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Decomposition and Seasonal changes in nutrient constituents in mangrove (*Bruguiera gymnorhiza*) litter of newly emerged deltaic Island (Nayachar) on the river Hooghly, West Bengal, India: r.e,f soil microarthropods.

M.K.DEY[1] and A.K.HAZRA[2]

1. PM C R DEY Memorial Society
2.Zoological Survey of India, New Alipore, Kolkata-53

Abstracts:

Litter fall production and litter decomposition are the principal factors for controlling the function of mangroves to store and cycle carbon and nutrients with in the ecosystem. Mangrove leaf litter (*Bruguiera gymnorhiza*) fall and decomposition was estimated using litter bags throughout the year (Pre monsoon, monsoon, and post monsoon) at four sites of Nayachar Island (Latitude 21°58'33''N and longitude 88° 04'54''E). The degrading leaf litter (*Bruguiera gymnorhiza)* forms a high nutrient material that is consumed by a wide variety of organisms, specially soil microarthropods and release nutrients to the mangrove ecosystem for recycling as well. This study presents the decomposition rate for *Bruguiera gymnorhiza* leaf litter throughout the year. It also quantifies physico-chemical factors along with microarthropods population abundance throughout the decomposition process. Soil microarthropods help ecosystem functioning by way of imparting important role of food chain, food-web system vis-a-vis in tropic relationships and also help nutrient cycling as decomposer. This study showed that breakdown of leaf litter was season and microarthropods population dependent.

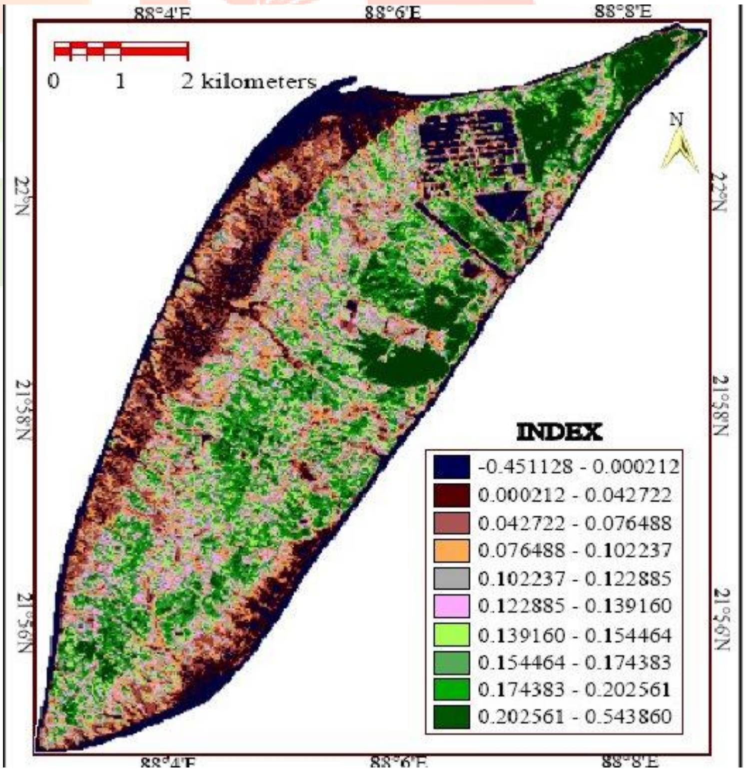
Key words: Decomposition, *Bruguiera gymnorhiza,* Mangrove, Microarthropods.

Introduction:

Mangroves are critical ecosystems due to their ecological roles as well as to their economic and social importance [1] mangrove are a typical ecosystem in the intertidal area from tropical to subtropical muddy beaches worldwide. It has critical ecosystem functions such as coastal protection, land stabilization and Co_2 fixation. It also provides important ecosystem services such as food, wood, Pharmaceutical production and other aesthetic value [2]. *Bruguiera gymnorhiza* is a very common tree in the Nayachar Island. This species usually colonizes on newly accreted mudflats of moderate to strong saline condition [3-4] . The degrading leaf-litter forms a high protein material that is consumed by a wide variety of organisms and release nutrients to the mangrove ecosystem for recycling as well. Chemical and organic constituents of leaf litter of different species of mangroves was reported earlier [5-11] although reports of these components for litter from *Bruguiera gymnorhiza* mangrove communities are limited. The present investigation also laid emphasize on the study of the decomposition process of *Bruguiera gymnorhiza* leave litters and the succession of different microarthropods (Acarina, Collembola, Coleoptera, Diptera, Hymenoptera, Isopoda etc) population in different phase of decomposition at Nayachar Island on the river bay of Hooghly.

