



Some aspects on the seasonal variations in the demographic structure and spatio-temporal distribution of a curly wood louse- *Cylisticus convexus*

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Abstract

Demographic structure and vertical distribution pattern of a curly wood louse, *Cylisticus convexus* in three study areas (Mekkarai, Kottavasal and Achankovil) in different seasons were studied, with special reference to soil edaphic and chemical factors. The density of wood louse was low during summer season (9.75 ± 2.5 & 12.3 ± 4.6), moderate in monsoon season (36 ± 8.28 & 18 ± 3.2) and very high during post monsoon season (36.4 ± 6.2 & 19 ± 3.36). The population density of *Cylisticus convexus* was high in Achankovil area in all seasons when compared to Mekkarai and Kottavasal except in summer, during which the population density was almost same in all the three study areas. Soil of Achankovil has high organic carbon (2.45%) and magnesium (79ppm) and calcium content (1754ppm). Soil of Mekkarai has high amount of nitrogen (2511ppm) and phosphorus (3.9ppm). The vertical distribution of *Cylisticus convexus* in soil is very low. It goes to a maximum depth of 30cm only from the surface. The Population density of this isopod is very high in the top soil than the middle layer even in summer. The distribution patterns of *Cylisticus convexus* mainly depends on the availability of high organic carbon content and low phosphorus and nitrogen content in the soil, which could substantiate their rich density in Achankovil than Mekkarai and Kottavasal.

Keywords: isopod, *Cylisticus convexus*, demographic structure, wood louse

Introduction

Soil is a natural ecosystem characterized by dynamic processes like energy flow and nutrient cycling. Soil provides an ideal habitat for the life activities of a wide range of microbes and invertebrates, at different trophic levels. Soil micro-arthropods are of immense importance in maintenance of various ecological systems. They play a very important and significant role in soil formation, increasing the porosity of the soil, soil aeration and in the promotion of the soil fertility by breaking down organic matters through the intricate process of digestion. The combined activity of the soil microbes is responsible for the decomposition of organic matter. The dark amorphous substance called humus is a product formed by the soil organisms. It is comparatively low in tropics where decomposition rate is much higher. *Cylisticus convexus* is a commonly known as curly wood louse because it rolls up when provoked. This is a tropical isopod which is seen at a depth of 1-5 cm. These micro arthropods prefer wet conditions (Yoshi.1966) [14]. The distribution patterns of these organisms varies in number at different soil layers. Many of them are seen on the surface soil. The number of population decreased in lower levels. Gisin (1943) [5], Nielsen (1949) [8], Kuhnelt (1955) [7] and Delamare Deboutteville (1951) [4] have shown that the higher population densities occur in the upper layers of the soil. Exception occurs only in the places where sufficient food is present at greater depths. Therefore the present study was undertaken to study the demographic structure of *Cylisticus convexus* in different seasons and to study the vertical distribution pattern of this tropical soil isopod.

Materials and methods

Study area

The study areas were selected in the Thirunelveli Districts of Tamil Nadu and Pathanamthitta Districts of Kerala in the leeward side of Southern Western Ghats in the Pandalam Hill Mountain. Mekkarai, lies between co-ordinates of $9^{\circ} 03' N$ latitude and $77^{\circ} 13' E$ longitude; Kottavasal lies between $11^{\circ} 08' N$ latitude and $79^{\circ} 35' E$ longitude, Achankovil lies between $9^{\circ} 05' N$ latitude and $77^{\circ} 07' E$ longitude were selected.

Collection and transportation of sample

Three location were selected from the leeward side of South western Ghats -Mekkarai, Kottavasal and Achankovil. From each site 5 sampling sites were selected. From these sites soil samples of $5 \times 5 \text{ cm}^2$ area from a depth of 5 cm were randomly collected from places of different altitudes in Thirunelveli and Pathanamthitta Districts using a soil auger. The monthly data will be pooled into seasonal data taking into consideration June to August as Monsoon season; September to November as post monsoon season and December to February 2019 as

summer season. At a depth of 0-10 cm, 10-20 cm and 20-30 cm soil samples were collected from soil profile. The soil samples will be collected in polythene bags. The soil samples are then taken to the Berlesse Tulgren funnel and the organisms were extracted in beakers containing picric acid. Population density was calculated after separating the organisms.

