

Lichen as Indicator of Forest Health Status in Achanakmar Amarkantak Biosphere Reserve

S.C.Tiwari

Associate Professor,
Department of Forestry, Wildlife & Environmental Sciences,
Guru Ghasidas Vishwavidyalaya, Bilaspur, C.G.
sct_in@yahoo.com

Arvind Prajapati

Research Scholar,
Department of Forestry, Wildlife & Environmental Sciences,
Guru Ghasidas Vishwavidyalaya, Bilaspur, C.G.
arvind_forestry2@yahoo.com

Abstract: *Achanakmar Amarkantak Biosphere Reserve is genetic express highway linking Eastern Himalaya and Western Ghats. One of the richest Bio-diversity habitat, is one of the highly potential conservational areas having rich floral and faunal diversity including lichen. Lichen epiphytes are important for biodiversity conservation and are also widely applied as environmental indicators. The lichen species distribution was studied in natural forest of Biosphere reserve by collection of lichen species and then identification of lichen specimen on each identified phorophytes in 20m x 20m quadrates. 20 number quadrates were laid down in three district namely; Anuppur, Dindori and Bilaspur districts in the biosphere reserve area. All the lichen host tree species including all phorophytes were enumerated and correlated with the degree of maintenance of natural forest, microclimatic condition and habitat. The detailed study reveals the occurrence of 11 indicator lichen communities of Arthonioid, Physcoide, Pyrenuloid, Lecidioid, Leprarioid, Cynolichen, Graphidioid, Lecanroid Parmelioide, Pertusarioide, Teloschistaceous in the forest. Presence of lichen according to habitat like saxicolouse, corticolouse, terricolouse were indicator of the nature of substrate and forest disturbances. Anuppur district showed the highest number of lichen followed by Dindori and then Bilaspur district. Majority of Crustose lichen followed by Foliose, Leprose and fruticose indicates the anthropogenic sensitivity of lichen*

Keywords: *Lichen identification, Epiphytic lichen, Forest health status, AABR*

1. INTRODUCTION

Achanakmar Amarkantak Biosphere reserve is the protected area for its flora and faunal diversity including lichen. This area include a total of 39.46% dense forest, 22.54% low dense forest and 22.45 % of Agricultural land [1] (Karwariya and Tripathi, 2012). Lichens are symbiotic organism of algae and fungi in which algae take part in photosynthetic activity and fungus provide moisture according to microhabitat of the forest. Current studies on lichen represents about 2303 species of lichen under 305 genera and 74 family in India [2] Singh and Sinha (2010). Enumeration on lichen at Amarakantak region was done by [3] Shukla and Singh (2012). They have added 22 new report to the Amarkantak area. Both forest age and continuity of forest canopy are critical factors for the development of epiphytic lichen communities. [4] Asta *et.al.* (2002) carried out causes of lichen evaluation value for describing vegetation. Lichen epiphytes are important for biodiversity conservation and are also widely applied as environmental indicators and the use of lichens as indicators is based primarily on a limited range of 'macrolichen' species. Transplant technique indicates variation in lichen community in city also explored [5] (Bajpai *et. Al.*, 2004) with the help of *Dirinaria consimilis* a foliose lichen to find out metal contamination in city. Also arsenic contamination on lichen find out by [6] (Bajpai *et. al.*, 2009) in the lichens of monuments to explore environmental quality. Many variables influence microhabitat characteristics important to lichen. Forest edge is different from forest centers in both light and wind which affects moisture

regime substrate, tree age, and space in the forest [7] (Esseen and Renhorn, 1998). Temperature, wind, Sunlight, Substratum and moisture play important role in distribution of specific lichen species in the forest.

2. MATERIALS AND METHOD

Study is based on collection of epiphytic lichens from different places by quadrat method in the forest of Achanakmar Amarkantak Biosphere reserve in which 20m x 20m twenty number quadrates were laid down in three districts namely; Anuppur, Dindori and Bilaspur districts in the biosphere reserve area. All the lichens were collected, identified and deposited at National Botanical Research Institute, Lucknow. On the basis of Indicator parameters like type of forest, lichen substratum, growth form and sensitivity of disturbances, lichen distribution in the forest were studied. Diversity of Bio indicator lichen community was correlated with the microclimatic condition, habitat and their host relationship among the forest of each three district to know the forest health status.

