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THE DEGRADATION RATES OF MANGROVE LEAVES OF *RHIZOPHORA APICULATA* (BL.)
AND *AVICENNIA MARINA* (FORSK.) VIERH. AT PHUKET ISLAND,
THAILAND

by

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ABSTRACT

The degradation rates of mangrove leaves of *Rhizophora apiculata* (Bl.) and *Avicennia marina* (Forsk.) Vierh. were studied from January to March 1977. The measurement of degradation rates of leaves was made by calculating the differences between the wet and dry weights. The experiment showed that *R. apiculata* leaves lost half of their weight in 40 days and those of *A. marina* in 20 days in the mangrove forest at Ao Yon, Phuket Island. The rate of degradation of *R. apiculata* leaves within the forest was relatively quicker than that of those placed in a non-mangrove environment.

There was no obvious difference in the weight loss of leaves of *R. apiculata* and *A. marina* placed in nets of differing mesh sizes in the mangrove channel and in the open seashore waters localities.

I. INTRODUCTION

The primary food source for aquatic and intertidal mangrove-dwelling organisms comes from vascular plant detritus, mostly from mangrove leaves (Odum, 1970). The breakdown of mangrove leaves is brought about by the activities of microorganisms such as fungi, bacteria, and protozoa (Odum, 1970, Feel, 1974, Mathias, 1974, Odum & Heald, 1974). Much work has been carried out on the mangrove ecosystem as a whole (Odum and Heald, 1972, 1975, Lugo, 1974, Kuenzler, 1968), but very few detailed studies have been done on the rates of mangrove leaf decomposition apart from those of Heald (1971) and Mathias (1974).

Recently, many studies have been made on various aspects of the mangrove environment of Phuket Island, western peninsular Thailand, where the present study was carried out. These include particulate matter in plankton sample by Hendrick (1976); the macrofauna by Frith, Tananasiriwong and Bhatia (1976) and the *Littorina* and *Murex* spp. dwelling in mangroves by Nielson (1976); the phenology of leaves, buds, flowers and propagules of *Rhizophora apiculata* (Bl.) were described by Christensen & Wium-Andersen (1977) and the redox property of the mangrove soil by Limpsaichol (1978). Mangrove forests occur along the east and southeast coasts of Phuket Island, in areas sheltered from the southwest monsoon

which occurs annually from May until November. On Phuket Island the tidal range is over three metres at spring tide and about one metre at neap tide. The leaves of the trees *Rhizophora apiculata* and *Avicennia marina* were collected from a mangrove forest at Ao Yon, on the southeast coast of Phuket Island (see Fig. 1). Experiments were carried out continuously during a period of two months. Comparisons were made between the rates of the decomposition of mangrove leaves of *R. apiculata* and *A. marina* left for varying periods of time at the Ao Yon mangrove forest. Furthermore, the leaves of *R. apiculata* were placed in a sub-littoral area near a shore lacking mangroves (see below) to determine whether the breakdown rates of the leaves in this situation differed from those in the mangrove forest. The aim of the present study was to provide data on degradation rates of mangrove leaves of *Rhizophora apiculata* and *Avicennia marina*. As no data on breakdown rates of leaves are available for Thailand, it is hoped that those given here will provide a basis for a more intensive future analysis of the detrital food webs of the mangrove forest of Thailand.

