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CANOPY INFLUENCES IN CONTRAST TO AN ADJACENT OPEN AREA: A CASE STUDY

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Abstract

Bhubaneswar is the capital and largest smart city of the Indian state of Odisha. Chandaka Reserve forest, situated in Khurdha and Cuttack district of Orissa lies between the new capital Bhubaneswar and old capital Cuttack, covering an area of 193.39 Sq.km. The objectives of the paper deals with an investigation of the conditions that developed in the canopy-influence-areas of different trees and forest stands in comparison to an adjoining open area in a nearby forest. Micro climatic conditions like soil, air temperature, relative humidity, light intensity were studied. Soil analysis, Important Value Indices (IVI), of ground flora species in three habitats in two different seasons, occurance of fungi in soil were also studied. Two influence circles are pointed out forming two completely separated zones around the tree *i.e.,* Truck-Influenced-Spaces (TIS) and Canopy-Influenced-Spaces (CIS) along with the inter-canopy-influenced-space (ICIS). Almost all the important characteristic features support this trend.

Key Words: Canopy, Micro-climatic conditions, Open area, IVI, Soil analysis.

Introduction

The conditions that evolve under the canopy of a tree are so marked in comparison to an adjacent area that they can hardly be left unnoticed. The changes which gradually appear with the development and spread of the canopy can be seen in the soil characteristics, ground flora, soil organisms and microclimate. In a mixed forest each tree with its specific chemical composition may have a controlling influence over the soil properties in the trunk and canopy region.

At times, therefore, it will not be surprising to find a great heterogeneity in chemical contents of a forest soil, over a distance of only a few centimetres, as has been demonstrated by Frankland *et al*., (1963). Sinke, (1962) based upon a study of temperature forest, has shown that the pattern of soil properties under a single isolated forest, tree is generally developed with radial symmetry (Plate I). Heatwole, (1961) has pointed out that in temperate regions generally the forest floor contains a rather uniform and continuous layer of single leaf-litter type. The present paper deals with an investigation of the conditions that developed in the canopy-influence-areas of different trees and forest stands in comparison to an adjoining open area in a nearby forest.

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Materials and Method

Study Site: A mixed deciduous forest (Chandaka) at a distance of 15 km from the heart of the Bhubaneswar city was selected for this study. A clear felled area and reforested 'teak' stand were also available in this forest.

Location: Chandaka Reserve forest, situated in Khurdha and Cuttack district of Orissa lies between the new capital Bhubaneswar and old capital Cuttack, covering an area of 193.39 Sq.km. It lies between latitude 20°16'05" to 20°26'03" N and longitudes 85°34'42" to 85°49'30" E. It is very close (15 km North West) to the capital city of Bhubaneswar in Orissa and can be approached by road *via* Khandagiri. (Fig. 1).

Table 1: Soil analysis (Values based on the oven dry weight of soil).

Characteristics		Teak Plantation			Mixed Forest			Open
		TIS	CIS	ICIS	TIS	CIS	ICIS	Area
Texture :	Sand %	34.4	61.35	51.00	43.4	59.3	55.9	64.8
	Silt %	14.3	4.40	9.26	11.2	5.4	7.8	2.6
	Residue*%	51.3	34.35	39.74	45.4	35.3	36.3	32.6
% Nitrogen		0.0075	0.0045	0.0025	0.0011	0.0035	0.0015	0.004
% Phosphorus		0.105	0.082	0.0012	0.130	0.068	0.001	0.037
% Moisture content		8.02	7.75	5.04	6.73	6.88	3.78	3.6
% Organic matter		0.3405	0.294	0.2838	0.3096	0.3147	0.3199	0.233

* This includes clay, + organic matter.

Soil: Soil types occurring in the reserve show considerable variation. Prominent types are sandy loam, red clay loam and red clay. Deep sandy loam occurs in Sunakhani, Tarakai, Akhanaga and Barhapita Blocks. Rest of the area have lateritic red loam of shallow to moderate depth, clay occurring in pockets (Mishra and Sarangi, 1984).

Vegetation: The vegetation of Chandaka is of the semi evergreen type according to

Fig.1: Study area.

Table 2: Importance Value Indices (IVI) of ground flora species in the three habitats in two different seasons.