3. RESULT

Most lichen thrives in high light and moderate temperature habitat. Lichen can grow on almost all natural substrates. *Shorea robusta* tree species has the maximum number of lichen on it showed the best host species of lichen due to nature of its bark. Altitudinal variation in the reserve results vigorous growth of lichen. Only one species of fruticose lichen *Cladonia praetermissa* A.W. Archer indicates the highest sensitive species due to anthropological disturbances in the reserve area within the lichen community. Forest has a large disturbance due to illegal cutting and felling of forest vegetation in Achanakmar Amarkantak Biosphere Reserve. Sensitive site like forest grazing, Forest fire, Soil erosion and wild life feeding habit can be identified with the lichen as following explored community.

4. FOREST INDICATOR COMMUNITIES OF AABR

Flora and fauna of specific area represents the environmental condition and ecosystem. Lichen communities are used as indicator of forest ecosystem function in several circumstances. Achanakmar-Amarkantak Biosphere Reserve has unique forest diversity and distribution pattern of species vary with the many factors. Different forest types with different tree species are good hosts for lichen species in the reserved forest. Lichen bio-indicator communities in the site are categorized as follows:

Arthonioid Lichen Community (Plate: b)

This group is characterized with unorganized Ascomata mostly rough granular thallus. In study area there were 7 Arthonioid lichen species which showed the virgin forest of the location. It also indicated the moist and humid climate of the forest. A number of *Cryptothecia* species sterile lichen in Achanakmar core zone area represents the successional stages of lichen.

Cyanolichen Community (Plate: c)

In this category of lichen, algal part (Blue Green Algae) takes part in symbiosis with fungal part. *Collema*, *Leptogium*, *Peltula*, and *Coccocarpia*, grows on all the soil, rocks and bark, indicates the moist shady location of Achanakmar Amarkantak Biosphere Reserve. This group is good indicator of forest ecosystem function, nutrient cycling and also are sensitive to pollution and forest age. Amarkantak has the unique collection of these community indicates the moist habitat of the forest including good and healthy regeneration status under the canopy. Sites like Dhunipani, Kpildhara, Amarkantak, Jagatpur Kabirchabutra has the good growth of Cyanolichen communities. Whereas the core zone has the poor growth of cyanolichen in lower altitude and indicates the poor and limited regeneration status.

Graphidioid Lichen Community (Plate: d)

The apothecia of this lichen community are in lirellate apothecia. The host species of this lichen indicates the smooth bark tree species of *Ficus* sp. This lichen community is prejudiced by the nature of bark. Evergreen forest of India is abode of Graphidaceous lichen [8] (Upreti, 1988) with the pyrenocarpous lichen. In Amarkantak *Shorea robusta* is dominant species but graphidioid lichen community prefer smooth bark tree species as a host. In the community association *Mallotus phillipensis* has the maximum growth of this community.

Lecideoid Lichen Community (Plate: e)

This group of lichen is characterized by bearing apothecia without thalline cover. They are mostly crustose distributed among the bark and rocks substratum. Lichen colonization of this group showed the major distribution in the area. The genera *Bacidia*, *Lecidea*, *Phyllopsora* and *Haematomma* are representing more than 15 species in the area indicating the deciduous tree composition and well distributed on rocks in open forests. *Phyllopsora* accounts well growth in moist places of higher altitude of Amarkantak forest.

Lecanoroid Lichen Community (Plate: f)

The Lecanoroid community is characterized by the apothecia bearing crustose lichen. Presence of Lecanoroid communities indicates the healthy forest diversity. This community includes *Lecanora*, *Lecidella*, *Vainoria sp.* host over the all smooth and rough bark texture. More than 20 species of this group is distributed well in the entire area. These lichen have the property of pollution tolerance and well colonization over all rocks, bark, initial stage of bark shading tree species like *Eucalyptus*, *Terminalia bellarica*, *Terminalia arjuna* etc.

Leprarioid Lichen Community (Plate: g)

This community takes part in the primary lichen colonization of forest. This community has the members lichen having the powdery and granular thallus of varnish like crust over the substratum. This community belongs to *Lepraria*, *Cryptothecia* and *Chrysothrix* are well distributed in the area. Among these *Lepraria* grows well in shaded places under the canopy over the bark and rocks. Some *lepraia* species also accounted well growth in shaded monuments and statues . While *Cryptothecia* and *Chrysothrix* species were well distributed in dry habitat of Achanakmar region, *Cryptothecia* species of sterile lichen is good indicator of lichen colonization in the core zone of the Tiger reserve.

