REGENERATION STATUS AND SPECIES DIVERSITY OF SELECTED TREE SPECIES IN SHERGARH WILDLIFE SANCTUARY OF BARAN, RAJASTHAN, INDIA

[1]KRISHNENDA SINGH NAMA, [2]KIRAN CHOUDHARY, [3]OMPRAKASH BAIRWA, [4]PRIYANKA SUMAN, [5]RINKESH KUMAR
[1]Associate Professor, [2]Assistant Professor, [345]Biologist
[12345]Lzebra College, Kota
[1]namasahib@gmail.com, [2]choudharykiran01@gmail.com

***Abstract*—The present research study was aimed to investigate to study the regeneration status of tree species and survival of naturally emerged seedlings in Shergarh wildlife sanctuary of Rajasthan, India. A total of 22 tree species were recorded from the study area. Regeneration status of seedlings were studied by transect method in all the studied blocks. Seedling Shannon-Weiner diversity index (H') ranged from 1.51 to 1.91 ind per hec. Seedlings Simpson concentration of dominance (Cd) was ranged between 0.157 to 0.281 and Sampling's Cd was 0.186 to 0.380. Species Richness (SR) of seedling ranged between 8 (Tikli) ti 15 (Amlawda) whereas SR of sapling was 8 (Chhota Dungar) to 17 (Amlawda). Menheink Index of Species richness of seedlings was ranged between 1.08 (Chhota Dungar) to 2.01 (Amlawda) wheras it was 0.42 (Chhota dungar) to 0.82 in Tikli for saplings. Climatic changes and anthropogenic disturbances are responsible for the high mortality of some tree species.**

***Index Terms*—Regeneration status, seedlings, saplings, anthropogenic pressure, Sanctuary.**

I. Introduction

A crucial step for a species to survive in a community under a variety of environmental circumstances is regeneration. Regeneration is essential because it preserves the intended species composition and stocking following a variety of disturbances, making it an essential component of forest management (Khumbongmayum et al. 2005). The future composition of forests within a stand in area and time is frequently depicted by the potential regeneration status of tree species (Henle et al. 2004). Any species' ability to regenerate is limited to a specific set of habitat conditions, and the degree of those conditions is a key factor of its geographical range (Grubb 1977). The ability of a tree species' seedlings and saplings to endure and develop is essential to its successful regeneration (Good & Good 1972). Perhaps the most crucial stage in ensuring the long-term viability of forests is successful regeneration (Saikia & Khan 2013). A population's reproductive state and future trajectory are determined by the ratio of different age groups within it (Odum 1971).

The demographic composition defined by the presence of sufficient number of seedlings, saplings, and young trees exhibits satisfactory regeneration behavior; a forest with insufficient seedlings and saplings of tree species exhibits poor regeneration; and a forest with no seedlings or saplings of tree species exhibits no regeneration at all (Saxena & Singh 1984). The biotic and abiotic elements of the forest ecosystem interact to influence tree species' regeneration as well as the survival and growth of their seedlings (Khan et al. 1986). Low and unpredictable seed availability and establishment frequently limit the recruitment of tree seedlings. Inadequate microsites and other factors that impact early seedling growth and death are another limitation (Clark et al. 1999). Seasonal variations in the microenvironment have an impact on the growth stages of trees, such as seedlings, saplings, coppices, and young trees that preserve the population structure (Rahman et al. 2011).

The need to comprehend forest regeneration arises from growing interest in forest development and management procedure that guarantees the preservation of the ecosystem's stability and community structure. Both ecologists and forest managers must comprehend the mechanisms influencing the regeneration of forest species (Slik et al. 2003). In SWLS and its surrounding areas, the current study was conducted to examine the regeneration status of tree species and the survival of their naturally emerged seedlings. This study could shed some light on how the woods in this region of Rajasthan will develop in the future.

II. Materials and Methods

Study area

The study area lies in Shergarh Wildlife Sanctuary, head quarter at Badora, Tehsil Atru in Baran Disctrict of Rajasthan. It lies between 24°35′ & 24°45′ North latitude and 70°27′ & 70°35′ East longitude. Shergarh was declared as a sanctuary by Govt. of Rajasthan notification no. P 11(35) Raj Group-8/83 dated 30 July, 1983. Further modified notification was issued vide State Government Number F 11 (10) Forest/92 Jaipur dated 25 May 1992. It contains 5 forest blocks comprising an area of 98.806 sq km, which are Barapati (16.02 sq km), Chotta Dungar (24.38 sq km), Bada Dunger (29.49 sq km), Naharia (25.96 sq km) and Teekly (2.94 sq km). Teekly is the smallest block whereas Bada Dungar is the largest one.

