International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2019): 7.583

Litter Decomposition Study (*Avicenniaofficinalis*) with the Help of Soil Arthropods w.r.f to Nayachar Island, West Bengal, India

M. K. Dey[1], A. K. Hazra[2]

Zoological Survey of India, New Alipore, Kolkata-53, India
mrinaldey[at]hotmail.com, mrinalkantidey86[at]gmail.com

Abstracts: ***Avicenniaofficinalis is the most common mangroves species in Nayachar Island (Latitude 21º58'33'' and longitude 88º 04'54''). This species tends to occupy the inner parts of the Island and is the most abundant mangrove. This study presents the decomposition rate for Avicenniaofficinalis leaf litter throughout the year. It also quantifies physic-chemical factors along with microarthropds population abundance throughout the decomposition process. Soil microarthropods help ecosystem functioning by way of imparting important role in food-chain, food-web system vis-à-vis in tropic relationships and also help nutrient cycling as decomposer. The present study attempt to analysis of soil microarthropods population extracted from mangroves litters under the process of decomposition over an interval period of 3 months throughout the year to investigate successional development of soil microarthropods population, species composition and tropic relationships of soil microarthropods communities in relation to changing ecological parameters of Avicenniaofficinalis during different phase of decomposition.***

Keywords: Mangroves, Decomposition, Microarthropods

1. Introduction

Soilis a decomposition product. Its solid phase has two main constituents, namely minerals derived from some parent materials e.g rocks by weathering and organic substance closely associated with minerals, mainly derived from the vegetation growing in the soil.Soil organisms actively play in the decomposition of organic litter[1,2].Living organisms were reported to have been established themselves very early in the process of decomposition of parent material, which indicates that organic decomposition is also associated with the early stage in soil formation. The organic content of the soil in its embryonic phase of development has been found to be very low as the vegetation and its associated fauna do not develop in high densities [3].Mangrove is one of the most extraordinary ecological formations occurring almost exclusively in the tropics. Like the tropical rain forests, the mangroves have also played a very important role in the economy of our coastal population for thousands of years, providing a wide variety of goods and services including wood production, support for commercial and subsistence fisheries aquaculture, salt production and shoreline and coastal erosion control. Mangroves are salt tolerant forest ecosystems of tropical and subtropical interdial coastal regions near river mouth. They form highly productive ecosystems since the inorganic nutrients, brought in by the incoming freshwater from land run-off, are trapped to form the source of energy for many organisms. Arthropods are one of the groups of soil fauna, which inhabit the soil, and the overlying layer of organic debris. According to Kuhnelt (1963)[4], 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 soils in comparison to other groups [6]. The present investigation also laid emphasis on the study of the decomposition process of *Avicenniaofficinalis* leave litters and the succession of different micro- arthropods population in the different phases of litter decomposition processes of the Nayachar Island of Midnapore coast, West Bengal, India.

2. Material and method

Avicenniaofficinalis 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 slandered method [9-11] and statistical analysis done by STATISTICA, Version 7.0.

3. Results and Discussion

Litter decomposition study with *Avicennia officinalis*
Avicenniaofficinalis, locally named "pearebain" 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 below:

a) Rate of Decomposition

The rate of litter decomposition of *Avicenniaofficinalis* was found to have increase gradually throughout the decomposition period and were estimated as 34%, 57%, 61.33% and 70% at the end of 3^{rd}, 6^{th}, 9^{th} and 12^{th} months respectively

Table 1: Mangrove litter decomposition in three months interval (Expressed in %)

		Plant
Months	Weight (gm)	A.o
Jun04-Aug04	Initial	200
	Final	132
	Difference	68
	%	34%
Jun04-Nov04	Initial	200
	Final	86
	Difference	114
	%	57%
Jun04-Feb05	Initial	200
	Final	76
	Difference	124
	%	62%
Jun04-May05	Initial	200
	Final	60
	Difference	140
	%	70%

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

The number of different faunal groups when litter bags were withdrawn after 3 months were - Acarina (4), Collembola(5), Coleoptera(1), and other microarthropods (1). After 6 months of decomposition of litter, the number of different faunal groups were - Acarina (9), Collembola(8) ,Coleoptera (2), Diptera (2), Isopoda (1) and other microarthropods (2). After 9 months, when the litter bags were withdrawn, the different faunal groups which were encountered were - Acarina (3), Collembola (4), Coleoptera (3), Diptera (3), Isopoda (3.67), Hymenoptera (3) and other microarthropods (2). At the end of 12 months when the litter bags were withdrawn, Acarina (4),Collembola (3), Coleoptera (5),Diptera (3), Isopoda (5.33), Hymenoptera (5) and other microarthropods (2) constituted the litter faunal community.

