Leaf Litter Production of a Tropical Forest of Bank Santa Marta Colombia

Natalia Fuentes, Lissette Y. Vizcaino and Tatiana S. Britto

University of La Guajira - Faculty of Engineering
Km 5 via Maicao, Riohacha - La Guajira, 728 27 29, Colombia

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Abstract

The contributions generated by litter production were studied during six months in three representative riparian forests, established in zones with different degree of alteration, along the river basin of the Gaira Santa Marta River. The monthly production of moisture-free dry weight per Litterfall on average was $7,985.56 \text{ g.m}^{-2}$ and was dominated by the foliar fraction (58.91 %), followed by the reproductive material (10.09 %), and in a lesser proportion the woody material (30.98 %). A temporal contribution pattern was observed with the peaks of higher production in the months of January and February (dry period), presenting a negative and significant correlation between precipitation and the patterns of matter production by leaf litter, mainly in the middle section and low represented by the vegetation studied.

Keywords: litter production, riparian forest, plant formations, precipitation, watershed

1. Introduction

Riparian zones are diverse, dynamic and complex natural ecosystems; with characteristics that differentiate them from the adjacent ecological systems by their physical, chemical, biological properties and the flows of matter and energy [1],[2]; constituting the most representative inter-phase zones between aquatic and terrestrial ecosystems. The entrance of matter and energy is considered one of the factors that exert a greater influence on the communities that develop in river ecosystems and riverside vegetation [3], [4]; in these ecosystems, organic matter constitutes one of the main ways of energy flow [5]. Although the organic material
can be generated within the aquatic ecosystem (native production) the derivative of the riparian forest (allochthonous production) is more important in some fluvial ecosystems, due to the interaction [5].

The importance of riparian vegetation as an agent that generates organic matter to fluvial ecosystems is strongly influenced by the order of the river, generating notable differences in the biological characteristics of aquatic communities and the availability of light [6], [7],[8]. The leaf litter generated by the riparian vegetation through physical or physiological processes exporting leaves, flowers, fruits, branches and other components to the interior of the water resource [9], [10]; has been shown to be the most important process that represents the highest transfer of nutrients from the aerial parts to the forest and river system [11], [12], where the amount and nature of litter has an important relationship in the formation and maintenance of these ecosystems, hence the quantification of their production by litter is an important approach for understanding [13].

In this sense, it can be said that the operation and sustainability of lotic ecosystems depends on their degree of forest-river interaction [14]; [15] which are based on the natural maintenance of the flows of matter and energy. However, forest exploitation alters the flows of matter and energy in forest systems, and sometimes, the effects can be irreversible, leading to significant changes in productivity, efficiency of their use, among other effects [12]. Despite this situation, there are few published studies aimed at ecological evaluations carried out in this area; currently only information is available regarding the structural elements of the riparian forest associated with this basin [16],[17], leaving aside the ecological services offered by the vegetation and that intervene in the adjacent lotto ecosystem. The present investigation is an approximation to the productivity of the vegetal species through the fall of the different fractions that compose the leaf litter and the efficiency of its contribution to the basin of the Gaira river, in its space-time dynamics.

2. Materials and methods

The study was conducted in the riparian forest of the Gaira river watershed, which is located on the northwestern slope of the Sierra Nevada de Santa Marta, in the department of Magdalena, Colombia; between 11° 52’06” - 11°10’08” N; and 74°46’22” -74° 11’07” W [18]. The litter production was evaluated as the moisture free dry weight biomass, accumulated monthly; for which 3 permanent 200 m study sections were established in the riverine forest of the Gaira river basin (sections 1, 2 and 3), which summarize the heterogeneity of the vegetation and the geomorphology of the slopes. In each section, litter was systematically collected in six fall traps (sampling units), according to the procedure proposed by Proctor. [19], number of replicas considered acceptable, according to Stocker et al. [20] allowing a standard error of the mean less than five percent [21]; In turn, a monthly sampling frequency was adopted [13], covering a total of six months of collection.
The contributions of foliar biomass by litter, were monitored with a total of 18 traps (six per section) with a collection area of 1 m$^2$ located at an approximate height of 120 cm above the surface of the soil [22],[25] in random points in the three study sections; the traps were made in fine mesh fabric that allowed recovering the smaller plant organs and the rain water outlet and a fixed ½-inch tube frame that managed to prevent movement by wind action [26].

The material collected in the traps was dried in an oven at 60 °C to determine its biomass in dry weight, according to the methodology used by Aussenac et al. [27], using an analytical balance Later, to know the contribution in biomass of the different components of the litter, the material was discriminated, in the following fractions: leaves, wood and branches with diameter <5 cm [2], reproductive structures and miscellaneous material. As miscellaneous it was considered any material that can not be identified as one of the aforesaid factions [26].

Data Analysis: The Kruskal-Wallis (KW) test was used to find differences between the variables: (1) Biomass contributions by fractions (BF floral biomass, BH leaf biomass, BL woody material biomass and BM non-identifiable material biomass) with plant formations located in the different sections (T1, T2 and T3) and (2) with the climatic events of sampling (rainy period samples M1, M2 and M3, dry period samples M4, M5 and M6). The statistical package used was the Statgraphics Centurion 15.1.