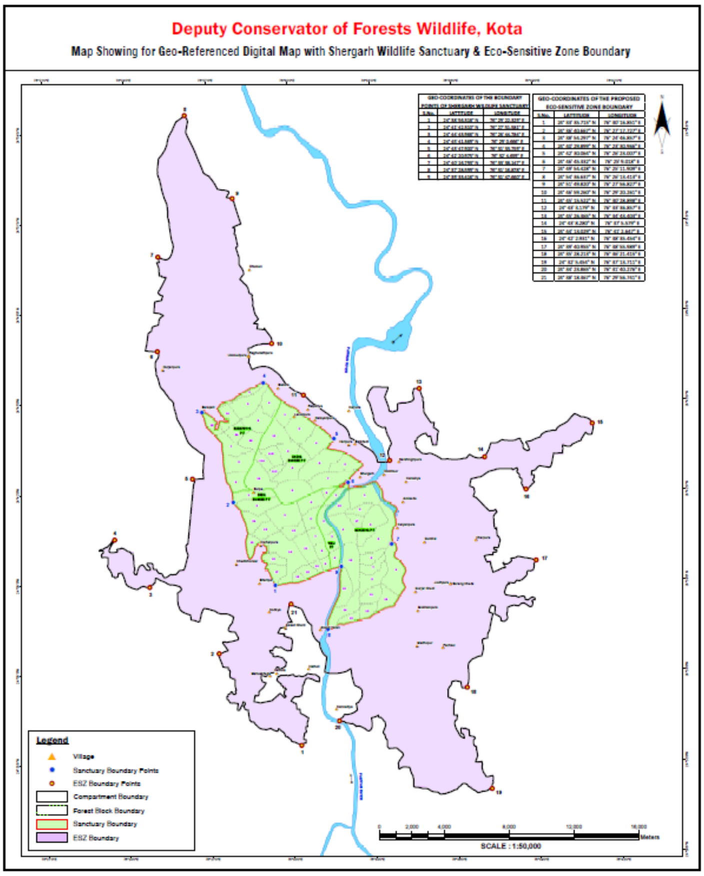

Fig-1: Map of Sanctuary area

The Northern and Western boundaries of the area are defined by village territories of Surpa and Ancholi (Map). Towards the South and East, the sanctuary is bordered by the Parvan River, which serves as a natural boundary along several stretches.

The climate of this area is sub-tropical & dry characterized by three distinct seasons. The rainy season often begins in mid-June and lasts into September. Also in January or February, there may be one or two winter showers. The rainfall pattern in the region is largely governed by the monsoon rains, which account for about 60-80% of the total annual rainfall. There are pre-monsoon rains in May and June. 730 mm of rain falls on average. The minimum temperature is 8^0C while the maximum temperature during summer is 45^0C. Humidity in the air generally remains low except in the rainy season when it ranges between 60- 80 percent. The forests of Shergarh sanctuary fall under Northern Tropical Dry Deciduous Mixed Forest as per Champion and Seth's classification.

Methodology

Analysis of Vegetation

Random sampling plots/quadrates were placed for the analysis of woody species as per Mishra (1968). Ten 10 m × 10 m quadrats were utilized to analyze trees (≥ 30 cm dbh), and two 5 m × 5 m plots were nested inside each quadrat to count shrubs.

The five forest blocks for woody vegetation was examined using established techniques for species richness, density, variety, and total basal cover (Curtis & McLntosh 1950; Phillips 1959). Tree species diversity was calculated by usig the Shannon-Wiener Index (Shannon and Weaver 1963). Species richness indices were calculated by using standard methods of Margalef (1958) and Menheink (1964). Species richness was calculated by a count of total number of species in particular forest block. Concentration of dominance was calculated by Simpson (1949) method.

Population structure

The population structure and survival of spontaneously emerging seedlings of every tree species documented in each forest were examined using the Khan et al. (1986) quadrat technique.

Twenty 10X10-meter quadrats were created in each of the chosen forest blocks.

Species were identified, and the density of all seedlings (less than 20 cm in height), saplings (less than 30 cm in collar circumference and more than 20 cm in height), and trees (less than 30 cm in dbh) was calculated. The population size of seedlings and saplings was used to measure the species' regeneration status (Khan et al. 1987).