c) Relative abundance (%)

Relative abundance of soil microarthropods revealed that after 3 months of decomposition, % of occurrence of Collembola was 45.45% followed by Acarina (36.66%), Coleoptera (9.09%) and other microarthropods (9.09%). After 6 months of decomposition, % of occurrence of Acarina was 56.6% followed by Collembola (41.62%), Coleoptera (0.44%), Diptera (0.44%), and Hymenoptera (0.44%) and other microarthropods (0.44%). After 9 months of decomposition, % of occurrence of Collembola was 19.04% followed by Isopoda (17.47%), Acarina (14.28%), Coleoptera (14.28%) ,Diptera (14.28%) and other microarthropods (5.88%) . After 12 months of decomposition, % 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 (3.55%)

Table 2: Relative abundance (%) of microarthropods in respect to plant litter decomposition

	Acari	Collmbola	Coleoptera	Diptera	Isopoda	Hymenoptera	Other
A.o	36.66	45.45	9.09	00	00	00	9.09
	37.5	33.33	8.33	8.33	4.16	00	8.33
	14.28	19.09	14.28	14.28	17.47	14.28	9.22
	14.63	10.97	18.29	10.97	19.50	18.29	7.31

d) Diversity of microarthropods in different phases of decomposition

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

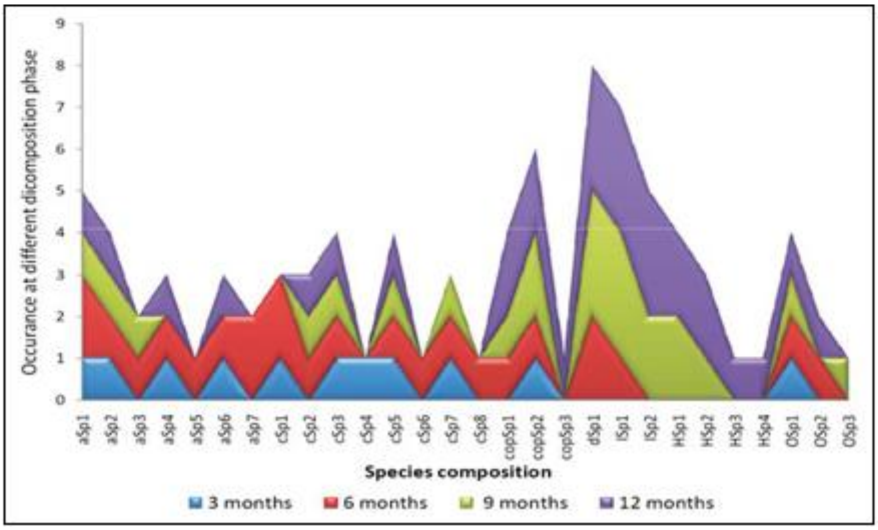

Figure 1: Occurrence of difference microarthropods species during difference phases of litter decomposition of *Avicenniaofficinalis*

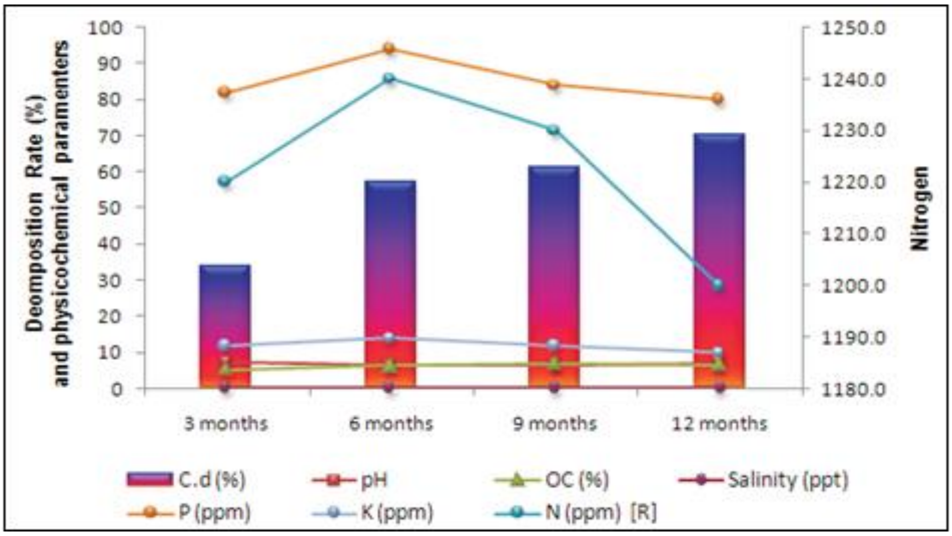

Figure 2: Different decomposition rate and with the occurrence of soil microarthropods population during different phases of decomposition of Avicennia *officinalis*