3. Results and discussion

There was a trend towards an increase in biomass contributions from litter from the riparian forest of the Gaira river basin, simultaneously with the events of minimum intensity of precipitation; although in a more evident form as regards the plant formations established in the very dry tropical forest and in the humid subtropical forest. The biomass quantities of the plant formations in the high, low and medium section corresponding to the 6 months of sampling (181 days) were 417.69 g·m$^{-2}$, 561.00 g·m$^{-2}$ and 501.09 g·m$^{-2}$ respectively, with average values of daily contributions of 2.30 g·m$^{-2}$·d$^{-1}$, 3.13 gm$^{-2}$·d$^{-1}$ and 3.34 gm$^{-2}$·d$^{-1}$ respectively, which do not present differences between they; showing significant differences between the dry and rainy periods (K-W = 17,064, p = 0.043, n = 98); the behavior of the contributions of biomass in tropical riparian forests in media saturated with humidity, litter falls in relation to precipitation; which is in line with the assertions of Lastres and Aymerich [27] who affirm that in climates with a marked periodicity of rains there is a negative relation of this with the fall of litter.
The biomass contributions of the different leaf litter fractions present a significant variation (K-W = 221.6, p <0.001, n = 396), where the leaf fractions and woody material present higher contributions than those reported by the reproductive and miscellaneous material. There was a tendency to increase biomass contributions from litter from the riparian forest of the Gaira river basin with a variability (KW = 17.06, p <0.001, n = 98) in the different stretches, simultaneous to the events of minimum intensity of precipitation; this indicates that the biomass contributions show a synchronous pattern in their rate of increase where the peaks of maximum values that are presented in this (samples M5 and M6) correspond to the events of minimum intensity of precipitation, this behavior may be reflecting the necessity of a certain magnitude in periods of drought to get rid of the vegetal species and to accumulate in the riparian soil to later enter in great amounts to the riverbed.

Leaf litter production in the riverine forests of the Gaira river basin is somewhat higher than the universal estimate (5.6 ton·ha\(^{-1}\)·year\(^{-1}\)) reported for plant formations established in zones tropical [28] and they approximate the values provided by Haase [29] for subtropical forests subject to seasonal flooding (6 ton·ha\(^{-1}\)·year\(^{-1}\)). The highest average leaf litter production values were found in the tropical thorny forest established in the lower area of the basin (12.55 ton·ha\(^{-1}\)·year\(^{-1}\)), where the greatest anthropic alterations are present. Despite the high litter production of the low stretch, this record is similar to or lower than at least six previous reports cited by Jordan [30] y Golley [31] for tropical forests in Zaire, Thailand and Malaysia whose annual litter averages fluctuate between 14.9 and 25.3 ton·ha\(^{-1}\)·year\(^{-1}\).
Figure No. 2. Contributions of the different litter fractions in the different plant formations (A) biomass of flowers and fruits BF, (B) biomass of leaves BH, (C) biomass woody material BL and (D) biomass miscellaneous BM) (T1 very humid forest high stretch, T2 humid forest medium stretch and T3 thorny mountain low stretch).

The values recorded in the subtropical humid forest established in the middle zone of the basin were lower than the production values (7 and 15 ton·ha\textsuperscript{-1}·year\textsuperscript{-1}) reported by Jordan [30] for the same type of plant formation, the lowest values correspond to highland forests which in turn agree with those found here in the riparian vegetation of the Gaira river basin. All the forests studied here surpass the values for subtropical mesothermal forests of northern Argentina (0.3 ton·ha\textsuperscript{-1}·year\textsuperscript{-1}, according to [32], strengthening the hypothesis that postulates higher productivity for forests subject to humidity [33], [34], [29]. Not being so limited by water during the dry season.

Temporal Relations: In two of the plant formations studied here (very humid subtropical forest and humid subtropical forest) there was a clear negative relationship between the amount of rain and the fall of litter during the six months of sampling; relations similar to those of Brow & Lugol [35] who put in evidence the relationship between leaf litter production and climatic conditions (ratio between annual average temperature and annual average rainfall) and those of Bray & Gorhan [36] who found that leaf litter was significantly related to annual mean precipitation.
Figure No. 3. Contributions of the different leaf litter fractions in the different samplings (A) biomass of flowers and fruits BF, (B) leaf biomass BH, (C) woody material biomass BL and (D) biomass miscellaneous BM. (M1 sampling 1, M2 sampling 2, M3 sampling 3, M4 sampling 4, M5 sampling 5, M6 sampling 6).

Litter was composed mainly by the foliar fraction (49.36 % BH), followed by the woody material (25.89 % BL) and in a smaller proportion the reproductive material (7.71 % BF) and unidentifiable material (17.04 % BM). Similar trends in leaf litter composition have been reported in other tropical forests made by Proctor et al. [20], [37], [38], [39], [40], [41], among others, who report that the leaves are the component that contributes the most to leaf litter.

Conclusions

The highest biomass returns occurred in the tropical thorny mountain established in the lower part of the basin (8769.69 g·m⁻²), followed by the subtropical humid forest with 6960.51 g·m⁻² and the very humid subtropical forest established in the middle part (8226.50 g·m⁻²) of the basin. Although the lack of information about the behavior of litter on the banks of lotic systems similar to those studied here does not allow for generalizations, it seems reasonable to conclude that in moisture-saturated media leaf litter falls unrelated to moisture.
References


https://doi.org/10.1017/s0266467400008634


https://doi.org/10.2307/2260267


https://doi.org/10.1139/f86-202


https://doi.org/10.2307/2259976


[23] C. Donoso, Producción de semillas y hojarasca de las especies del tipo forestal alerce (Fitzroya cupressoides) de la Cordillera de la Costa de Valdivia, Chile, *Revista Chilena de Historia Natural*, 66 (1993), 53-64.


Received: August 31, 2018; Published: October 4, 2018