Parmelioid Lichen Community (Plate: h)

Parmelioid lichen community is type of foliose lichen and the dominant tree species, *Shorea robusta* is best host species of this community. This community prefers the places of sufficient penetration of light towards direction of sun on bark and some rocks. Amarkantak, Jagatpur, Karanjya, and Achanakmar region accounted too much diversity of this community belonging to 7 species.

Physcioide Lichen Community (Plate: i)

This community belongs to the family of *Physciaceae*. The crustose and foliose growth form of this community exist major distribution in whole area and variety of substrate like rock and bark. This type of lichen is good indicator of pollution because they are most tolerant to pollution. A monitoring work has been carried out by using this community in the area. The foliose genera *Dirinaria*, *Pyxine*, *Physcia Heterodermia*, and *Phaeophyscia* exhibit majority of lichen growth. Amarkantak, Achanakmar, areas with very high anthropogenic disturbance are well colonized by this lichen specially *Dirinaria*, *Physcia*, *Pyxine*, and *Heterodermia* species. Some locations of moist habitat of forest has the healthy growth of this community.

Pertusarioid Lichen Community (Plate: j)

The community is characterized by crustose, verrucose fertile, perithecoide apothecia, and verrucose sorediate thallus. The community indicates old tree forest. The thick rough barked trees of *Shorea robusta* is good host species of pertusarioid lichen. The lichen species under breast height of tree species were found affected by forest fire every year in Amarkantak forest, but this lichen group bears the defending property between the rough bark of *Shorea robusta* as comparison to foliose, is good indicator of forest fire.

Teloschistaceous Lichen community (Plate: k)

This community belongs to crustose growth of lichen and anthroquinone bearing lichen gives yellow appearance to the thallus. *Caloplaca* and *Letrouitita* genus is well distributed in forest substratum of rocks and bark respectively. *Caloplaca* occurred in both rocks and bark in Amarkantak forest. The genus *caloplaca* indicates the moist, humid weather of Amarkantak in dense forest of *Shorea robusta*. The genus *Letrouitita* indicates also the same condition near to

waterfall like moist place of Kapildhara, Dhunipani, Sonmuda over the bark. *Caloplaca* cover the rough and smooth bark of *Ficus* species also. Where as *Letrouitia* is host on *Mallotus philipensis* due to its bark property.

Pyrenuloide Lichen Community (Plate: 1)

This community belongs to presence of perithecia and presence of this community is indicator of moist and humid climatic conditions of the forest. Amarkantak is highest altitude in comparison to other sites and mountain valleys, ridge occupied shaded habitat of small waterfall areas. Pyreanuloide lichen communities were found in near waterfall areas. The earlier study explains the evergreen forest of India with having the, maximum growth of Pyrenuloid and Graphidaceous lichen. Similarly some observation on lichen also made by [9] (Bhatia, 1957) in western Himalaya indicate the pattern of forest distribution.



(a) View of study site



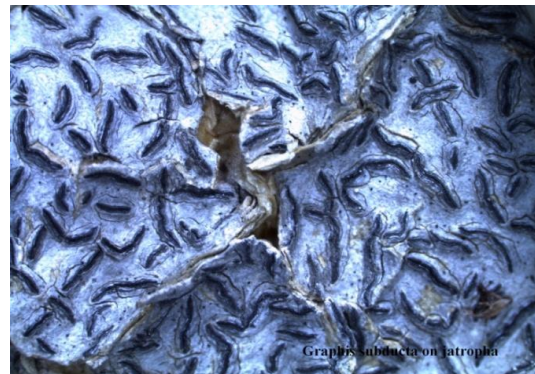
Arthonia pertusariella Mull . Arg

(b) Arthonioid Lichen community



Coccocarpia palmicola

(c) Cyanolichen community



Graphidaceae subducta

(d) Graphidioid lichen community



Bacidia incongruense (Stirt) Zhabl.