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 month and continued upto 12 months of decomposition. This category of microarthropod included species like *Scheloribatesthermophilus (asp1), Scheloribatespraeincisus (asp3), Galumnaflabellifera (asp5), Multioppia (asp7), Isotomurusbalteatus (csp1), Lepidocyrtusmedis (asp6), Calxsp(csp7), Lepidocyrtusmedis (asp6) and Urocteasp (osp3).*

The sharp population fluctuation of litter inhabiting microarthropod species *viz. Xylobatesseminudes (asp4) and Artemasp (osp2*) where population density started increasing after 3 months of decomposition litter while declining population trend registered after 9 months of decomposition and again an increasing trend of population was recorded after last phase (9 to12 months) of decomposition of litter .

The clear population fluctuation of litter inhabiting microarthropods species (*viz.* Family Carabidae, Staphlinidae, Dytiscidae, Mycetophilidae, *Philoscinsp*, *Procellionidessp*, *Monomorium destructor*, *Monomoriumfloricola*, *Monomoriumlatinoide and Pheidolaroberti* where population density started increasing after 3 months of decomposition of litter and these increasing trend was continued upto 12 months of decomposition .

The marked population fluctuation of litter inhabiting microarthropods species *viz.Scheloribatesparvus(asp2) and Sinellasp(csp5*) where the population density was found to be maximum during all phase of decomposition.

f) Physicochemical parameters during different phase of decomposition

- **pH :**Minimum pH (6.3) was recorded after 6 months of decomposition and maximum p H(7.3) was recorded after 3 months of decomposition period (Figure –3).
- **Organic carbon (%):** Organic carbon showed its minimum value (5.2%) after 3 months of decomposition and maximum (8%) was recorded after 9 months of decomposition period (Figure-3).
- **Salinity (ppt):** Salinity was found to lowest (0.01ppt) after 9 months of decomposition and that of highest (0.1ppt) was noticed after12 months of decomposition period (Figure –3).
- **Total Nitrogen (ppm):** Total nitrogen showed its minimum value (1200ppm) after 12 months of decomposition and that of maximum value (1240ppm) after 6 months of decomposition (Figure –3).
- **Total phosphorus (ppm):** Minimum total phosphorus (80ppm) was recorded after 12 months of decomposition and maximum (94ppm) after 6 months of decomposition phases (Figure –135).
- **Available potassium (ppm):** 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).

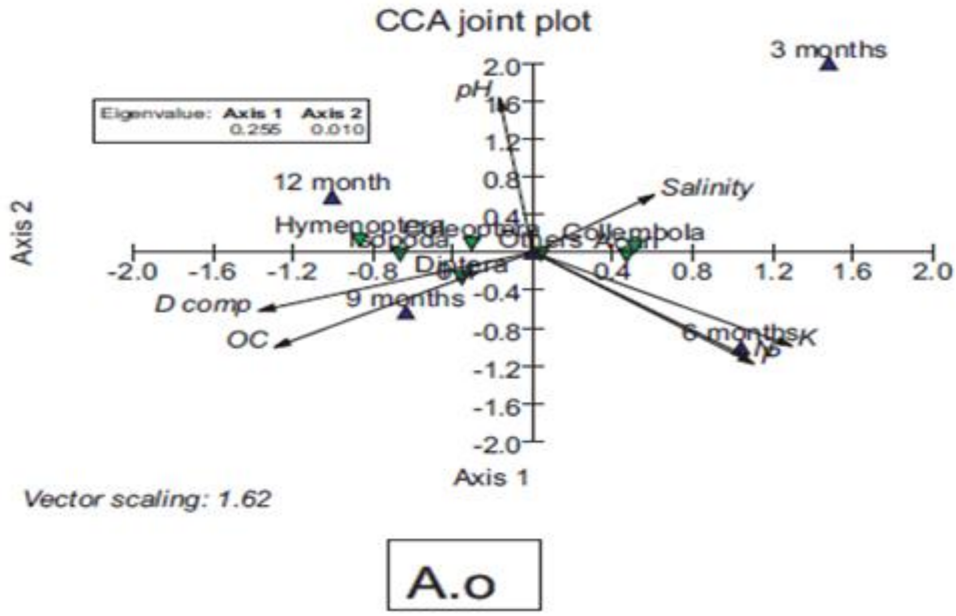

Figure 3: Joint plot of CCA Showing environmental factors of specific plants decomposition vs. different groups of microarthropods along with month interval