Soil edaphic factors analysis

From the soil samples the soil edaphic factors like soil pH, temperature Exchangeable acid and Exchangeable base, Organic carbon content, Moisture content, sand, silt and clay content were detected. The soil chemical factors like Nitrogen, Phosphorus, Potassium, Calcium and Magnesium content were analysed. The soil temperature was measured from the site using soil thermometer. Soil pH was measured using soil pH meter. Exchangeable acid and Exchangeable base, Calcium and Magnesium by the 0.05 methods of Jackson (1987). Edaphic factors will be estimated as per the procedure of Trivedy and Goel (1987) ^[13]. Soil organic carbon content was measured by using the procedure of Walkley and Black (1934). Soil moisture content was measured by gravimetry method.

Soil chemical factors analysis

From the dried and sieved soil samples, the chemical factors like nitrogen, phosphorus, potassium contents were determined by the standard procedure of (15). Nitrogen content was analyzed by Kjeldahl distillation method, phosphorous by molybdate stannous chloride method and potassium content by flame photometry method (APHA, 2012). Calcium and Magnesium content of the soil were determined by EDTA titration method of (16).

Statistical analysis

Descriptive statistics were done by using Microsoft excel software. One way ANOVA was conducted to find the difference in the soil properties between sites. To determine population density mean and standard deviation of the samples were found out. Two way ANOVA was conducted to determine the significant differences in population density of *Cylisticus convexus* between different depths and seasons using SPSS Software (2015)

Result and discussions

Soil edaphic factors

pH

The pH of Mekkarai varies between 4.0 to 4.2 in different study sites. The pH of kottavasal soil ranges from 4.0 to 4.3 and Achankovil ranges from 5.3 to 5.9 (Table I). One way ANOVA showed a significant difference in the pH of Mekkarai, kottavasal and Achankovil. (F=8.2526 P<0.05)

Organic Carbon content

The value of OC% ranges from 2.0 - 2.06 in Mekkarai and 2.15-2.62 in kottavasal. The organic carbon content of Achankovil ranges from 2.12-2.45. (Table I). One way ANOVA showed a significant difference in organic carbon of three study areas. (F=24.908 P<0.05)

Exchangeable acid and Exchangeable base

The EA% and EB% was very high in Achankovil compared to kottavasal and Mekkarai. The EA ranges from 2.8-3.2 in Mekkarai, 3.12-3.65 in kottavasal and 78-88 in Achankovil. The EB ranges from 8.69-9.58 in Mekkarai, 9.12-9.54 in kottavasal and 9-11 in Achankovil.(Table I). The One way ANOVA conducted showed a significant difference in EA% of three study areas and showed no significant variation in the EB%. (EA% F=4.622 P<0.05 and (EB% F=1.512 P<0.05)

Sand, Silt and Clay (%)

The content of sand was almost same in Mekkarai and Kottavasal compared to Achankovil. Compared to Mekkarai and Kottavasal silt content was low in Achankovil. The clay content in Achankovil was also high. The sand content varies from 52-55 % in Mekkarai, 52-58% in Kottavasal and 7.9-8.7% in Achankovil. The silt percent ranges from 14.12-15.32% in Mekkarai, 11.2-14.23% in kottavasal and 0.048-0.078% in Achankovil. Clay content ranges from 4.21-5.63% in Mekkarai, 4.52-6.32% in kottavasal and 14-19% in Achankovil. (Table I). One way ANOVA conducted showed a significant difference in the sand content of three study areas.(F=27.02 P<0.05). One way ANOVA of clay and silt showed no significant difference in three study areas.(Silt % F=0.5433 P>0.05) (Clay % F=0.3243 P>0.05).

Nitrogen, Phosphorus and Potassium content

The Nitrogen content was high in Kottavasal and Achankovil where as phosphorus and potassium was high in Kottavasal and Mekkarai compared to Achankovil.(Table I). The one way ANOVA conducted to find any significant difference in the NPK content of Mekkarai, Kottavasal and Achankovil showed a very high positive significant difference in these three chemical properties of all study areas. (N- F=2035.23 P<0.05; P-F=17.0683 P<0.05 and K-F=518.60 P<0.05).

Calcium and Magnesium content

Calcium and magnesium content was very high in Achankovil when compared to Mekkarai and Kottavasal. The Content of calcium varies from 214-258 ppm in Kottavasal, 125-258 ppm in Mekkarai and 1245-1451 ppm in Achankovil. The magnesium content varies from 52-65ppm in Kottavasal, 62-69ppm in Mekkarai and 48-79ppm in Achankovil. One way ANOVA showed a significant positive difference in the Ca and Mg content of three study areas. (Ca -F= 15.8037; P<0.05 and Mg -F=415.2493, P<0.05).

