Survival Ratio of Mangrove Juveniles in Nagura Estuary, Ishigaki Island, Okinawa*

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Abstract

Survivals of 304 juveniles of two mangrove species were studied for one year on Ishigaki Island. Fifteen percent of *Bruguiera gymnorrhiza* juveniles survived in a closed forest of this species, and 27% in the open. *Rhizophora mucronata* juveniles were found only in the open, and only one died during the year. An initial succession which advances from a *Rh. mucronata* forest to a *B. gymnorrhiza* forest was proposed in relation to the survival pattern of these juveniles.

Introduction

The survival ratios of juveniles of two mangrove species, *Bruguiera gymnorrhiza* (L.) Lamk. and *Rhizophora mucronata* Lamk.[1], were studied for one year on Nagura estuary, Ishigaki Island. These mangrove species produce large viviparous seeds to establish themselves in the saline habitat. However, there have been few studies on their process of establishment. URASAKI et al. (1982) performed an experiment on the dispersal and settlement of viviparous *Kandelia candel* seeds which they released in a river at ebb tide. RABINOWITZ (1978) studied the initial mortality of mangrove seedlings in Panama, and concluded it was inversely correlated with the initial propagule weight. YAMASHIRO (unpublished) obserbed a *Kandelia candel* scrub on Tanegashima Island, Kagoshima Prefecture for more than eight years, and found that the survival ratios of the seedlings varied depending on whether or not they were in areas enclosed by their parent plants.

The present authors described on the biomass of mangrove forest in Nagura estuary (SUZUKI and TAGAWA, 1983), and this paper is the second report of the same forest.

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1) ITO et al. (1983) described that the specimens of *Rhizophora* in Okinawa prefecture have intermediate character of *Rh. mucronata* and *Rh. stylosa*.

