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Annals of Biological Research, 2011, 2 (5) :75-82
(http://scholarsresearchlibrary.com/archive.html)

ISSN 0976-1233
CODEN (USA): ABRNBW

Assessment of relation between soil characteristics and wood species biodiversity in several size gaps

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ABSTRACT

The role of disturbance in the structure and dynamics of ecological systems is an essential issue in ecology. The purpose of this research was to comparison of soil characteristics in forest gaps with several size and relation to plant species biodiversity in Lalis forests, Chalous. In order to investigate factors, three gap size small gap (200 m^2), medium gap (400 m^2), and large gap (600 m^2) with three replicate were selected in locate. During the late summer 2008, mineral soil samples (0–30 cm depth) were collected from four different places in each gap, all over the gap area randomly. Nine circular subplots of 3.14 m^2 (100 cm radius) were established inside each gap. Subplots were positioned one in the central part of the gap and the others along the cardinal directions. The percent of vegetation cover every wood species was estimated in each subplot and in the whole gap. Some of soil characteristics, such as total carbon, total nitrogen, available phosphorous, soil acidity (pH), C/N ratio, and saturation moisture were measured. By using analysis of variance statistical difference between Soil characteristics in respect to gap size were found. Results showed that the highest carbon and C/N ratio is related to small gaps. The highest of nitrogen, phosphorous, pH, and moisture characteristics are related to large gaps, too. Determination of relation between plane cover biodiversity and soil characteristics were accomplished by correlation. Similar to results, by using correlation statistical difference between diversity indices with soil characteristics was found. With thicken of soil characteristics consist of nitrogen, phosphorous, pH, and moisture increased diversity species (Simpson) and richness species (Margalef) indices. On the contrary, with wane of carbon and C/N ratio increased Simpson and Margalef indices.

Keywords: Correlation, Disturbance, Forest, Lalis**,** Margalef Index, Simpson Index**.**

INTRODUCTION

One of the challenges of forest management today is how to promote the regeneration of species in order to maintain their populations and preserve their genetic variability. Therefore, it is necessary to identify and investigate appropriate management procedures for an adequate conservation of ecological functions. Disturbances caused by canopy gaps received much attention in the last decades [52] and they are regarded as important factors in forest dynamics [41]. Canopy openings as a result of tree falls create an environment different from the adjacent forest [54], which influences plant regeneration [46]. In addition, gap processes partly determine forest structure and play an important role to maintain plant species richness [36]. Thus, the creation of gaps in forests is an opportunity for the system to change in both species dynamics and ecological processes [22] by increasing environmental heterogeneity and altering abundances and distribution of abiotic and biotic resources [36]. In general, disturbances within forests influence the availability of resources as light, water, and nutrients, which are critical for seedlings establishment and growth diversity. Gap formation is suggested as an alternative forest management approach to avoid extreme changes in nutrient cycles. Research in soil nutrient availability has important relevance for the understanding of processes in forest ecosystems [24]. Nutrient availability depends highly on the decomposition of organic matter and subsequent release of material in plant available forms by mineralization, converting organic compounds into inorganic forms. The major factors controlling decomposition in forest ecosystems are soil moisture and temperature. Thus nutrient availability in forests can be affected by forest management, as it may alter these factors [26]. To avoid these and other undesirable effects, new approaches in forest management are gaining increasing interest [20]. One possible approach is to natural disturbances, thereby creating gaps. Most studies of gaps have addressed vegetation dynamics, regeneration through seedling establishment, wood species diversity, effects of microclimatic variables on the diversity and, in general, have concentrated on aboveground processes [15, 21, 36, and 49]. Thus, this research surveyed soil factor in forest gap with several sizes and studied influences this factors on the wood species diversity.

MATERIALS AND METHODS

Study Area

The study site is located in, approximately 80 km of Chaloos, Iran northern that Virgin forest namely Lalis (36° 29′ and 36° 32′ Latitudinal- 51° 23′ and 51° 28′ Alitudinal). It is a 60 ha Fagus mixed forest stand (old growth) in intermediate elevation within hard wood Forest, that do not any cutting sometime. The climate at mixed hardwood forest is humid subtropical, with average temperatures ranging from 32.2 °C to 0 °C, and rainfall totaling 800-1000 mm annually. The kind of best rock involved is the Marny, Lime -Marny stone, mixed to Marn- Silty and soil type is the poudzolic red mid pesudoglay.