Date of sampling / Name of the species	11-10-2018			10-1-2019		
	Teak Plantation	Mixed Forest	Open area	Teak Plantation	Mixed Forest	Open area
Desmodium trilorum	107.4	67.0	92.8	85.8	56.7	89.9
Sporobolus diander	34.4	-	20.0	10.7	-	4.3
Sida varonicaefolia	24.6	23.0	1.2	58.7	43.0	4.3
Cyanotis sp.	12.0	3.4	3.2	-	-	-
Justicia quinqueangularis	11.3	10.2	-	-	-	-
Phyllanthus simplex	9.7	8.	2.4	-	-	-
Cassia tora	8.1	5.1	4.8	-	-	-
Borreria hispida	6.3	1.7	2.1	-	-	-
Aneilema nudiflorum	5.7	-	-	-	-	-
Triumfett aneglecta	3.3	-	-	-	-	-
Cocculus villosus	3.3	-	-	-	-	-
Blepharis maderaspatensis	2.7	-	1.5	-	-	-
Setaria glauca	1.9	-	-	-	-	-
Oplismenus burmennll	11.4	67.8	-	-	18.6	-
Digitaria granularis	10.0	15.0	6.2	69.4	7.7	52.5
Elephantopus scaber	3.3	12.1	1.5	-	35.0	-
Rungia pectinata	-	11.7	-	31.5	49.7	-
Barleria cristata	5.7	10.9	-	-	-	-
Ichnocarpus frutescens	1.3	5.9	0.9	-	-	-
Curcuma angusifolia	1.3	5.3	-	-	-	-
Glossogyne pinatifida	-	1.9	-	-	-	-
Vernonia cinerea	-	1.9	-	-	-	-
Eragrostis unioloides	-	3.6	19.4	-	-	4.3
Panicum sp.	-	-	18.0	-	-	-
Lindernia crustacea	-	1.9	15.7	-	-	-
Dactyloctaenium aezypticum	1.3	-	14.4	-	-	-
Alysicarpus monilifer	5.7	-	14.0	-	5.4	27.9
Cyperus rotundus	6.5	1.6	13.5	17.5	8.8	-
Fimristyllis diphylla	-	-	10.4	-	-	-
Evolvulus alsinoides	-	-	8.5	-	-	-
Zornia diphylla	-	-	6.4	-	-	-
Cassia pumila	4.8	-	6.2	-	-	-
Bothriochloa pertusa	-	-	4.9	-	-	4.3
Anotis calycina	1.3	3.0	4.8	-	-	-
Lindernia cillata	2.0	1.9	4.6	-	-	-
Paspalidium flavidum	-	1.9	3.5	-	-	-
Heteropagan contorius	-	-	3.7	-	-	-
Alloteropsis cimicina	-	-	2.4	-	-	-
Cyperus exaltatus	-	-	2.4	-	-	-
Exacum pedunculatum	-	-	1.5	-	-	-
**Ziziphus oenoplea*	-	-	-	-	11.8	-
**Butea monosperma*	-	-	-	7.5	-	
* *Gymnema sylvestre*				7.5	5.4	4.3
**Pterocarpus marsupium*	-	-	-	5.2	-	-
Acacia Arabica	-	-	-	7.5	7.7	-
Hemidesmus indicus	-	-	-	-	5.4	-
Cynodon dactylon	-	-	-	-	-	26.8
**Diospyros melanoxylon*	-	-	-	5.4	5.4	13.6
Euphorbia hirta	-	-	-	-		4.3
* *Terminalia tomentosa*	-	-	-	-		4.3
Launea asplenifolia	-	-	-	-		4.3
Teraminus labailis	-	-	-	-		4.3

* Seedling

Table 3: Occurrence of fungi in soils of areas under study.

Name of the species	Teak Plantation			Mixed Forest			Open
	TIS	CIS	ICIS	TIS	CIS	ICIS	Area
Absidia spinosa	+	–	–	–	–	–	–
Phycomyees sp.	+	–	–	–	–	–	–
Pyhium sp.	+	–	–	–	–	–	–
Phoma hibernica	+	–	–	–	+	–	+
Aspergillus fumigatus	+	+	–	–	–	–	+
Penicillum nigricance	+	+	–	+	–	+	–
Curvularia lunata	+	+	–	+	+	–	–
Aspergillus niger	+	+	+	+	+	+	+
Alternaria humicola	–	+	–	–	–	+	+
Chaetomium sp.	–	+	–	–	–	–	–
Paecilomyces varioti	–	+	–	–	–	–	–
Sterile mycelium A	–	+	–	–	–	–	–
Cunninghamella verticillata	–	+	–	+	–	–	–
Cheanophora sp.	–	+	–	+	–	–	–
Chaetophoma sp.	–	–	–	+	–	–	–
Sncephalastrum racemosum	–	–	–	+	–	–	–
Sterile mycelium B.	–	–	–	+	–	–	–
Helminthosporium anomalum	–	–	+	+	–	–	–
Pullularia sp.	–	–	+	–	–	–	–
Fusarium culmorum	–	–	–	–	+	–	–
Mucor racemosum	–	–	–	–	+	–	–
Pseudobotrys sp.	–	–	–	–	+	–	–
Rhizocionia bataticola	–	–	–	–	+	–	–
Trichoderma viridae	–	–	–	–	+	+	–
Aspergillus terreus	–	–	–	–	–	+	–
Hormodendrum cladosporoides	–	–	+	–	–	+	–
Penicillium frequentance	–	–	–	–	–	+	+
Aspergillus flavus	–	–	–	–	–	–	+