1. Strong regeneration if seedlings > saplings > adults;
2. Acceptable/fair regeneration if seedlings > or < saplings ≤ adults;
3. Inadequate or poor regeneration if the species only endures the sapling stage without producing any seedlings (saplings may be <, >, or = adults).
4. If a species exclusively exists in mature form, there will be no regeneration.
5. Fresh or new regeneration in cases where the species only contains seedlings or saplings and no adults.

The chosen seedlings showed no signs of damage or injury and had consistent growth.

III. Results

Tree Community composition

The studied forest of Shergarh Wildlife Sanctuary is composed of Northern Tropical Dry Deciduous Mixed Forest which is of vital importance to the local people and for the wildlife inhabiting in and around the SWLS. But this forest area is under the high anthropogenic pressure due to excessive extraction of forest resources (Table-1). The forest blocks showed differences in terms of some important structural attributes of forest like density, diversity, species richness etc (Table-2).

Table-1: Vegetation and disturbance factors in study area

Forest Block	Main Vegetation	Anthropogenic disturbances
Barapati	Diospyros melanoxylon, Anogeissus pendula, Butea monosperma, Cassia fistula, Terminalia bellirica	HTL, HG, LSC
Chhota Dungar	Anogeissus pendula, Diospyros melanoxylon, Butea monosperma, Holarrhena antidysenterica, Mitragyna parvifolia	LG, LTL. HSC
Tikli	Anogeissus pendula, Diospyros melanoxylon, Carissa congesta, Lannea coromandelica	HG, CNTFP
Amlawda	Anogeissus pendula, Diospyros melanoxylon, Holarrhena antidysenterica, Mitragyna parvifolia	HG, LSC, HTL, CNTFP
Bada Dungar	Anogeissus pendula, Diospyros melanoxylon, Cassia fistula, Butea monosperma	LSC, HTL, CNTFP

LTP= Low tree lopping, LG= Low Grazing, HTL= Heavy tree lopping, HG= Heavy grazing, LSC= Low Ste cutting, HST= Heavy ste cutting, CNTFP= Collection of non-timber forest products.

Table-2: Structural ecological attributes of studied 5 forest blocks of SWLS

Forest Block	Total tree individuals	Species Richness (S)	Margalef Richness	Shannon Index (H')	Dominance (Simpson's Index)	Density comparision	Mean Frequency	IVI
Barapati	542	13	1.91	1.91	0.203	54.2	73.8	44.05
Chotta Dungar	259	13	2.16	1.76	0.247	25.9	45.4	55.08
Tikli	227	15	2.58	1.79	0.251	22.7	38.0	63.35
Amlawda	1113	17	2.31	1.72	0.236	111.3	58.8	48.63
Bada Dungar	677	16	2.31	1.55	0.320	67.7	36.3	68.97

Species richness is highest in Amlawda (17) which represents that Amlawda has the highest floristic heterogeneity, followed by Bada Dungar (16), Tikli (15), chotta dungar (13) and Barapati (13). Bada Dungar and Amlawda shows similar kind of Margalef richness. According to the diversity order Barapati (1.91) has the most balanced species distribution and Bada Dungar has the lowest one (1.55). Lower values of Simpson's index indicate greater evenness. Bada Dungar is most strongly dominated by a few species. Amlawda exhibits exceptionally dense woody vegetation (111.3) and Tikli has lowest (22.7). Barapati shows the most uniform species occupancy.

The five forest blocks exhibit marked variation in phytosociological structure and regeneration dynamics. Amlawda represents a highly productive and regenerating dry deciduous stand characterized by high stem density and strong recruitment. Barapati exhibits the highest ecological stability, with maximum Shannon diversity and lowest dominance, indicating a mature and structurally balanced community. Tikli supports high species richness but poor seedling recruitment, suggesting recent regeneration limitations. Bada Dungar shows strong dominance by a few woody species and an adult-biased population structure, indicative of potential future recruitment constraints. Overall, the vegetation composition across these blocks is largely influenced by Kala Dhonk, Tendu, Palash, and associated dry deciduous associates, reflecting typical tropical dry deciduous forest assemblages of southeastern Rajasthan.

Across all five forest blocks, Anogeissus pendula consistently exhibits the highest density, frequency, and IVI, confirming its role as the principal ecological dominator of these dry deciduous forests. Diospyros melanoxylon represents the second most important associate species in all blocks. Amlawda supports the highest absolute density and structural complexity, whereas Bada Dungar shows the strongest dominance concentration with reduced community evenness. Tikli exhibits high species heterogeneity but low occupancy of several associated species, indicating patchy microhabitat distribution.