Research Method

In order to investigate soil factors and affection's on diversity and richness wood species, three gap size small gap (200 m^2), medium gap (400 m^2), and large gap (600 m^2) with three replicate were selected in locate [1]. During the late summer 2008, mineral soil samples (0–30 cm depth) were collected from four different places in each gap, all over the gap area randomly [1]. The percent of every wood species was estimated in whole gap and in order to analyses of biodiversity indices of Simpson and Margalef indices had been used [53]. Some of soil characteristics, such as total carbon, total nitrogen, available phosphorous, soil acidity (pH), C/N ratio, and saturation moisture were measured. Prior to the soil analysis, all the soil samples were air-dried and sieved (<2 mm). Saturation moisture was measured by mud-saturation, pH was measured in distilled water and 1 MKCl (soil: solution ratio 1:2.5) with a glass electrode, total carbon was determined by dichromate oxidation [2], and it was converted to organic matter by multiplying the percentage of carbon by 1.72, total nitrogen was measured by the Kjeldahl method [32]. Available P was determined by Bray II method [51].

Data analysis

Data were subjected to a two-way ANOVA ($p \leq 0.05$), considering as soil factors and biodiversity indices in forest gaps with several sizes (small, medium, and large). Treatment means were compared using the Student–Newman–Keul test. Than correlation linkage surveyed between soil factors and value of biodiversity indices with Pearson correlation coefficient.

RESULTS

In Tables 1 and 2 are reported the data on the soil factors and biodiversity indices in small, medium, and large gaps. Gap size influenced on soil properties and biodiversity indices. The results showed that total nitrogen, available phosphorous, *pH* and saturation moisture increased with increasing of gap size and the most value of these factors were observed in large gaps (Table 2). Total carbon and *C/N* ratio decreased with increasing of gap size and the most of both factors pertained to small gaps (Table 2). The results of correlation between soil factor and biodiversity indices evinced that with increasing factors such as *N*, *P*, *pH* and saturation moisture in large gaps the Simpson and Margalef indices increased to positive correlation (Table 3, Figure 1 and 2). But between *C* and *C/N* ratio factors with diversity and richness wood species have been strongly negative correlated (Table 3, Figure 1 and 2).

Table 1. Two-Way ANOVA of soil factors and biodiversity indices

Variable		Sum of Squares	Df	Mean of Squares	*F*-Statistics	Sig.
Carbon (%)	Replicate	0.06	2	0.03	5.08 **	0.08
	Gap Class	0.15	2	0.08	13.72 *	0.016
	Error	0.02	4	0.01	-	-
Nitrogen (%)	Replicate	0.0003	2	0.0001	8 *	0.040
	Gap Class	0.05	2	0.02	1406 **	0.00
	Error	6.67 E – 0.005	4	1.67 E – 0.005	-	-
C/N ratio	Replicate	0.01	2	0.06	0.09 ns	0.918
	Gap Class	26.47	2	13.23	195.91 **	0.00
	Error	0.27	4	0.07	-	-
Phosphorous	Replicate	1.87	2	0.93	2.04 ns	0.245
	Gap Class	155.34	2	77.67	169.53 **	0.00
	Error	1.83	4	0.46	-	-
pH	Replicate	0.04	2	0.02	6.4 ns	0.057
	Gap Class	0.22	2	0.11	40 **	0.002
	Error	0.01	4	0.003	-	-
Saturation moisture	Replicate	1.40	2	0.70	1.30 ns	0.37
	Gap Class	15.55	2	7.78	14.39 *	0.015
	Error	2.16	4	0.54	-	-
Shannon and Wiener	Replicate	0.03	2	0.02	4.59 ns	0.09
	Gap Class	1.01	2	0.51	137.90 **	0.00
	Error	1.23	4	0.62	-	-
Menhenick	Replicate	0.003	2	0.002	0.13 ns	0.884
	Gap Class	1.23	2	0.62	47.80 **	0.002
	Error	0.05	4	0.01	-	-