Table 1: Soil edaphic and chemical factors of at different collection sites

Sample	pH	OC (%)	EA (%)	EB (%)	Sand (%)	Silt (%)	Clay (%)	N (ppm)	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)
Mekkarai I	4.1	2.01	3.1	9.1	54	14.12	4.21	2014	3.8	147	145	65
Mekkarai II	4.2	2.0	3.2	9.21	52	15.21	4.63	2511	3.9	152	125	69
Mekkarai III	4.0	2.06	2.8	9.58	55	15.32	5.21	2024	3.21	148	258	62
Mekkarai IV	4.1	2.04	2.98	8.94	52	14.32	5.12	2014	3.21	136	245	68
Mekkarai V	4.02	2.03	2.8	8.69	54	15.2	5.63	2031	3.54	195	254	63.21
Kottavasal I	4.2	2.41	3.21	9.23	54	11.2	4.52	2412	3.2	187	214	65
Kottavasal II	4.0	2.62	3.25	9.32	54	14.21	5.36	2147	3.54	145	254	52
Kottavasal III	4.3	2.15	3.65	9.23	58	11.62	5.63	2541	3.45	125	258	54
Kottavasal IV	4.2	2.32	3.52	9.12	56	14.23	6.32	2145	3.9	149	224	58
Kottavasal V	4.1	2.41	3.12	9.54	52	14.23	6.23	2415	3.56	158	254	56
Achankovil I	5.9	2.12	83	10	8	0.48	15	2411	2.4	114	1320	74
Achankovil II	5.8	2.12	78	11	8.5	0.58	14	2147	2.6	154	1450	48
Achankovil III	5.3	2.32	86	9	8.7	0.68	18	2158	3.21	142	1245	79
Achankovil IV	5.7	2.45	82	9.8	7.9	0.69	19	2312	2.15	114	1451	76
Achankovil V	5.6	2.41	88	9.7	7.5	0.78	17	2415	2.14	124	1754	79

Population Density

Monsoon season

Population density of *Cylisticus convexus* is high in Achankovil than Mekkarai and Kottavasal during monsoon. The density was high in the month of August (36 ± 8.285) and low in July (33.5 ± 2.643) per m² in Achankovil. The density was high in the month of August (29 ± 6.245) and low in the month of June (25 ± 2.684) in Kottavasal. The density was high in the month of August (22.25 ± 5.143) and low in the month of June (18 ± 3.266) in Mekkarai. (Table II). The one way ANOVA conducted showed a very significant positive difference (F=33.807 P<0.05)

Post monsoon

Population density of *Cylisticus convexus* was high in the Achankovil area compared to Mekkarai and Kottavasal during post monsoon season. The population density ranges from 33-36.4 per m² in Achankovil, 27-31.3 per m² in Kottavasal and it was only 19-26.25 per m² in Mekkarai. The One way ANOVA showed a significant positive difference in the density of *Cylisticus* in these three study areas. (F=67.535 P<0.05)

Summer season

The density of *Cylisticus convexus* was almost same in three study areas during summer season. It ranges from 9.75-12.3 per m². Population density was high in the month of December when compared to January and February. The One way ANOVA conducted with the above data showed no significant difference in the population density of *Cylisticus* in these three study areas. (F=0.685 P < 0.05)

Table 2: Population density of *Cylisticus convexus* in Mekkarai, Kottavasal and Achankovil during three seasons

Season	Month	Mekkarai	Kottavasal	Achankovil
Monsoon	June	18 ± 3.266	25 ± 2.684	35.25 ± 5.251
	July	21.5 ± 4.795	26.3 ± 4.234	33.5 ± 2.643
	August	22.25 ± 5.143	29 ± 6.245	36 ± 8.285
Post monsoon	September	26.25 ± 4.5	31.3 ± 3.234	36.4 ± 6.244
	October	22.5 ± 5.972	28.7 ± 5.762	33.5 ± 2.380
	November	19 ± 3.366	27 ± 2.836	33 ± 3.915
Summer	December	12.3 ± 4.690	11.2 ± 4.56	11 ± 2.581
	January	11.5 ± 2.866	10.3 ± 3.236	9.75 ± 2.5
	February	11.25 ± 2.986	11.1 ± 2.763	10.5 ± 2.645

Vertical distribution pattern

Achankovil: *Cylisticus convexus* was found to be more in the top layer of soil during monsoon season (0-10 cm depth). 18/m², 20/m², 19/m² in June, July and August respectively. The density was low in the middle layer (10-20 cm depth). It was only 9/m², 15/m², 12/m² in June, July and August. The density was very low in the bottom layer (20-30 cm depth). It was 7/m², 10/m², 10/m² in June, July and August. In the summer and post monsoon season also more density was seen in the top layer (0-10cm) followed by middle layer (10-20cm) and bottom layer (20-30cm). This points out the vertical distribution of *Cylisticus convexus* in different layers of soil is mainly focus towards bottom (Table V). Two way ANOVA was conducted to find any significant difference in the density of *Cylisticus convexus* at different depths showed a positive result (F=21.726 P<0.05) and also there is significant difference in the density of different soil layers at different seasons. (F=32.812 P<0.05).