Material & Method:

Bruguiera gymnorhiza 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 [11-13] . Freshly fallen leaves of different mangroves plant were collected from the mangrove belt of Nayachar Island (Latitude 21^{o}58'33''N and longitude 88^o 04'54''E). 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 [14-16]



. 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 [16] 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) [17]](*Nayachar Island Map Source: Researchgate.net*).

Result & Discussion:

Bruguiera gymnorhiza, locally named as "Kankra" an important species of mangrove was selected for litter decomposition study and the successional occurrence of different microarthropodal faunal components, rate of decomposition and changes of different physicochemical parameters associated with decomposing litters have been presented bellow

a. Rate of decomposition

The rate of litter decomposition of *Bruguiera gymnorhiza* was found to have increase gradually throughout the decomposition period and were estimated as 39%, 73%, 78% and 85% at the end of 3rd, 6th, 9th and 12th months respectively (Figure-1).

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

The number of different faunal groups when litter bags withdrawn after 3months were - Acarina (27) , Collembola (20), Coleoptera (2), Diptera (1) , Hymenoptera (1) and other microarthropods (2) . After 6 months of decomposition of litter, the number of different faunal groups were - Acarina (257), Collembola (189), Coleoptera (2), Diptera (2), Hymenoptera (2) and other microarthropods (2), After 9 months, when the litter bags were withdrawn, the different faunal groups, which were encountered were – Acarina (128), Collembola (85), Coleoptera (4), Diptera (3), Isopoda (2), Hymenoptera (3) and other microarthropods (2) . At the end of 12 months when the litter bags were withdrawn, Acarina (27) , Collembola (20) , Coleoptera (5) , Diptera (5), Isopoda (7), Hymenoptera (6) and other microarthropods (2) constituted the litter faunal community (Figure-1&2).

c.

Relative abundance (%)

Relative abundance of soil microarthropods revealed that after 3 months of decomposition, % of occurrence of Acarina was 50.94% followed by Collembola (37.73%) , Coleoptera (3.77%) , other microarthropods (3.77%) and Hymenoptera (1.88%) . After 6 months of decomposition, % of occurrence of Acirana was 56.6% followed by Collembola (41.62%), Coleoptera (0.44%), Diptera (0.44%), Hymenoptera (0.44%) and other microarthropods (0.44%). After 9 months of decomposition, % of occurrence of Acarina was 56.38% followed by collembola (37.44%), Coleoptera (1.76%), Diptera (1.32%), Hymenoptera (1.32%), Isopoda (0.88%) and other microarthropods (0.88%). After 12 months of decomposition, % of occurrence of Acarian was 37.5% followed by Collembola (27.77%), Isopoda (9.72%), Coleoptera (6.94%), Coleoptera (6.94%), other microarthropods (2.77%) and Hymenoptera (0.33%) (Fig-1&2).

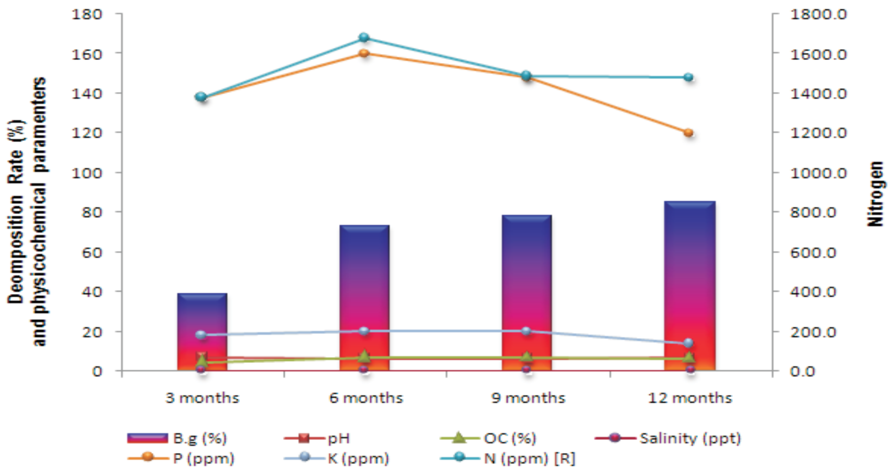


Fig -1, Density of soil microarthropods population with relation to physichochemical paramentrs during different phases of decomposition of *Bruguiera gymnorhiza.*