(e) Lecideoid Lichen Community



Lecanora perplexa Brodo

(f) Lecanoroid lichen Community



Lepraria santosii (Hue) Sivan

(g) Leprarioid Lichen Community



Parmotrema crinitoids J.C. Wei

(h) Parmelioid Lichen Community



Dirinaria aegialita (Afzel)

(i) Physcioid Lichen Community



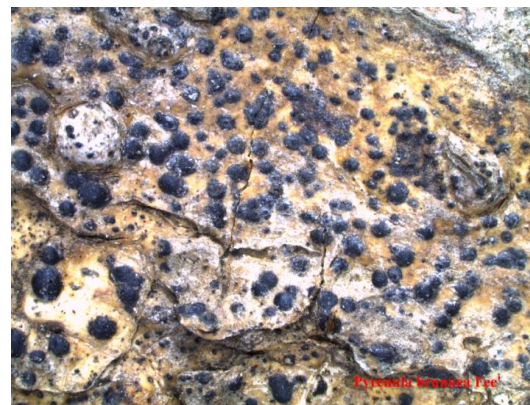
Pertusaria sp.

(j) Pertusarioid Lichen Community



Caloplaca amarkantakana Y. Joshi & Upreti

(k) Teloschistaceous Lichen community



Pyrenula brunnea fée.

(l) Pyrenuloide Lichen Community

Table 1. Distribution of lichen Communities in Achanakmar Amarkantak Biosphere Reserve

S.No.	Lichen community	Lichen species	Growth Form	Habitat	Anuppur 67	Bilasp-ur 34	Dindori 56
1	Arthonioid	Arthoniaceae					
		<i>Arthonia pertusariella</i> Mull. Arg	Cr	Co	+		
		<i>Arthonia recedens</i> Stirton.	Cr	Co	+		
		<i>Cryptothecia lunulata</i> (Zahlbr.) Makhija & Patw.	Cr	Co	+	+	+
		<i>Cryptothecia subtectata</i>	Cr	Co		+	

		Stirt.					
		<i>Cryptothecia macrospora</i> Makhiza & Patw.	Cr	Co			+
		<i>Cryptothecia involuta</i> stirton	Cr	Co			+
		<i>Herpothallon isidiatum</i> Jagadeesh & G.P.Sinha	Cr	Co	+		+
		Caliceaceae					
		<i>Dirinaria applanata</i> (Fée) D.D.Awasthi	Fo	Co	+	+	+
		<i>Dirinaria aegialita</i> (Afzel.)	Fo	Co	+		
		<i>Dirinaria confluence</i> (Fr.) D.D.Awasthi,	Fo	Co	+		
		<i>Dirinaria consimilis</i> (Stirt.) D.D.Awasthi	Fo	Co	+	+	+
		<i>Dirinaria picta</i> (Sw) Clem. Shaer,	Fo	Co		+	
		<i>Rhinodina sp.</i>	Cr	S			+
		Phsciaceae					
		<i>Heterodermia diademata</i> (Taylor) D.D.Awasthi	Fo	Co	+		+
		<i>Heterodermia bscurata</i> (Nyl) Travis	Fo	Co	+		
		<i>Heterodermia speciosa</i> (Walf) Travis	Fo	Co			+
		<i>Hypotrachina exsecta</i> (Taylor) Hale	Fo	Co			+
		<i>Phaeophyscia ciliata</i> (Hoffm.) Moberg,	Fo	Co	+		
		<i>Phaeophyscia hispidula</i> (Ach.) Moberg,	Fo	Co			+
		<i>physcia albinea</i> (Ach) Malbr	Cr	S		+	
		<i>Physcia sorideosa</i> (Vain.) Lynge.	Cr	S	+		
		<i>Physcia phaea</i> (Tuck.) J.W. Thomson	Cr	S	+		
		<i>pyxine coccoes</i>	Fo	s	+		+
		<i>Pyxine sunbsinerea</i> stirt.	Fo	s	+		
		<i>Pyxine sorideata</i> (Ach.)	Fo	S	+	+	
		Coccocarpaceae					
		<i>Coccocarpia palmicola</i> (Spreng.) Arv.& D.J.Galloway,	Fo	Co	+		
		Collemataceae					
		<i>Collema leptaleum</i> Tuck.,	Fo	Co	+		+
		<i>Leptogium burnetiae</i>	Fo	Co	+		+
		<i>Leptogium pseudopapillosum</i> P.M. Jörg	Cr	S	+		+
		Graphidaceae					
		<i>Diorygma junghunii</i> (Mont. & Bosch.) Kalb & al.,	Cr	Co	+		+
		<i>Graphis lineola</i> Ach.	Cr	Co			+
		<i>Graphis subducta</i> Vain.,	Cr	Co	+	+	+
		<i>Haemithecium sp</i>	Cr	Co		+	
		<i>Fissurina</i>	Cr	Co		+	
		Lecanoraceae					
		<i>Lecanora achroa</i> Nyl.in Cromb	Cr	Co	+	+	
		<i>Lecanora alba</i> Lumbsch.	Cr	Co	+	+	+
		<i>Lecanora allophana</i> (Ach.) Nyl.	Cr	Co	+		