Champion and Seth's classification (1968). But due to severe biotic pressure, edaphic factors and relative humidity, the existing vegetation has lost its original characters (Choudhury, 1975, Panda, 1992, Roy *et al.*, 1992, Biswal, 1993, Swain, 2000). The Sanctuary is presently covered mostly by bushy/ shrubby vegetation. Based on species composition, the forest is classified into following types: (1) Semi evergreen forest. (2) Dry mixed deciduous forest. (3) Bamboo brakes.

In the interior of the forest stand, canopies of well grown trees were selected. The soil samples were taken from the 'trunk-influence-spaces (TIS), canopy influence-spaces (CIS), Inter-Canopy-Influence Spaces (ICIS) and also from an adjoining open area. Each time a composite of 3-5 samples was taken for detailed analysis in the laboratory. Procedures of soil analysis were followed as described by Piper, (1944). The organic matter of the soil was determined indirectly by determining the total organic carbon present followed 'Walkley and Black's method' (Walkley and Black, 1934).

The sampling of the ground flora as done in October and in January using Quadrats of 30×30 cm. These were laid along parallel lines at an interval of 5 metres. The Importance Value Indices (IVI) were calculated from the relative values of Frequency (F), Density (D) and Cover (C).

The fungal flora was studied by the dilution plate method using Czapek's yeast extract agar for cultivation of fungi. Fungal colonies were examined after 7-10 days and identified by Barnett's illustrated genera of imperfect fungi (1960) and Gilman's Manual of soil fungi (1957).

Microclimatic conditions like soil air temperature, relative humidity, light intensity and rate of evaporation were studied by using soil and air thermometers, dry and wet bulb thermometer, 1_{ix} meter and atmometers respectively.

Results and Discussion

The result of various soil characteristics of different influence-spaces *viz*. TIS, CIS and ICIS (Table 1 and Plate 1) show a significant change in the nitrogen and phosphorous contents from the TIS to the open area. Both the nutrients go on decreasing in a radial symmetry. Around tree trunk a heavy accumulation of bark litter and rain washings enrich the soil in these nutrients. The slow decomposition of bark also appears to be responsible for its greater accumulation in the TIS. The organic matter and the moisture content also show a similar trend.

The results of mechanical analysis show that the percentage of sand is minimum area. The beating action of the rain water washes away the finer particles leaving behind the sand to accumulate in the open area.

A study of the sampling of ground flora in the three types of habitats, *i.e.* pure teak stand, mixed forest stand and an adjacent clear felled or open area, shows that quite a large number of species, ferns, grasses and sedges form the vegetation during the rainy season (Table 2). Under the canopy of 'teak', species like *Desmodium triflorum, Sporobolus diander, Sida varonicaefolia, Cyanolis* spp., *Justicia quinqueangularis* and *Phyllanthus simplex* have the highest IVI as compared to other habitats. But certain other species like *Aneilema*

Table 4: Microclimatic studies (February 5, 2019).

Factor	Time	Teak Plantation			Mixed Forest			Open Area
		TIS	CIS	ICIS	TIS	CIS	ICIS	
Soil Temperature in °C	11 A.M.	16.8	17.4	20.0	17.8	18.1	19.6	25
	1 P.M.	19.8	20.5	21.2	19.0	17.8	18.0	30
	3 P.M.	17.8	17.7	19.3	21.2	20.8	20.0	25
Evaporation Rate c.c./hour	11 A.M.	4.0	4.5	4.8	3.2	5.1	5.4	4.7
	1 P.M.	5.5	6.2	6.7	4.8	6.2	6.7	8.3
	3 P.M.	4.7	5.5	6.0	4.1	5.3	5.0	6.5
Light intensity*	11 A.M.	27	30	57	19	22	50	66
	1 P.M.	30	35	61	21	25	56	74
	3 P.M.	22	26	52	17	19	46	60
% Relative Humidity	11 A.M.	-	86	-	-	85	-	56
	1 P.M.	-	57	-	-	86	-	69
	3 P.M.	-	88	-	-	88	-	62
Air Temperature in °C	11 A.M.	-	18.2	-	-	18.7	-	20.5
	1 P.M.	-	21.4	-	-	22.2	-	23.0
	3 P.M.	-	19.5	-	-	20.8	-	21.0