Kottavasal: In Kottavasal more population density was seen in the top layer followed by middle layer and bottom layer in summer, monsoon and post monsoon seasons. It is clear that the population density of *Cylisticus convexus* in different layers and the vertical distribution pattern is focussing towards bottom (Table IV). Two way ANOVA conducted to find any significant difference in the density of *C.convexus* at different depth showed a significant difference (F=11.734 P<0.05).

Mekkarai: A clear pattern of vertical distribution in the population density of *Cylisticus convexus* was seen in Mekkarai. The density is high in the top layer (0-10cm depth) gradually decreases with other two layers. Seasonal differences in the density was also very clear. (Table III). Two way ANOVA conducted showed a major difference in the density of *Cylisticus* at different layers of soil (F=25.806 P<0.05) and also between different seasons (F=7.8271 P<0.05)

Table 3: Distribution patterns of *Cylisticus convexus* (mean per m²) in different seasons at Mekkarai

Depth	Monsoon	Post monsoon	Summer
	June	September	December
0-10 cm	13	12	10
10-20 cm	10	8	9
20-30 cm	8	7	4
	July	October	January
	0-10 cm	11	10
10-20 cm	8	7	4
20-30 cm	5	5	3
	August	November	February
	0-10 cm	10	16
10-20 cm	8	6	5
20-30 cm	6	5	4

Table 4: Distribution patterns of *Cylisticus convexus* (mean per m²) in different seasons at Kottavasal

Depth	Monsoon	Post monsoon	Summer
	June	September	December
0-10 cm	15	11	7
10-20 cm	9	5	5
20-30 cm	7	5	3
	July	October	January
	0-10 cm	14	9
10-20 cm	11	7	4
20-30 cm	6	5	2
	August	November	February

0-10 cm	16	12	6
10-20 cm	10	5	2
20-30 cm	8	2	2

Table 5: Distribution patterns of *Cylisticus convexus* (mean per m²) in different seasons at Achankovil

Depth	Monsoon	Post monsoon	Summer
	June	September	December
0-10 cm	18	12	8
10-20 cm	9	8	6
20-30 cm	7	6	5
	July	October	January
	0-10 cm	20	12
10-20 cm	15	9	8
20-30 cm	10	8	4
	August	November	February
	0-10 cm	19	12
10-20 cm	12	6	6
20-30 cm	10	5	4

Conclusion

The soil of Achankovil is highly acidic in reaction and rich in organic carbon content. The texture of the soil is sandy loam. The Exchangeable acidity is negligible while exchangeable base is in medium level. The soil is rich in phosphorus and nitrogen content and has very high level of calcium, potassium and magnesium. The soil of Mekkarai is moderately acidic and soil texture is sandy loam. The population density of wood louse is always high in post monsoon season followed by monsoon and summer. High density of *C.convexus* in the Achankovil in postmonsoon and monsoon showed that they prefer high organic carbon content.

During summer, monsoon and post monsoon seasons the vertical distribution pattern of this isopod showed more preference to top soil. The bottom layers show low density of *C.convexus* indicate that this organism is elude to move deep soil layers. They prefer aestivation in the holes and crevices of barks and stones. The vertical migration power of isopods are very less compared to collembola (Yoshi, 1966) ^[14]. In this study it is observed that the vertical distribution power of this species is low and it goes to a maximum depth of 30cm from the surface during any seasons of the year.

The tropical isopod *Cylisticus convexus* was selected for this study. The population density of isopod in three study areas (Mekkarai, Kottavasal, Achankovil) with reference to different seasons were estimated. The soil edaphic and chemical properties of Mekkarai, Kottavasal and Achankovil were analysed. Vertical distribution pattern of isopod was studied in the three study areas in different seasons. The population density of isopod was high in Achankovil in all the seasons compared to Mekkarai and Kottavasal. The population density of this species was almost same in all three study areas during summer. The soil of Mekkarai, Kottavasal and Achankovil has sandy loam in texture and acidic in reaction. Achankovil has high organic carbon and magnesium content. The distribution of *Cylisticus convexus* is mainly depends on the availability of rich organic carbon content and least availability of phosphorus in the soil.

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