Lichen as Indicator of Forest Health Status in Achanakmar Amarkantak Biosphere Reserve

		<i>Lecanora andina</i> Räsänen,	Cr	Co	+		+
		<i>Lecanora austrointumescens</i> Lumbsch & Elix	Cr	Co			+
		<i>Lechonera chlarotera</i> Nyl.,	Cr	Co	+		
		<i>Lecanora formosula</i> Lumbsch,	Cr	S	+		
		<i>Lecanora helva</i> Stizenb.	Cr	Co			+
		<i>Lecanora interjecta</i> Mull Arg	Cr	Co	+		
		<i>Lecanora mellanomata</i> C.Knight	Cr	Co		+	+
		<i>Lecanora perplexa</i> Brodo,	Cr	Co	+	+	+
		<i>Lecanora subimmersa</i> (Fée) Vain.,	Cr	S	+	+	
		<i>Lecanora sulphurescens</i> Fee	Cr	S	+		
		<i>Lecanora pseudistera</i> Nyl.	Cr	Co			+
		<i>Lecidella entroleucella</i> (Nyl.)	Cr	Co			+
		<i>Vainionora variabilis</i> Kalb & Elix	Cr	Co	+	+	+
		Letrouitiaceae					
		<i>Letrouitia muralis</i> Hafellner	Cr	Co		+	
		<i>Letrouitia transgressa</i> (Malme) Hafellner & Bellem.	Cr	Co	+	+	+
		Parmeliaceae					
		<i>Bulbothrix isidiza</i>	Fo	Co	+		+
		<i>Bulbothrix setschwanensis</i> (Zahlbr.) Hale	Fo	Co	+		
		<i>Hypotrachina exsecta</i> (Taylor) Hale	Fo	Co			
		<i>Parmotrem crinitoids</i> J.C.Wei	Fo	Co		+	+
		<i>Parmotrema mesotropum</i> (Müll. Arg.) Hale	Fo	Co			+
		<i>Parmotrema parasorediosum</i> (Nyl.) Hale	Fo	Co	+	+	+
		<i>Parmotrema tinctorum</i> (Desper. ex Nyl.)	Fo	Co	+	+	
		<i>Xanthoparmelia pseudocongensis</i> Hale	Fo	Co	+		
		Pertusariaceae					
		<i>Pertusaria quassiae</i> (Fée) Nyl	Cr	Co	+	+	+
		<i>Pertusaria mellastomella</i> Nyl.	Cr	Co	+		+
		<i>Pertusaria amarkantakana</i> Preeti Shrivastav & D.D.Awasthi.	Cr	Co	+		+
		<i>Pertusaria concinna</i> Erichsen,	Cr	Co	+	+	+
		<i>pertusaria indica</i> Preeti Shrivast. & D.D.Awasthi	Cr	s	+		
		<i>Pertusaria leucosora</i> Nyl.	Cr	S	+		+
		<i>Pertusaria leucosorodes</i> Nyl.	Cr	Co	+	+	+
		<i>Pertusaria pertusa</i> (L.)	Cr	Co	+	+	+
6	Parmelioide						
7	Pertusarioide						