II. STUDY AREA

The study was carried out at two localities (see Fig. 1) as follows:—

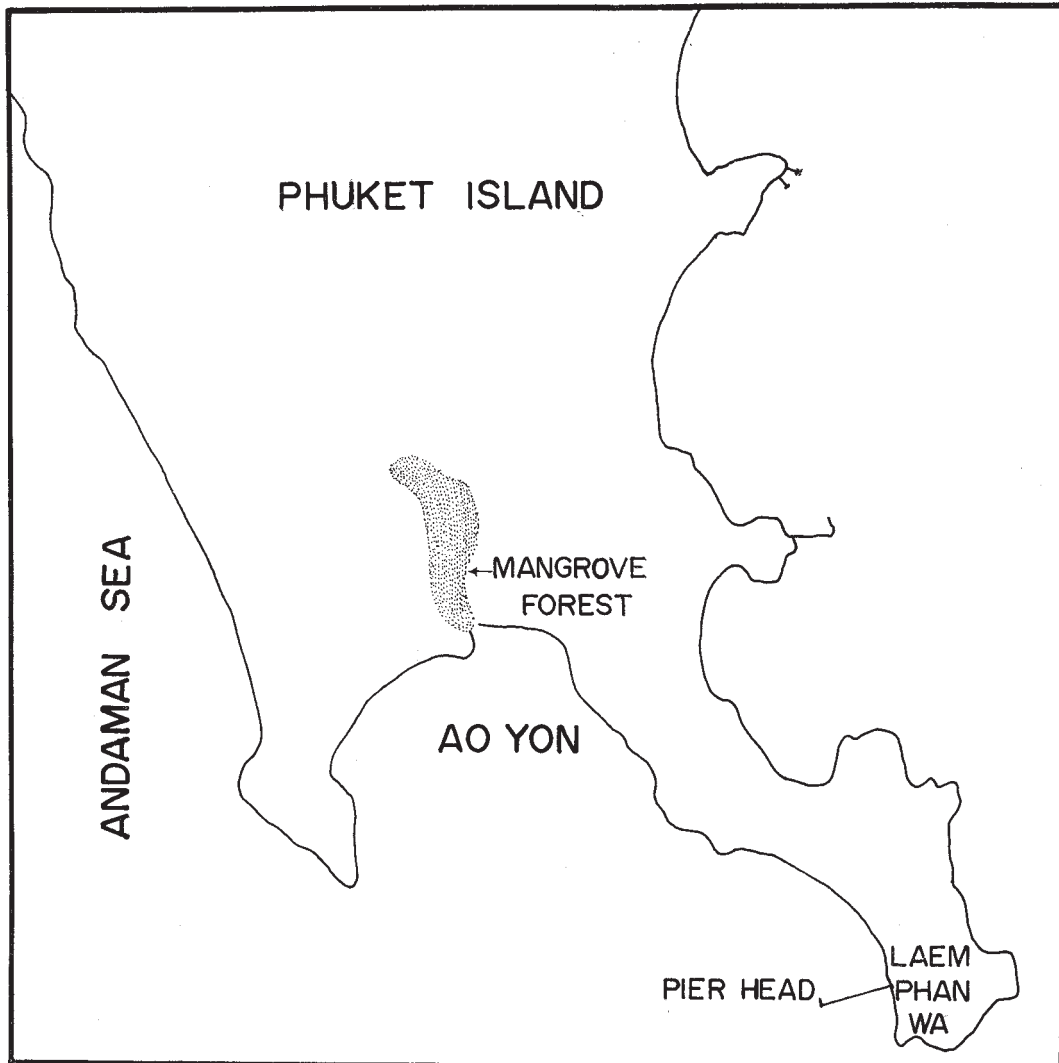


Fig. 1—Showing the study area at 2 localities : Mangrove forest and Laem Phan Wa.

a) MANGROVE FOREST

A small mangrove forest behind a raised beach-crest on the southeast coast of Phuket Island ($98^{\circ}23'40''\text{E}$, $7^{\circ}48'40''\text{N}$), at the base of hills, with a shallow tidal channel, lacking banks, running landward to seaward, throughout the forest. During rains this channel drained fresh water from the nearby hills into the sea. The study was not, how-

ever, carried out during the rainy period and consequently the channel water was sea water.

The upper shore landward forest area comprised of young *Rhizophora apiculata* (Bl.), *Avicennia marina* (Forsk.) Vierh. and *Nipa fruticans* Wurm. in muddy-sand to sandy-mud substrates; the mid-shore area comprised of natural forest, mostly *R. apiculata*, with a seaward flat of soft to firm

mud along the channel edges and with sandy-mud to muddy-sand on higher ground; in the lower shore area the channel flowed between the sandy beach crest into the sea.

b) LAEM PHAN WA

The pier head of the Phuket Marine Biological Center at Laem Phan Wa on the southeast coast of Phuket Island, a relatively exposed area in sublittoral water of about 15 m. depth adjacent to littoral area of fringing coral reef with landward sandy beach crest.

III. MATERIALS AND METHODS

Leaves were collected from *Rhizophora apiculata* and *Avicennia marina* mangrove trees from the Ao Yon mangrove forest. The leaves were senescent, yellow in colour, and just ready to fall. On return to the laboratory, the leaves were washed to remove all dirt and any associated animals, and then left to dry at room temperature for half a day to allow the surface water to evaporate. The leaves were divided into samples, each sample consisting of either 50 g. of *R. apiculata* or 20 g. of *A. marina* (about 15–20 leaves per sample). Each sample was placed in a separate nylon mesh bag (about 22–28 cm. along each edge) and then sealed with staples. Different mesh sizes of 1.5 mm., 2.5 mm. and 20 mm. were used for the experiments. Ten bags of 1.5 mm. and ten bags of 2.5 mm. mesh size of the *Rhizophora* samples were fastened to prop roots of *R. apiculata* in the mid shore region of the Ao Yon study area. The bags were attached so that they lay in the channel current flowing through the mangrove forest and were therefore continually covered with flowing water. The same number of bags of the same mesh sizes were tied to a buoy floating near the pier-head at the Laem Phan Wa study site, and thus were suspended in the surface water.

