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Degradation of red mangrove (*Rhizophora mangle* L.) leaves in the Bay of Panama

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Resumen: Un experimento de descomposición de las hojas de mangle rojo (*Rhizophora mangle* L.) demostró la pérdida del 50%del peso seco después de 27 días de inmersión en la Bahía de Panamá. La concentración de nitrógeno en las hojas en descomposición se incrementó del 0.3% al 2.9% (peso seco) en un período de 93 días, mientras que el fósforo aumentó del 0.04% al 0.13%(peso seco) en este mismo lapso. Las hojas en descomposición fueron colonizadas por una epibiosis, que en las primeras semanas estuvo formada por una película de aparente naturaleza microbiológica, seguida con posterioridad por invertebrados marinos. La comparación de estos resultados con los que presenta la literatura científica para el sub-trópico, sugieren que el proceso de degradación en el Pacífico de Panamá es más rápido.

Early works have described trophic relationships between mangrove swamps and nearby coastal communities (Odum and Heald 1972 and 1975) outlining the importance of mangrove detritus in the coastal food web. The food value of the litterfall production from mangrove depends on its changes during degradation.

Abundant mangrove forests in Central America and the warm temperatures of seawater suggest an important detritus production. However, most of the published data concerning the degradation of mangrove leaves have been generated at latitudes near the edge of distribution of mangrove (Heald 1971, Cundell *et al.* 1979, Newell *et al.* 1984). The gradient in latitude between the sites of these studies (mostly performed in Florida) and Central America might represent differences between the process of degradation of the mangrove leaves in both areas. This experiment was designed to describe the degradation in seawater of red mangrove leaves in the Bay of Panamá and compare results with findings from similar experiments reported in the literature and performed at other latitudes. Coastal degradation of mangrove litterfall is considered important in the Pacific coast of Panamá since tides are semi-diurnal and 5 meters in range, thus a large amount of the mangrove litterfall is rapidly washed out into the open subtidal zone where it degrades.

The decomposition of red mangrove (*Rhizophora mangle* L.) leaves was studied using mesh bags. Sixty grams (fresh weight) of senescent leaves of red mangrove were placed in 2.0 mm mesh nylon cloth bags 15 cm x 15 cm. An experimentally determined dry weight/fresh weight factor of 0.48 for red mangrove leaves was used to estimate the dry weight of leaves from the fresh weight data. Fifty decomposition bags were submerged in the Bay of Panama at 3 m depth from the pier of the Smithsonian Tropical Research Institute from May 27, 1983 to August 22, 1983. During this period the seawater temperature ranged from 28.0 to 29.5° C, whereas salinity ranged from 29.5 to 32.5 o/oo. Four bags were retrieved periodically (between 5 to 10 days). The extent of biological colonization on the remain of the leaf material was recorded, and dry weight of leaf re-

mains was determined by drying at 90° C to constant weight. Percentage of nitrogen in remains of mangrove leaves (dry weight basis) was estimated from the macro-Kjeldahl analysis, the phosphorus concentration was determined by digestion with a perchloric-sulfuric-nitric acid mixture and subsequent colorimetric analysis by the molybdate blue method as specified by the American Public Health Association (1981).

The red mangrove decomposition experiment showed a 50% dry weight loss after 27 days of immersion in the Bay of Panama. This degradation rate is high when compared with results from similar experiments (Table 1). The equations of linear regression between the remaining dry weight of leaves (g) vs. time of degradation (in days) in Florida (Heald 1971) and in this work are as follows:

$$Y = 68.82 - 0.19 \times \text{(Florida)}$$

$$Y = 69.54 - 0.64 \times \text{(Panamá)}$$

Table 1

Loss of 50 % of dry weight in leaves of red mangrove degrading in coastal water.