		Tuck.,					
		<i>Pertusaria rigida</i> Müll. Arg.	Cr	Co	+		+
		<i>Pertusaria subochracea</i> Stirt.	Cr	Co			+
		<i>Pertusaria tuberculifera</i> Nyl	Cr	Co	+		+
		<i>pertusaria velata</i> (Turner) Nyl.	Cr	Co	+		+
8	Pyrenuloide	Pyrenulaceae					
		<i>Pyrenula brunnea</i> fée.	Cr	Co	+		+
		Ramalinaceae					
		<i>Bacidia arnoldiana</i> Körb.,	Cr	S	+		
		<i>Bacidia delicata</i> (Larbel.ex.leighton) Coppinse	Cr	Co			+
		<i>Bacidia fusconigrescens</i> (Nyl.) Zahlbr.,	Cr	Co			+
		<i>Bacidia incongruens</i> (Stirt.) Zhalbr.,	Cr	Co		+	+
		<i>Bacidia millegrana</i> (Taylor) Zahlbr.,	Cr	Co			+
		<i>Bacidia submedialis</i> (Nyl.) Zhalbr.,	Cr	Co	+		+
		<i>Phyllopsora catervisoriata</i>	Cr	Co			+
		<i>Phyllopsora buetteneri</i> (Müll. Arg.)	Cr	Co	+		
		<i>Phyllopsora corallina</i> (Eschw.) Müll. Arg.	Cr	Co	+		+
		<i>Phyllopsora himalayensis</i> G.K.Mishra, Upreti & Nayaka	Cr	Co	+		
		Haematommataceae					
		<i>Haematomma puniceum</i> (Sw.) A.Massal.,	Cr	Co		+	
		Lacideaceae					
		<i>Lecidea granifera</i> (Ach.) Vain.	Cr	Co	+	+	+
		<i>Lecidea sp.</i>	Cr	Co		+	
		Stereocaulaceae					
		<i>Lepraria santosii</i> (Hue) Sipman,	Lep	S	+		+
		<i>Lepraria coriensis</i> (Hue) Sipman,	Lep	S,Co	+	+	
		<i>Lepraria ecorticata</i> (J.R.Laundon) Kukwa	Lep	Co	+		
		<i>Lepraria incana</i> (L) Ach.	Lep	S	+		+
		<i>Lepraria lobificans</i> Nyl.	Lep	Co,S	+	+	
		<i>Lepraria yunnaniana</i> (Hue) Zahlbr	Lep	Co			
		<i>Leprariya sp</i>	Lep	Co	+	+	
		Teloschistaceae					
		<i>Caloplaca amarkantakana</i> Y.Joshi & Upreti	Cr	S	+		+
		<i>Caloplaca atrosanguinea</i> (G.Merr.) I.M.Lamb	Cr	Co			+
		<i>Caloplaca cupulifera</i> (Vain.) Zahlbr.,	Cr	S	+	+	
		<i>Caloplaca subpolioeotera</i> Y. Joshi & Upreti	Cr	S	+	+	
		<i>Caloplaca bassia</i>	Cr	S	+		
		Cladoniaceae					
	Dimorphic	<i>Cladonia praetermissa</i> A.W. Archer		Fruticose	+		

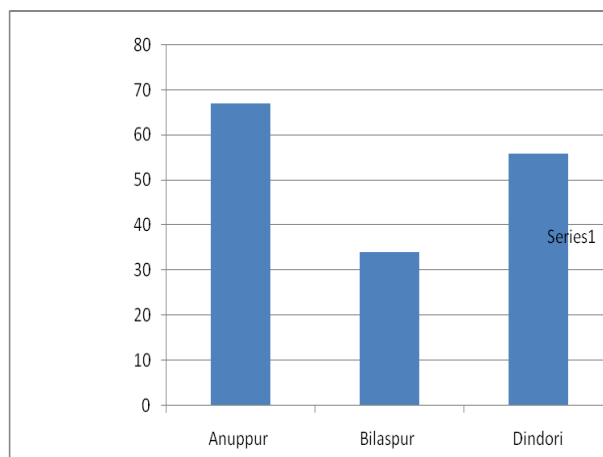


Fig1. Graph representing the distribution of lichen in three districts of Biosphere Reserve.