Ten bags of 2.5 mm. and ten bags of 20 mm. mesh size of the *Avicennia* samples were attached

to the prop roots of *R. apiculata* in the same situation as the *Rhizophora* samples.

One to four bags were collected about once a week and brought back to the laboratory for further analysis. The leaves were firstly observed under a stereo-microscope to remove any associated animals, such as amphipods and isopods. All organic debris and silt were then removed by rinsing the leaves with running tap-water. Each sample was then dried in the oven at 105°C for a minimum of 24 hrs. and then reweighed to determine its dry weight.

As a control, the wet and dry weights of eleven samples of *R. apiculata* and eleven samples of *A. marina* which had not been placed in the field were calculated. The relationship between the wet and dry weights of these samples provided an average conversion factor for subsequent comparison with the dry weights of the field results. The conversion factor of *Rhizophora* and *Avicennia* is given in Tables 1 and 2 respectively.

Table 1. Conversion of fresh weight to dry weight in red mangrove leaves (*Rhizophora apiculata*).

Fresh weight in grams	Dry weight in grams after drying at 104°C	Conversion Factor
1. 50.7350	15.4745	0.305
2. 51.6520	16.7490	0.324
3. 53.0430	15.1900	0.286
4. 51.4796	15.7850	0.307
5. 52.5260	15.6985	0.299
6. 50.6190	13.6008	0.269
7. 52.2870	14.7960	0.283
8. 51.9590	15.0140	0.289
9. 50.8230	15.1775	0.299
10. 52.3070	13.9756	0.267
11. 52.6450	15.8590	0.301

Mean conversion factor = 0.294

Table 2. Conversion of fresh weight to dry weight in black mangrove leaves (*Avicennia marina*).

	Fresh weight in grams	Dry weight in grams after drying at 104°C	Conversion Factor
1.	21.4256	12.1900	0.569
2.	21.4345	12.5805	0.587
3.	20.9110	12.3154	0.589
4.	20.7490	12.2875	0.592
5.	21.0487	13.1645	0.625
6.	20.8056	13.7030	0.659
7.	21.0515	11.8850	0.565
8.	21.2605	13.4828	0.634
9.	20.7325	12.8746	0.621
10.	20.8695	12.4475	0.596

Mean conversion factor = 0.604

IV. RESULTS

There was no obvious difference between the weight loss of samples in the 1.5 mm. and 2.5 mm. mesh sizes of *Rhizophora* at either the mangrove or pier localities, or between the 1.5 mm. and 20 mm. mesh size of *Avicennia* at the former locality. Thus, data for the different mesh size are presented collectively in Fig. 2. The *Rhizophora* leaves lost about half their weight in 40 days and the *Avicennia* leaves in 20 days within the mangrove forest at Ao Yon (see Fig. 2). Thus, the decomposition rate of *Avicennia* leaves is apparently twice as fast as that of *Rhizophora*. Moreover, rate of decomposition of *R. apiculata* leaves within the forest was relatively quicker than that at the pierhead (see discussion).