* These are relative values shown by the pointer on the dial.

nudiflorum, Truimfetta neglecta, Cocculu svillosus, Blepharis maderaspatensis and *Setaria glauca*etc., are restricted to it only.

Under the mixed forest canopy, the species of high IVI are *Oplismenus burmennii, Digitaria granularis, Elephanto pusscaber, Rungia pectinata, Barleria cristata*and *Ichnocarpus frutescens*. It is interesting to note that *Rungia pectinata* appears to be absent from the 'teak' canopy and open area while *Oplismenus burmennii* has a very low IVI in the 'teak' canopy only. Grasses like *Eragrostis unioloides, Dactyloctaenium aezypticum, Bothriochloa pertusa, Heteropogan contorius, Panicum* spp. and other plants like *Zornia diphylla Lindernia crustacean. Alysicarpus monilifer* and *Cyperus rotunus* which appear to be very characteristic of the open area are seen missing from the mixed forest and 'teak' stand, or present with a very low IVI.

During the winter months, it is observed that the total number of ground flora species is very much reduced in all the three habitats. The tree seedlings, winter herbs, or other perennial plants become conspicuous. *Cynodon dactylon* which appeared to be absent in the rainy season, is recorded to be abundant in the open area, as is clear from its high IVI (Table 2).

The selective action of the various tree influence spaces in the forest tends to bring about a segregation of ground flora species, thus it is quite often seen that *Cassia tora* and some grasses form patches in the ICIS. Similarly geophytes like species of *Dioscorea* and *Cyperus* tend to restrict to the TIS whereas *Sida varonicaefolia* and *Rungia pectinata* appear to thrive well in litter pockets. *Oplismenus burmennii* and *Elephantopus scaber* appear to be restricted to the densely covered areas rich in organic matter. The seedlings of *Bueta monosperma* grow only in wide openings of the canopy. Ordinary sampling procedures fail to reveal this complex mosaic of ground flora patterns. Only a wide field experience and careful observations reveal such distributional patterns.

In all 28 species of fungi could be isolated from the soils of the three areas (Table 3). In general the number of fungi under the canopy is more than the inter canopy and open areas. *Curvularia lunata* is found to be restricted to the TIS and CIS and not in the ICIS or open area. Fungi like *Absidia spinosa, Phycomyces* and *Pythium* spp. were found to be restricted to the TIS only where the bark is abundant. *Cunninghamella verticillata, Syncephalastrum racemosumi and* Choanephora were found to occur together. *Hormodendrum* sp. was found exclusively in the ISIS, while *Aspergillus niger* was cosmopolitan within the area. *Aspergillus fumigatus, A. flavus, Alternaria himicola, Penicillium frequentance* and *Phomahi bernica* reported to be in the aerospora species were present in the open habitat. Large numbers of fungi of the TIS are either cellulose decomposing, comprising of various ascomycetes and deuteromycetes or lignin decomposing comprising of basidiomycetes (Agrawal, 1970). The high moisture content of the soil of TIS (Table 1) is responsible for a large number of fungi (Saksena, 1955). The higher quantity of organic matter and hence of nitrogen in TIS also appears to be responsible for a larger number of fungi.

The results of microclimatic studies (Table 4) show that the forest canopy greatly modifies the conditions prevailing inside. There is a difference of 15% in the relative humidity between the forest canopy and the open area. During the day the air temperature in general is more in the open area showing a difference in the temperature. The light intensity goes on increasing from '27' to '74' from the TIS to the open area. The rate of evaporation depends upon the temperature and relative humidity hence it was found to be more in the open area as compared to the TIS and CIS.

Conclusion

The present paper deals with a study of the influences of tree canopy on different factors like soil characteristics, ground flora, fungi and micro-climate. Two

influence circles are pointed out forming two completely separated zones around the tree, *viz*. Truck-Influenced-Spaces (TIS) and Canopy-Influenced-Spaces (CIS) along with the inter-canopy-influenced-space (ICIS). Almost all the important characteristic features support this trend.

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