Regeneration status

The percentage of various life stages (trees, seedlings, and saplings) of various species aids in forecasting potential shifts in the composition of forests. Distinct forms of regeneration status (i.e., good, fair, bad, and new regeneration) were observed in distinct forest blocks based on the density of seedlings, saplings, and trees.

Table-3 Consolidated data of regenerating seedling tree species in SWLS

Forest Block	Cd	Pielou's Eq.	SR	MI	MeI
Barapati	0.166	0.82	13	1.76	0.42
Chotta Dungar	0.170	0.88	7	1.08	0.44
Tikli	0.204	0.79	8	1.53	0.81
Amlawda	0.157	0.86	15	2.01	0.48
Bada Dungar	0.281	0.68	11	1.69	0.57

Cd = Simpson Concentration of Dominance; Eq = Pielou Equitability; SR = Species Richness; MI = Margalef Index of Species Richness; MeI = Menheink's Index of Species Richness

The seedling layer demonstrates marked spatial heterogeneity among forest blocks. **Amlawda** supports the richest and most diverse seedling assemblage, characterized by low dominance and high evenness, reflecting favorable regeneration conditions. **Bada Dungar** exhibits the highest dominance and lowest evenness, indicating recruitment concentration around a few dominant species. **Tikli**, despite lower total seedling density, shows the highest Menhinick richness, suggesting efficient niche partitioning under lower population pressure. The moderate beta diversity (β = 2.31) indicates appreciable turnover in seedling composition among blocks, highlighting landscape-level habitat heterogeneity and the importance of conserving multiple forest patches for maintaining regional regeneration diversity (Table 3).

Table 4- Consolidated data of sapling tree species in studied forest blocks of SWLS

Forest Block	Cd	Pielou's Eq.	SR	MI	MeI
Barapati	0.275	0.71	12	1.67	0.45
Chotta Dungar	0.340	0.62	8	1.19	0.42
Tikli	0.186	0.84	11	1.92	0.82
Amlawda	0.248	0.79	17	2.28	0.50
Bada Dungar	0.380	0.58	12	1.75	0.51

Cd = Simpson Concentration of Dominance; Eq = Pielou Equitability; SR = Species Richness; MI = Margalef Index of Species Richness; MeI = Menheink's Index of Species Richness

The sapling stratum reveals substantial variation in community organization among forest blocks. Amlawda supports the richest sapling flora, reflecting highly favorable recruitment conditions and habitat heterogeneity. Tikli exhibits the lowest dominance and highest evenness, suggesting balanced interspecific recruitment and efficient niche sharing. In contrast, Bada Dungar shows the highest dominance and lowest equitability, indicating concentration of regeneration around a few highly competitive species. The moderate beta diversity (β = 2.25) suggests substantial species replacement among blocks, emphasizing the ecological importance of conserving multiple forest patches to maintain landscape-scale recruitment diversity (Table 4). Survival of Seedlings

Table-5 Seedling density (Ind Per hac.) of various tree species in studied forest blocks

Species	Barapati	Chhota Dungar	Tikli	Amlawda	Bada Dungar
Anogeissus pendula	27.30	8.00	0.50	24.60	2.50
Diospyros melanoxylon	24.00	7.50	3.40	20.70	19.10
Butea monosperma	14.10	0.90	0.00	3.60	1.50
Cassia fistula	1.90	0.10	0.00	0.00	1.50
Terminalia bellirica	8.40	0.60	0.30	.80	0.00
Holarrhena antidysenterica	7.00	5.50	0.00	25.40	7.70
Mitragyna parvifolia	1.30	2.20	0.00	4.40	0.60
Phoenix sylvestris	1.90	0.00	0.00	0.00	1.30
Ziziphus mauritiana	0.90	0.00	0.00	0.00	0.00
Syzygium salicifolium	2.30	0.00	0.00	3.60	0.00
Madhuca longifolia	3.00	0.00	0.00	0.00	0.00
Tectona grandis	1.10	0.00	0.00	0.00	0.00
Lannea coromandelica	0.00	0.oo	0.10	0.00	0.00
Dichrostachys cinerea	0.00	0.00	0.00	0.00	0.20
Annona squamosa	0.00	0.00	1.00	0.00	0.00
Dolichandrone falcata	0.00	0.10	0.00	0.00	0.00
Ficus racemosa	0.00	0.00	0.20	0.00	0.00
Schleichera oleosa	0.00	0.00	0.00	0.60	0.00
Cordia dichotoma	0.00	0.00	0.00	0.20	0.00
Crateva religiosa	0.00	0.00	0.00	2.50	0.60
Flacourtia indica	0.00	0.00	0.00	0.70	0.00