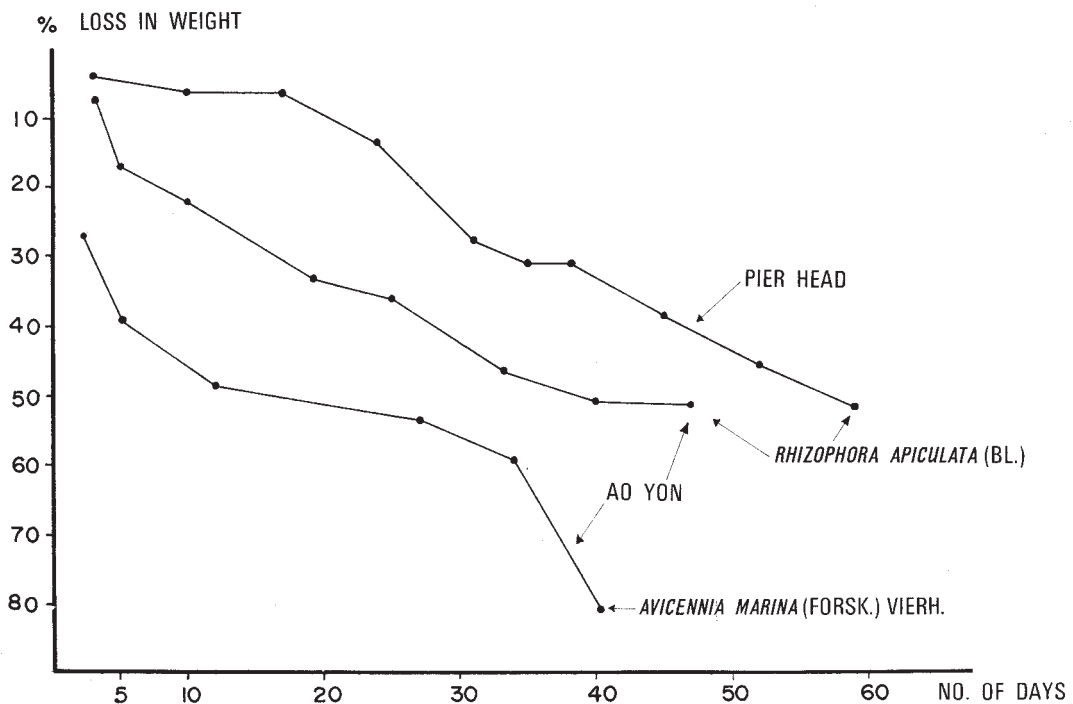


Fig. 2—Percentages of weight loss of mangrove leaves.

V. DISCUSSION

It was found that the *Rhizophora* leaves within the mangrove forest situation decomposed much faster than those in the open sub-littoral area. This notable difference between the degradation time was undoubtedly due to the larger number of micro-organisms such as fungi and bacteria, and grazing animals (meio and macrofauna) found in the former habitat (Head, 1971, Odum and Heald, 1975). During the present study a large number of grazing macrofauna animals such as amphipods, shrimps, crab and snails (*Nerita* sp.) were found associated with the decomposing leaves. Amphipods of the species *Grandidierella bispinosa* (Schell), *Quadrivisio bengalensis* (Stebb.), *Corophium triaenonyx* (Stebb.) and *Melita* sp. (nr. *seticornis* Bousf.) were, however, the most abundant and thus must play an important role in the breakdown of leaves. It is noteworthy in this respect that Heald (1971) found that "degradation rate is in part a reflection of its influence on the abundance and species composition of amphipod population", and thus, the results of this study provide further evidence to support Heald's findings. It should be noted that within the mangrove forest the microbial activities on the *Rhizophora* and *Avicennia* leaves were apparent by a slimy appearance on the leaves, but it was not within the scope of the present study to investigate the extent of these microbial activities.

The *Rhizophora* leaves lost about half their weight in 40 days within the mangrove channel sea water. It is noteworthy that Heald (1971) recorded a similar period of time of 45 days for leaves of *Rhizophora mangle* to decompose when placed in a sea water channel in an estuarine mangrove in Florida, whereas Fell (1974) recorded a much longer period of 2 months for the leaves of *R. mangle* to lose half their weight in sea water.

The *Avicennia* leaves decomposed almost twice as quickly as those of *Rhizophora*. This was probably due, however, to the differences in the relative thickness of their leaves, those of the former species being much thinner. These results

were of interest in as much as Heald (1971) in Florida found little difference between the decomposition rates of these two mangrove species. It is noteworthy that the time taken for the leaves of *Avicennia* to lose half their weight (20 days) was similar to that found for the species by Mathias (1974) in a Malaysian mangrove swamp.

Physical factors such as the daily tides runoff and rainfall, as well as biological processes, affect the decomposition rates of mangrove leaves (Lugo, 1974). Moreover, the decomposition of mangrove leaves takes place only to a minor degree within the mangrove area proper, as the majority of the leaves are washed out into the open sea (Perkins, 1974). It was not within the scope of the present investigation to determine the influence of the physical factors on leaf breakdown, or the wash out of litter from the mangrove. It is hoped that the data presented here will, however, provide a basis for a more intensive investigation of these parameters.

VI. CONCLUSIONS

The results showed that the degradation rate of *Rhizophora* in the mangrove forest was quicker than that in a sub-littoral situation. This notable difference between the degradation time was undoubtedly due to the larger number of micro-organisms such as fungi and bacteria and grazing animals (meio-and macro-fauna) found in the former habitat (Heald, 1971, Odum and Heald, 1975).

The leaves of *Avicennia* lost their weight twice as fast as those of *Rhizophora*. This notable difference was apparently due to the *Rhizophora* leaves being thicker than those of *Avicennia*.

Obvious differences in the degradation rates of *Rhizophora* leaves in both mangrove and pier habitats or of *Avicennia* leaves in mangrove habitat were not found between them in differing mesh sizes of the nylon bags.

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