phases(Pre monsoon). Maximum relative abundance of Collembola was recorded on 3 months; Acarina on 6^{th} months; Coleoptera on 9^{th} months and Isopoda on 12^{th} months of the decomposition. Maximum values of organic carbon, N, P, K. were recorded during 6^{th} month decomposition phases (Fig 2-3).Maximum number of total microarthropods occurred during the 6 months of decomposition phases, when organic carbon, N, P, K values also maximum yet, pH and salinity did not seen to play any role and the possible reason may be due to the minute range of fluctuation in litter bags (Table-1-2). However, it was seen that the organic carbon, N, P, K, in all the litter bags of *Exocearia agallocha*plant's litters displayed significant positive relationship with the soil microarthropods which corroborated the findings of Gulis and Suberkropp, 2003 [22-25] , Hence the organic carbon, N, P, K, after leaching out from the litter, seemed to play a greater role in the regulation of microarthropods population. Correlation coefficient analysis between Collembola and ecological factors like N. P, K and organic carbon, showed significant positive correlation in most of the *Exocearia agallocha*litter's decomposition in different sites of Nayachar Island. The present study revealed that though there was a succession of population in microarthropods, their role differed either individually or conjointly in litter decomposition. However, Harding and Stuttard [26-27] were opined that metabolism, chemical decomposition of litter and microarthropods were less important compared with microflora . In the present study appearance and steady increase of Acarina, Collembola and Coleoptera population were found during the 1^{st} phase of decomposition. On the second phase of decomposition, gradually different groups of microarthropods *viz.* Acarina, Collembola, Coleoptera appeared and also displayed increasing trend in their population while Hymenoptera and other microarthropods started to record their appearance in the last phase of decomposition process. In the 3^{rd} phase, the population density of Acarina, Collembola and Coleoptera showed declining trend while the population density of Hymenoptera, Isopoda and other microarthropods revealed an opposite trend. In the last phase, the population density of Acarina, Collembola and Coleoptera totally dwindled with the recording of maximum density of Isopoda and other microarthropods (Fig 2-3and 4). The dynamic activities of soil microarthropods during different phases of decomposition(*Exocearia agallocha)* were varied. The litter gets primarily broken down by Collembola and this partially decomposed litter gets acted upon by Acarina followed by Coleoptera, Diptera, Hymenoptera and other microarthropods. The correlation coefficient analysis revealed the organic carbon, N, P, K in all the litter bags of different selected study sites which revealed significant positive relationship with the soil microarthropods. In present study, Canonical correspondence analysis revealed that different ecological parameters of leaf decomposing litters(*Exocearia agallocha)***,** soil and different decomposition rate have different intensity of impact on soil microarthropods faunal abundance.Overall findings of this study emphasizes that the different groups of soil microarthropods not only plays important role in litter decomposition(*Exocearia agallocha)* simultaneously, they also plays important role in the nutrient cycling in the coastal environment of Purba Medinipur coastal area, West Bengal, India.

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