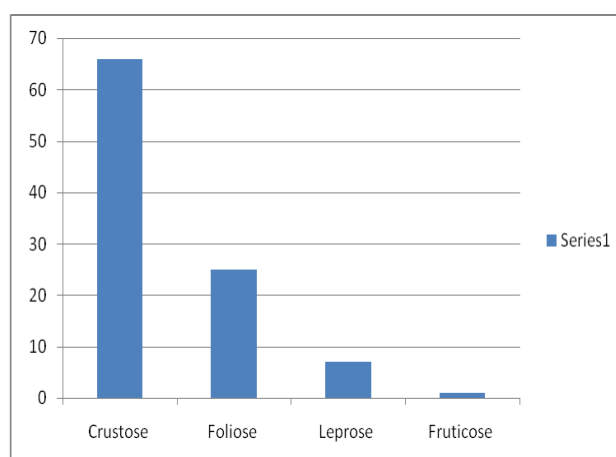


Fig2. Graph representing the distribution of lichen according to their growth form

Abbreviation: Cr: Crustose, Co: Corticolouse, S: Saxicolous, Lep: Leprose, +: Foliose

5. DISCUSSION

Occurrence of 11 communities with having 16 genera of abundance growth of lichen indicates the healthy forest structure. Graphidioide lichen community indicates smooth bark tree species like *ficus religeosa*, *ficus bengalensis*, these tree species are good nutrition supplier of all birds and insect family. Lichen abundance in top canopy like Foliose, Crustose lichen on twigs indicates undisturbed forest whereas crustose and poor growth of lichen indicates sensitivity to microclimate change in the Bilaspur district. Only one fruticose lichen on soil entire the Biosphere Reserve even in central India signifies the sensitivity to anthropogenic disturbance of soil. Bark shading trees like *Syzigium cumini*, *Eucalyptus eucalyptus* with enriched growth of lichen supplies nutrient to the forests ground floor. *Lepraria* species like *Lepraria coriensis*, *Lepraria lobificans* are also known as primitive species helps in pioneering of life and take part in lichen succession. Genera of *Pertusaria* species are observed resistant to forest fire are well distributed upto a breast height in forest prone areas.

Amarkantak is abode of diversity, monitoring with the help of lichen diversity will make available basic and essential natural information used by basic scientific disciplines. It may be used to understand the habitat in which lichen exists in the sensitive and non sensitive area.

REFERENCES

- [1]. Karwariya S. and Tripathi S. Land use/Land cover Mapping of Achanakmar Amarkantak Biosphere Reserve, India Usng Unsupervised Classification Technique. International Journal of Computational Engineering Research: 2012, 1302-1307.
- [2]. Singh, K. P. and Sinha G. P. Indian Lichens: An Annotated Checklist Botanical Survey of India, Ministry of Environment and Forests, 2010.

- [3]. Shukla, A.N. and Singh K. P. Glimpses of The lichen flora of Achanakmar Amarkantak Biosphere Reserve in Central India. *American Journal of Plant Science*. 2012, **3**, 697-708.
- [4]. Asta, J., Erhardt, W., Ferretti, M., Fornasier, F., Kirschbaum, U., Nimis, P.L., Purvis, W., Pirintzos, S., Scheidegger, C., Van Haluwyn, C., Wirth, V., Mapping lichen diversity as an indicator of environmental quality. In: Nimis, P.L., Scheidegger, C., Wolseley, P. (Eds.), *Monitoring with Lichens Monitoring Lichens*. Kluwer, Dordrecht, 2002, 273-279
- [5]. Bajpai, R., Upreti D.K. and Mishra S.K. Pollution monitoring with the help of lichen transplant technique at some residential sites of Lucknow. *Journal Environmental Biology*, 2004, **25**, 191-195.
- [6]. Bajpai, R., Upreti D.K. and Dwivedi S.K. Arsenic accumulation in lichens of Mandav monuments, Dhar district, Madhya Pradesh. *Environmental. Monitoring. Assessment*. 2009, **159**, 437-442.
- [7]. Eseen, P.A. & Renhorn, K.E.. Edge effect on an epiphytic lichen in fragmented forests. *Conservation Biology*, 1998, pp 12:1307-1317
- [8]. Upreti, D.K. Diversity of lichen in India. In: *Perspective in Environment* (Eds. S.K. Aggarwal; J.P. Kaushik; K.K. Kaul and A.K.Jain) A.P.H. Publishing Corporation, New Delhi, 1998, pp 71-79
- [9]. Bhatia, K.K. Some observations on the lichen communities of the Western Himalayas. *Bulletin of the Botanical. Society. University. Saugar*. 1957, **9(1-2)**: 36-39.