Vachellia leucophloea	0.00	0.00	0.00	0.00	0.30

Barapati is dominated by Anogeissus pendula and Diospyros melanoxylon, indicating strong regeneration of typical dry deciduous species. Chhota Dungar has moderate regeneration led by Anogeissus pendula, Diospyros melanoxylon, and Holarrhena antidysenterica. Tikli has very low overall density and regeneration restricted mainly to Diospyros melanoxylon and Annona squamosa. Amlawda shows highest regeneration density, strongly represented by Holarrhena antidysenterica, Anogeissus pendula, and Diospyros melanoxylon. Bada Dungar is dominated by Diospyros melanoxylon and Holarrhena antidysenterica, suggesting selective regeneration of tree species. The seedling layer confirms an Anogeissus pendula–Diospyros melanoxylon community**,** with Amlawda and Barapati representing the most actively regenerating forest patches (Table 5).

Table-6 Block wise Total Seedling density

Forest Block	**Total Density**
Barapati	**97.80**
Chhota Dungar	**25.30**
Tikli	**9.80**
Amlawda	**96.70**
Bada Dungar	**37.60**

Maximum seedling density was observed in Barapati (97.80) followed by Amlawda (96.70) and Minimum was in Tikli (9.80) as Tikli is comparatively small block in size also (Table-6).

IV. Discussion

The potential regenerative status of the species that make up the forest stand in space and time determines the forest's riches (Jones et al. 1994). The forest's regeneration is an essential process whereby old trees die and are permanently replaced by younger ones. In SWLS and its surrounding areas in Rajasthan, India, an attempt was undertaken to investigate the tree regeneration status and seedling survival five forest blocks. The research area's overall regeneration state was comparatively high. Because it is a sanctuary, human activities like cutting down trees and gathering garbage and fuelwood are somewhat restricted. In the end, this promoted the regrowth of the greatest number of tree species. Additionally, good rainfall, moderate temperatures, and significant variations in soil properties created a favorable habitat for the lush growth of numerous tree species. In present study seedling density ranged from 27 individual per hectare to 0.1 individual per hectare.

The variation in seedling density among the forest blocks and or species may be due to change in soil quality, habitat loss, human disturbances and the location of Parvan river which could restrict the distribution of some species via the germination and establishment of seedlings. Shorter-term seedling survival and mortality rates may offer crucial indicators of a forest stand's future composition (Deb & Sundriyal (2008); and the current study's findings showed significant variations between seedling groups. Early developmental stages (seedling/sapling) have a high initial mortality rate that is brought on by microsite effects and tiny animals on land. Competition with one another and other plants is crucial during later (juvenile/adult) mortality. Gap size and light availability, physical damage, dry soil, and herbivore assault are typically blamed for increased mortality (Nunez-Farfan & Dirzo 1989). Both biotic and abiotic elements, as well as the surrounding environment, have a significant impact on seedling survival (Harper 1977). Maximum mortality rate of seedlings happened in the winter, which may have been caused by the low temperatures and low soil moisture levels that were prevalent. It has been well documented how soil moisture affects tree seedling survival and growth in forests (Deb & Sundriyal 2008; Schulte & Marshall 1983). In general, seedlings are susceptible to the dry, cold weather that occurs during the winter, and many of them perish in both gaps and understorey (Khumbongmayum et al. 2005). According to Cierjack et al. (2008), severe conditions typically inhibit plant regeneration.

V. Acknowledgment

The authors acknowledge the support of the Forest Department, Rajasthan, field staff of Shergarh Wildlife Sanctuary. The authors would like to express their sincere gratitude to all those who contributed to the successful completion of this research. We are especially thankful to Deputy Conservator of Forests Mr. Anurag Kumar Bhatnagar, for valuable guidance, insightful feedback, and continuous support throughout the study. We also acknowledge the support provided by Wildlife Division, Kota for granting access to the necessary resources and facilities.

References

[1] **CIERJACK, A., N. K. RUHR, K. WESCHE & I. HENSEN. (2008)**. Effects of altitude and livestock on regeneration of two tree line forming Polylepis species in Ecuador. Plant Ecology 194: 207-221.