Author	Species	Days	Site	Lat.
Boonruang 1978	*R. apiculata*	40	Thailand	7 N
Heald 1971	*R. mangle*	45	Florida	27 N
Fell 1974	*R. mangle*	60	Florida	27 N
This work	*R. mangle*	27	Panamá	8 N

The slopes of both equations were different ($t = 3.35$, $n = 60$, $p < 0.001$). The rapid degradation of leaves is expected to be associated with the high temperature of seawater, as suggested by Heald (1971), and to the intense biological activity observed on the debris by a diverse epibiota (Figure 1). A film of bacterial and fungi origin developed by the end of the first week of immersion of the leaf bags. This microbial colonization over the degrading leaves of mangrove only occurred when leaf tannins had been leached out (Cundell *et al.* 1979). After the first week, small marine invertebrates were observed on the degrading leaf material. The most common of these were polychaetes, bivalves, gastropods, grapsid crabs and alpheid shrimps. Parallel to the biological activity observed in the leaf bags, chemical changes were noted on the remains. The concentration of nitrogen and phosphorus (referred to dry weight) was recorded to increase with time as leaves

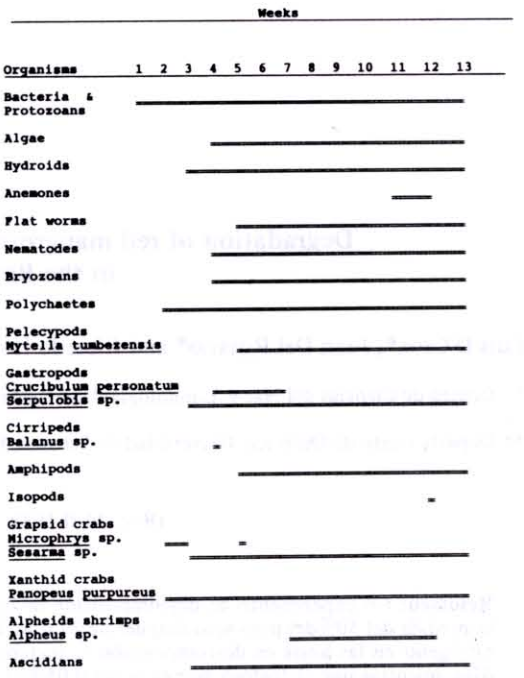

Figure 1. Biological colonization of degrading red mangrove leaves in the Bay of Panamá.

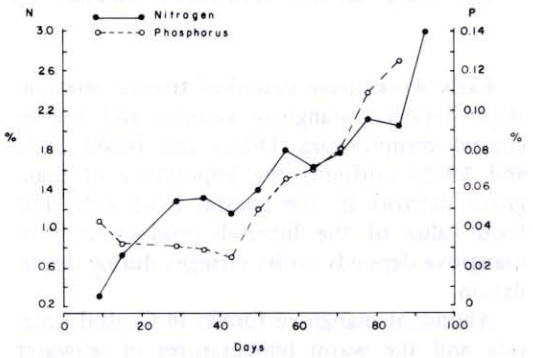

Figure 2. Percentages of nitrogen (continuous) and phosphorus (discontinuous) in the remains of red mangrove leaves subjected to degradation in the Bay of Panamá.

were degraded (Figure 2). The concentration of nitrogen in the mangrove leaves at the beginning of the experiment was 0.3% , but after 93 days of immersion it increased to 2.9 % . Similarly, the initial concentration of phosphorus was near 0.04% and by the end of the experiment it rose to 0.13% . These changes might be related to the formation of microbial proteins (Cundell *et al.* 1979). The increase of nitrogen on the remains is higher than data reported in Florida (Table 2).

Table 2

Increase of nitrogen in the remains of red mangrove leaves under degradation

Author	Species	Nitrogen (days) *	Site	Lat.
Cundell et al. 1979	*R. mangle*	0.89% (50)	Florida	27 N.
Heald 1971	*R. mangle*	3.45% (360)	Florida	27 N.
Newell et al. 1984.	*R. mangle*	0.90%(360)	Florida	27 N.
This work	*R. mangle*	2.80%(93)	Panamá	8 N.

* Days of degradation in coastal water.

In conclusion, this experiment suggests that red mangrove leaves in the Bay of Panama degraded and chemically changed at a faster rate than in the subtropics.

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