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 (1974)[12] were opined that metabolism, chemical decomposition of litter and microarthropods were less important compared with microflora. However, Howard and Howard (1974)[13] stated that burst of activity of micoarthropods, particularly Collembola and Acarina was triggered because of the fungal population rise. Subsequently, the activities of these microarthropods were responsible for the reduction of not only plant debris but also the fungal hyphae forming the organic matter of the soil. Decomposition will slow down and totally stop if this animal activity was removed [14] confirming that Acarina and Collembola were inefficient feeders and decomposition was accelerated by comminuting of the litter . In any case there was general agreement that the overall rate of decomposition may increase when the material was converted into faeces [15]This was further confirmed by Drift [16] who reported that the primary effect of soil fauna was indirect rather than direct.

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 3).

Canonical corresponding analysis in relation to decomposition study revealed that different ecological parameters of soil mixed up with litter decomposed ingredients and different decomposition rate have different intensity of impact on faunal abundance of soil microarthropods. The results also highlighted Order and species assemblage structure of different plant litters (Fig-3).

Overall findings of this study emphasizes that the different groups of soil microarthropods not only plays important role in litter decomposition simultaneously, they also plays important role in the nutrient cycling in the coastal environment.

References

[1] Jenny, Hans 1980.The Soil Resource, Origin and Behaviour, Springer-Verlag, New York.

[2] Jenny, Hans 1994. Factors of Soil Formation.A System of Quantitative Pedology. New York: Dover Press. (Reprint, with Foreword by R. Amundson, of the 1941 McGraw-Hill publication).

[3] Newel, K. 1984. Interaction between two decomposer Basidiomycetes and a collembolans under Sitka spruce: Distribution, Abundance and selective grazing, *Soil. Biology and Biochemistry*, **16**: 227-233.

[4] Kuhnelt, W. 1963. Soil inhabiting arthropods. *Ann.Rev. Entomol*,**8**: 115-136.

[5] Drift, J. Van Der, 1951. Analysis of the animal community in a beach forest floor.*Meded.Inst. Toegep. Biol. Onders. Nat*. **9**:1-168.

[6] Kevan, D. K. Mch 1965. The soil fauna –its nature and biology. 33-51. In : Ecology of soil borne plant pathogens, Prelude to biological control.(Ed. K.F. Baker) Univ. Calif. Press, Berkeley.

[7] Anderson, J. M. 1973. The breakdown and decomposition of sweet chestnut (*Castaneasativa*Mill) and beech (*Fagussylvatica* l) leaf litter in two deciduous woodland soils. Breakdown leaching and decomposition.*Oecologia*, **12** ,251-274.

[8] Macfadyen, A. 1955. A comparison of methods for extracting soil arthropods, 315-332.**In**: *Soil Zoology (D.K.McEKevan, Ed.)* Butterworth, London.

[9] Strickland, J.D. and Parsons, T.R. 1968. Apractical handbook of seawater analysis.*Fish.Res.Bd. Can. Bull*. No.**167**: 57-143.

[10] Walkey, A. and I.A. Blacks, 1934. An examination of the Degtjareff method for determining soil organic matter and a proposed modification of chromic acid titration method .*Soil.Sci*. **37**: 29-38

[11] Murphy, J. and J.P. Rilay, 1962. A modified single solution method for the determined of Phosphate in natural waters.*Anal.Chem. Acta*.**27**: 31-36.

[12] Harding, D.J.L. and Stattard, R.A. 1974. Microarthropods: In Biology of plant litter decomposition **Vol -2** (eds. G.H. Dickinson and G.J.F. Pugh) *Academic press*, London PP -489-532.

[13] Howard, P.J.A. & D.M. Howard, 1974. Microbial decomposition of tree and shrub leaf litter. I. Weight loss and chemical composition of decomposition litter. *Oikos*.**25** : 341-352.

[14] Burges, A. 1976. The decomposition of organic matter in the soil . 479 – 492. **In** : soil Biology (A Burges, F. Raw, Eds.) London –New York, Academic Press.

[15] Drift, J. Van Der, 1961. Dorzaken in gevolg van.Verschillen in bodenafauna in verschilende type neikenbos.Nedert.Bosbouwk.*Tijdschr*. **33**(4) : 90 –108.

[16] Drift, J. Van Der, 1975. The significance of millipede Glomerismarquinata (Villers) for oak litter Decomposition and an approach of its part in energy flow. Proc. *5th Int. Coll. Soil Zoology*, Prague, 293-298.