[2] **CLARK, J. S., B. BECKAGE, P. CAMILL, B. ET AL. (1999).** Interpreting recruitment limitation in forests. American Journal of Botany 86: 1-16.

[3] **CURTIS J. T. & R. P. MCINTOSH. (1950).** The interrelation of certain analytic and synthetic phytosociological characters. Ecology 31: 434-455.

[4] **DEB, P. & R. C. SUNDRIYAL. (2008).** Tree regeneration and seedling survival patterns in old-growth lowland tropical rainforest in Namdapha National Park, north-east India. Forest Ecology and Management 255: 3995-4006.disturbed and protected sub-tropical forests of North East India. Acta Oecologica- Oecologia Applicata 8: 247-255.

[5] **GOOD, N. F. & R. E. GOOD. (1972).** Population dynamics of tree seedlings and saplings in mature Eastern hardwood forest. Bulletin of Torrey Botanical Club 99: 172-178.

[6] **GRUBB, P. J. (1977).** The maintenance of species richness in plant communities. The importance of the regeneration niche. Biological Review 52: 107-145.

[7] **HARPER, J. L. (1977).** Population Biology of Plants. Academic Press, London.

[8] **HENLE, K., S. SAREE & K. WIEGAND. (2004)**. The role of density regulation in extinction processes and population viability analysis. Biological Conservation 13: 9-52.

[9] **JONES, R. H., R. R. SHARITZ, P. M. DIXON, P. S. SEGAL & R. L. SCHNEIDER. (1994)**. Woody plant regeneration in four floodplain forests. Ecological Monographs 64: 345-367.

[10] **KHAN, M. L., J. P. N. RAI & R. S. TRIPATHI. (1986).** Regeneration and survival of tree seedlings and sprouts in tropical deciduous and sub-tropical forests of Meghalaya, India. Forest Ecology and Management 14: 293-304.

[11] **KHAN, M. L., J. P. N. RAI & R. S. TRIPATHI. (1987).** Population structure of some tree species in

[12] **KHUMBONGMAYUM, A. D., M. L. KHAN & R. S. TRIPATHI. (2005).** Survival and growth of seedlings of a few tree species in the four sacred groves of Manipur, Northeast India. Current Science 88: 1781-1788.

[13] **MARGALEF D. R. (1958).** Information theory in ecology. General Systems 3: 36-71.

[14] **MENHINICK E. F. (1964).** A comparison of some species diversity indices applied to samples of field insects. Ecology 45: 859-861.

[15] **MISRA R. (1968).** Ecology Workbook. Oxford and IBH Publishing Co. New Delhi.

[16] **NUNEZ-FARFAN, J. & R. DIRZO. (1989).** Leaf survival in relation to herbivory in two tropical pioneer species. Oikos 54: 71-74.

[17] **ODUM, E. P. (1971).** Fundamentals of Ecology. Saunders Company, Philadelphia, USA.

[18] **PHILLIPS, E. A. (1959).** Methods of Vegetation Study. Henry Holt and Co. Inc., New York.

[19] **RAHMAN, M. H., A. S. A. KHAN, B. ROY & M. J. FARDUSI. (2011).** Assessment of natural regeneration status and diversity of tree species in the biodiversity conservation areas of Northeastern Bangladesh. Journal of Forestry Research 22: 551-559.

[20] **SAIKIA, P. & M. L. KHAN. (2013).** Population structure and regeneration status of Aquilaria malaccensis Lam. in homegardens of Upper Assam, northeast India. Tropical Ecology 54: 1-13.

[21] **SAXENA, A. K. & J. S. SINGH. (1984).** Tree population structure of certain Himalayan forest associations and implications concerning their future composition. Vegetatio 58: 61-69.

[22] **SAXENA, A. K., S. P. SINGH & J. S. SINGH. (1984).** Population structure of forest of Kumaon Himalaya: implications for management. Journal of Environmental Management 19: 307-324.

[23] **SHANNON, C. E. & W. WEAVER. (1963).** The Mathematical Theory of Communication. University of Illinois Press, Urbana, USA.

[24] **SIMPSON, E. H. (1949).** Measurement of Diversity. Nature 163: 688-690.

[25] **SLIK, J. W. F., P. J. A. KEBLER & P. C. VAN WELZEN. (2003).** Macaranga and Mallotus species (euphorbiaceae) as indicators for disturbance in the mixed lowland dipterocarp forest of east Kalimantan (Indonesia). Ecological Indicators 2: 311-324.