*Ns: No Significant; *: in 0.05 Significant; **: in 0.01 Significant*

Table 2. Means (± S.E.) of soil factors and biodiversity indices among gap sizes

Gap class	Carbon (%)	Nitrogen (%)	C/N ratio	Phosphorous	pH	Saturation moisture	Shannon and Wiener	Menhenick
Small	4.32 (0.02) [a]	0.38 (0.01) [c]	11.37 (0.15) [a]	17.73 (0.45) [c]	5.7 (0.06) [b]	66.58 (0.68) [b]	1.15 (0.02) [c]	1.97 (0.05) [c]
Medium	4.21 (0.07) [a]	0.47 (0.003) [b]	8.89 (0.09) [b]	22.6 (0.61) [b]	5.7 (0.06) [b]	69.27 (0.09) [a]	1.51 (0.06) [b]	2.36 (0.07) [b]
Large	4.01 (0.09) [b]	0.56 (0.003) [a]	7.20 (0.13) [c]	27.9 (0.21) [a]	6.03 (0.03) [a]	69.47 (0.34) [a]	1.97 (0.07) [a]	2.87 (0.05) [a]

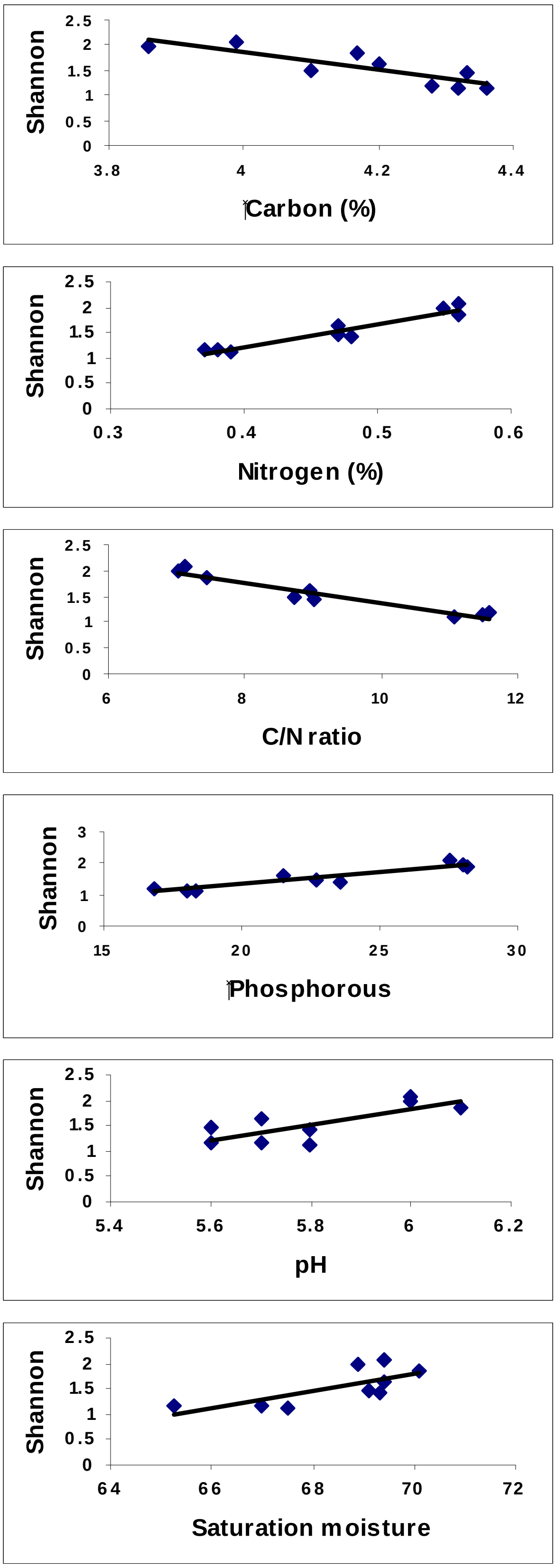

Figure 1. Correlation among Shannon and Wiener index and soil factors

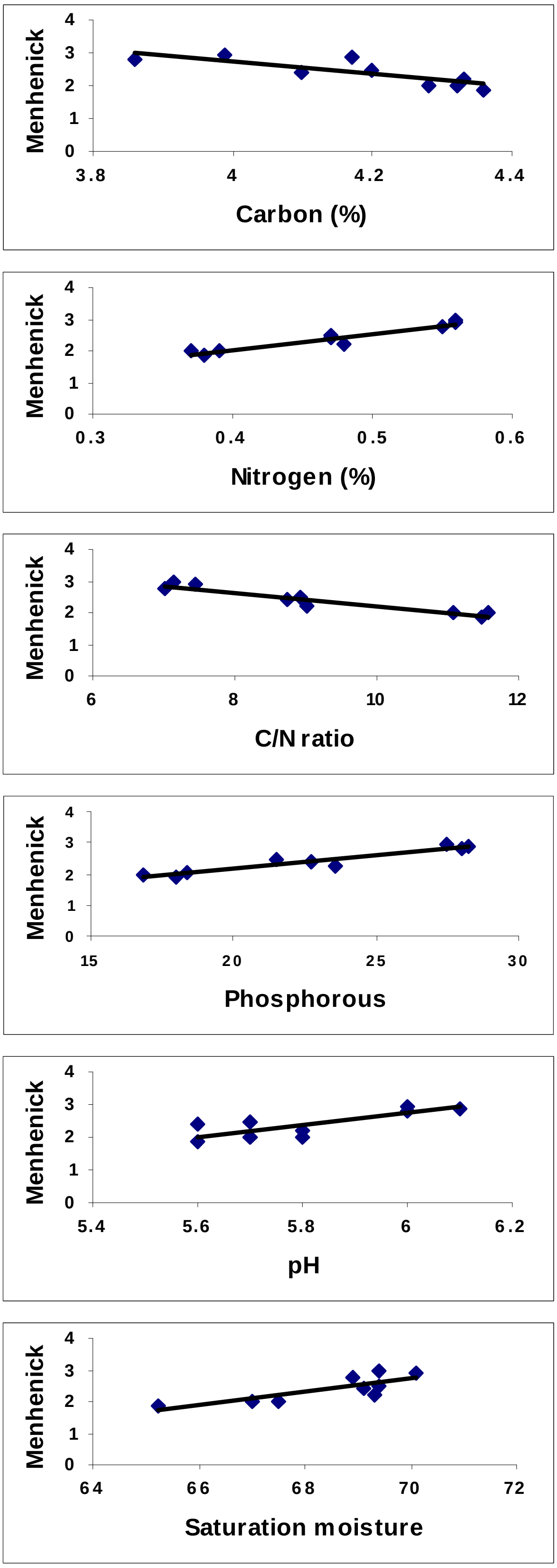

Figure 2. Correlation among Menhenick index and soil factors

Table 3. Correlation values of soil factors with biodiversity indices

Variable		Carbon (%)	Nitrogen (%)	C/N ratio	Phosphorous	pH	Saturation moisture
Shannon and Wiener	*R*	- 0.85 **	0.96 **	- 0.96 **	0.94 **	0.77 *	0.74 *
	P	0.004	0.00	0.00	0.00	0.016	0.023
Menhenick	*R*	- 0.82 **	0.97 **	- 0.96 ** 0.00	0.95 **	0.80 *	0.81 **
	P	0.007	0.00		0.00	0.010	0.008