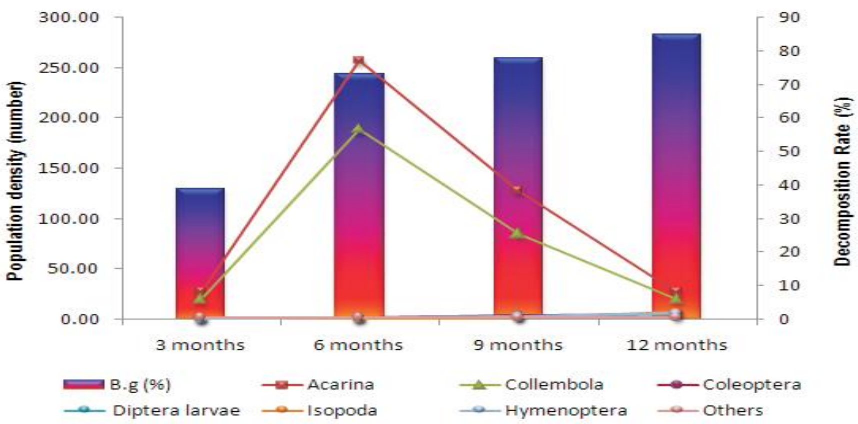


Fig -2: Different decomposition rate and with the occurance of soil microarthropods population during different phases of decomposition of *Bruguiera gymnorhiza.*

d. Diversity of microarthropods in different phases decomposition

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

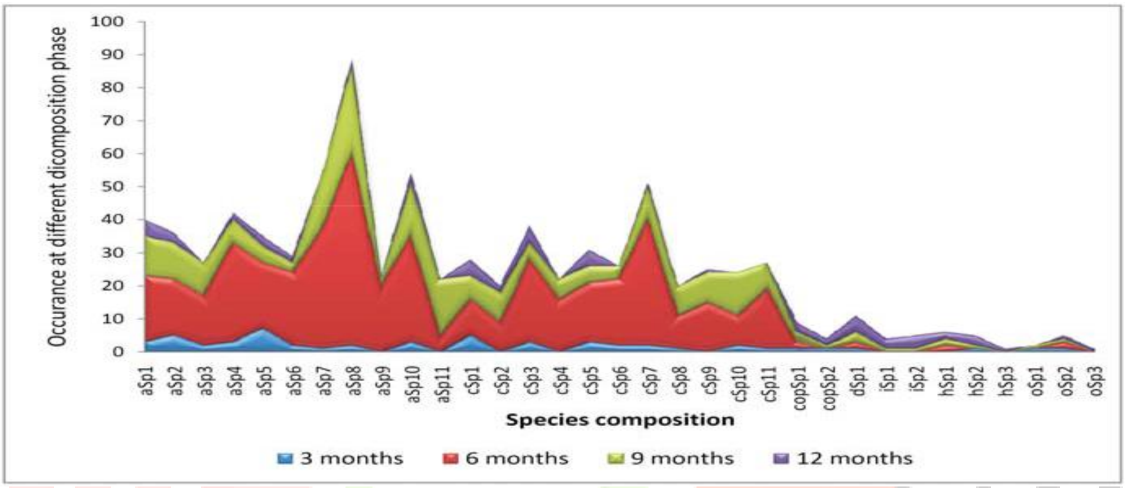


Fig-3. Occarance of difference microarthropods species during difference phases of litter decomposition of *Bruguiera gymnorhiza*

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 6months of decomposition of litter whereas population density showed declining trend after 6 and continued upto 12 months decomposition. This category of microarthropods included species like *Scheloribates thermophilus (asp1), Scheloribates parvus (asp2), Scheloribates praeincisus (asp3), Xylobates seminudus (asp4), Galumna flabellifera (asp5), Oppia sp (asp6), Multioppia sp (asp7), Tectocepheus velatus(asp8), Tectocepheus sp (asp9), Allonothrus sp (asp10), Masthermannia sp (asp11), Isotomurus balteatus (csp1), Isotomiella minor (csp2), Entomobrya sp (Csp4), Sinella sp (csp5), Lepidocyrtus sp (csp6), Calx sp(csp7), Lepidocyrtus medis (csp8), Proisotoma sp (csp9), Mesaphorura choudhuri (Csp –10), Sminturides sp (csp11) and Artema sp (osp2)* (Figure-3).