**: in 0.05 Significant; **: in 0.01 Significant*

DISCUSSION AND CONCLUSION

Recently, focusing on plant species biodiversity is important for forest resources management [1, 18, and 34]. Thus, in recent decades many studies focused to effect of site several factors on plant diversity [17, and 45]. Different of seral [30], natural disturbances [40] and site soil positions [38] are biggest factor in decrease or increase of plant species diversity. This research surveyed influence of total carbon, total nitrogen, available phosphorous, *C/N* ratio, saturation moisture, and *pH* on wood species diversity and richness. Soil characteristics such as moisture, nutrients and *pH* have been strongly correlated with vegetation [5, and 39]. Since, natural disturbances like forest gap produced widespread changes in site soil, therefore change in soil material and nutrient availability recruitment potency of wood species modified in forest gaps with several sizes [13]. In accordance with results total carbon decreased with increasing size of gaps and decrease of carbon have been strongly correlated with diversity and richness of wood species. Aggregation of bush in small gaps into large gaps cause increased carbon content special in soil first layers [56]. Exchanges between carbon and oxygen increased Co_2 in soil several layers that unsuitable on plant growth. Co_2 superfluity in forest soil slackened root intake and micro organisms' activity and in totality decreased forest soil productivity [44]. Also, presence of beech species with maximum carbon in bush intensified aggregation of carbon in small gaps and under canopy cover site [21]. So, in accordance with Rosenzweig (1995) increases of carbon coalesce with decreases of wood species diversity [43]. N limits forest production in a large number of forested ecosystems, including many temperate forests [10, and 42]. Thus, N availability and the N cycling in forests can be affected by forest management and vegetation expanse, as it may alter several factors [12, 26, and 50]. The higher values of total N found in the large gaps could be explained by the favourable microclimatic conditions that had a stimulating effect on microbial biomass [28], suggesting that the main reason for increase N concentration found in these sites was a rapid of N mineralization by soil microorganism [7]. But, importance subject is positive correlation between total nitrogen and wood species diversity. Betwixt soil parameter N availability have an important role in soil productivity [23]. After gap formation and prior to the establishment of a new generation of trees, N availability differs from that in a closed forest because of reduced uptake by plants and changes in substrate quality. In the canopy opening, microclimatic conditions are changed as compared to the closed forest [27]. More light reaches the forest floor, and often temperatures and soil moisture levels are increased [29, and 31]. Numerous studies have reported that microbial activity is stimulated by increased moisture levels and soil temperatures [25, 37, and 47]. These conditions may change as plant growth regenerates and the canopy closes again. The first step in understanding small-scale spatial variation in N availability in natural forest ecosystems is to study the soil decomposer food web, which may influence N mineralization along gradients in environmental conditions within short distances [8, and 9], e.g. as caused by gap formation. Sound quality of upon condition in large gap toward small gap caused increases of N availability augmented wood species diversity. Increasing of N availability is to some degree controlled by the C/N ratio of the soil [4]. Further, the C/N ratio together with soil pH controls the N dynamics in forested sites, affecting both N-mineralization and nitrification rates [4, 48, and 55]. Since the mechanisms described above will reduce the C/N ratio in the soil, the amounts of inorganic N may be increased. The C/N ratio, an index used to monitor the decomposition of litter and to predict weight loss [6], confirmed this finding. The fact that C/N ratio and concentration of humic carbon were greatest in small gaps indicates that humification prevailed, whereas mineralization prevailed in the medium, large gaps and forest sites. In total increased of C/N and decreased of pH in small gaps lessened wood species diversity that in accordance with Muscolo et al (2007) [1]. Phosphorus availability is essential for plant growth and may be a limiting factor in forest ecosystems [11]. Since plant utilize only inorganic P [35], organic P compounds must first be hydrolyzed by phosphatases which mostly originate by bacteria and fungi. Numerous studies showed that phosphatase activities are well correlated with soil moisture, evidencing that the drought tended to reduce their activities in soil [3]. A decrease in phosphatase activities may be critical because of the decrease in P supply which in turn might have a direct effect on plant extension. Thus, observed increased of available phosphorous increasing wood species diversity. The result is in accordance with those of studies done by Dodor and Tabatabai (2003) [16]. According to the results, the soil saturation moisture increased significantly by increasing the gaps size. Soil water values are higher in the large gaps than in the small gaps probably in relation to both an increase in precipitation and a decrease in transpiration in the large gaps [14, and 33]. Increasing of soil saturation moisture increased value of biodiversity indices in large gaps. Always the low soil moisture can limit seedling establishment in the forest understory. In addition, there are interactive effects regarding water resources affecting plant development and diversity on multiple directions that further complicate anticipation of results. Thus increasing of moisture increased species diversity and richness that is similar by Buckley et al (1998) [19].

In conclusion, within the range of gap diameters included in this study, results have shown that gaps of large size increase soil moisture. Despite this effect on microclimate, an impact of gap size on C, N and P cycles was significant in large gaps in terms of higher availability of these nutrients and greater amount of humic matter decomposition. However, on the basis of the results, we believe that the creation of gaps with suitable sizes (400-600 m^2) may be important from an ecosystem perspective representing the appropriate management procedures for an adequate conservation of ecological functions, capable to preserve soil properties and favour wood species diversity and natural regeneration of all wood species. Since this study was not replicated across a range of site types, we cannot generalize our conclusion. We hope that these results will be tested in a replicated study to determine whether they are general. We believe that such a study in different natural forest could be conducted using the set of measurements and the analytical tools we have presented.

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