The clear population fluctuation of litter inhabiting microarthropod species *viz* Family Carabidae (Cop-1), Mycetophilidae (Dsp1), *Philoscin sp(isp1), Procellionides sp(isp2) , Monomorium floricola (hsp2), Monomorium latinode(hsp3) and Uroctea sp(osp3)* where population density started increasing after 3 months of decomposition of litter and these increasing trend was continued up to 12 months of decomposition of litter (Figure-134).

The marked population fluctuation of litter inhabiting microarthropods species *viz. Marpissa sp(osp1*) where population density started increasing after 3 months of decomposition litter while declining population trend registered after 6 months of decomposition and again an increasing trend of population was recorded after 12 months decomposition of litter (Figure-3).

f. Physicochemical parameters during different phases of decomposition: -

pH: Minimum p H(6.3) was recorded after 6 months of decomposition and maximum p H (7) after 3 months of decomposition period. Organic carbon (%): Organic carbon showed its minimum value (5.57%) after 3 months of decomposition and maximum (7.2%) was recorded after 6 months of decomposition . Salinity (ppt): Salinity was found lowest (0.01ppt) after 6 months of decomposition and that of highest (0.1ppt) was noticed after 9 months of decomposition period. Total nitrogen (ppm): Total nitrogen showed its minimum value (1380ppm) after 3 months of decomposition and that of maximum (1680ppm) after 6 months of decomposition period . Total phosphorus (ppm): Minimum total phosphorus (120ppm) was recorded after 12 months of decomposition and maximum (160ppm) after 6 months of decomposition period. Available potassium (ppm): Minimum available potassium (14ppm) was estimated after 12 months of decomposition and that of maximum (20ppm) was found after 6 months of decomposition

Discussion:

Mangrove forests are among the world's most productive ecosystem, as well as unique wetland ecosystem in intertidal coastal regions of the tropics and subtropics [4-6]. Litter fall production and leaf litter decomposition are the principal factors for controlling the functions of mangroves to store and cycle carbon and nutrients within the ecosystem. Decomposition of litter contributes to the production of dissolved organic matter in the soil . Nutrient cycling starts when leaves fall to the ground and are subjected to microbial degradation [6] . Microbes such as bacteria and fungi contribute to the decomposition of mangrove materials, and to be transformation and cycling of nutrients. Processes of litter fall decomposition on mangrove forest floors are influenced by several parameters, including mangrove species, season, and position of the stand in the intertidal zone [18-19]. The most important components of all litter materials are the leaves; they can represent 40-85% of the litter fall [9-10]. Among the biotic factors , the diversity and abundance of living organism have shown a high importance in the decomposition , especially for leaf tissue that have compounds that inhabit the action of predators and decomposition [11]. 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 [18-21] . 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 [22-27] 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 *(Bruguiera gymnorhiza)* 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 [27-35]. 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 6th months; Coleoptera on 9th months and Isopoda on 12th months of the decomposition. Maximum values of organic carbon, N, P, K. were recorded during 6th 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 (Fig -1&2). However, it was seen that the organic carbon, N, P, K, in all the litter bags of *Bruguiera gymnorhiza* plant's litters displayed significant positive relationship with the soil microarthropods which corroborated the findings of Gillikin, D. & Verheyden, A. [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 *Bruguiera gymnorhiza* 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, Gillikin, D. & Verheyden, A. [27] were opined that metabolism, chemical decomposition of litter and microarthropods were less important compared with microflora [28-36] . In the present study appearance and steady increase of Acarina, Collembola and Coleoptera population were found during the 1st 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 3rd 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 1-3). The dynamic activities of soil microarthropods during different phases of decomposition (*Bruguiera gymnorhiza)* 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 (*Bruguiera gymnorhiza)*, 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 (*Bruguiera gymnorhiza)* 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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