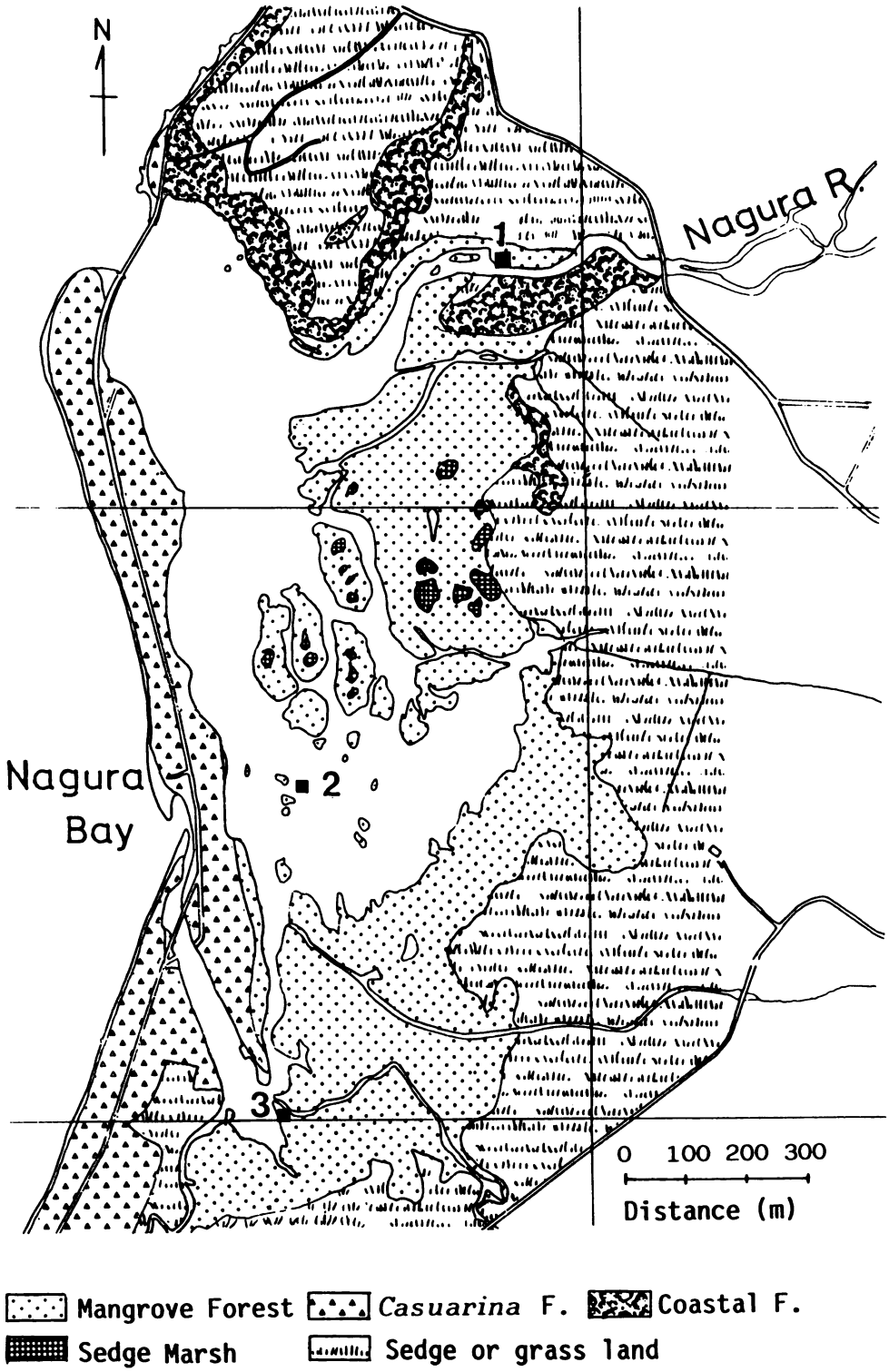

Fig. 1. Vegetation map of Nagura estuary, Ishigaki Island, and location of three plots.

Study Site and Methods

Three plots were made on July 1980 in Nagura estuary (24°23′N, 124°08′E) on Ishigaki Island, Okinawa Prefecture (Fig. 1). Plot 1 was 10 m wide along the Nagura river and 15 m long toward the bank, and *B. gymnorrhiza* was the dominant speceis in Plot 1. A lot of its juveniles were found on the forest floor. In Plot 3 (10 m × 10 m), *Rh. mucronata* and *B. gymnorrhiza* dominated. The diameter at breast-height (DBH) of plants higher than 1.3 m and height of all plants in the two plots were recorded.

The plants clearly separated into two groups of height, those lower than 2 m and higher than 2 m, as seen in Fig. 2. We, therefore, recognize the former as juvenile, and the latter as tree. Three small plots for tracing juvenile populations were made in plot 1 (plot 1-1) and in the open right outside the forest (Plot 1-2). Plot 2 was made in the open in the estuary, where *Rh. mucronata* juveniles had formed a sparse colony. To obtain data on about 100 juveniles in each plot, the size of the plot was changed according to the density of those juveniles. The diameter of the juveniles at ground level and their height were measured in each plot, and they were numbered with a plastic label tied on the stem with thread on July 16, 1980. On July 16, 1981, the diameter and height of surviving juveniles and new seedlings were again measured by the same method.

Two plastic stakes were pounded into the ground near Plot 1-1 and Plot 2, and the above ground lengthes were measured on July 17, 1980 and again on July 16, 1981 to ascertain the accumulation rate of soils carried by tide and river waters.

Results and Discussion

The frequency distribution of plant height in Plots 1 and 3 are shown in Fig. 2. In Plot 3, the larger trees were *Rh. mucronata*, while the smaller trees were *B. gymnorrhiza*. As the species composition varied from the land side toward the river side of Plot 1, it was divided into two subplots of 100 m^2 on the side toward the river (Plot 1-R) and 50 m^2 on the bank side (Plot 1-B). *B. gymnorrhiza* dominated in Plot 1-R, and *Excoecaria agallocha* L. dominated in Plot 1-B. The aboveground biomass of Plot 1-R was estimated to be 102 ton/ha by the equation proposed by SUZUKI and TAGAWA (1983). The basal area (summed area of stem cross sections at breast-height) of live and dead trees in Plots 1 and 3 are shown in Table 1. There were a lot of dead *Rh. mucronata* trees in Plot 1-R. Young and pure stands of *Rh. mucronata* were often found in the open estuary such as in Plot 2, but young and pure stands of *B. gymnorrhiza* were not found in Nagura estuary. In other words, it is thought that the open estuary will first be occupied by *Rh. mucronata* juveniles and that *B. gymnorrhiza* will gradually replace them and dominate, if sands and detritus accumulate there continuously.

The survival ratio and average height of mangrove juveniles are shown in Table

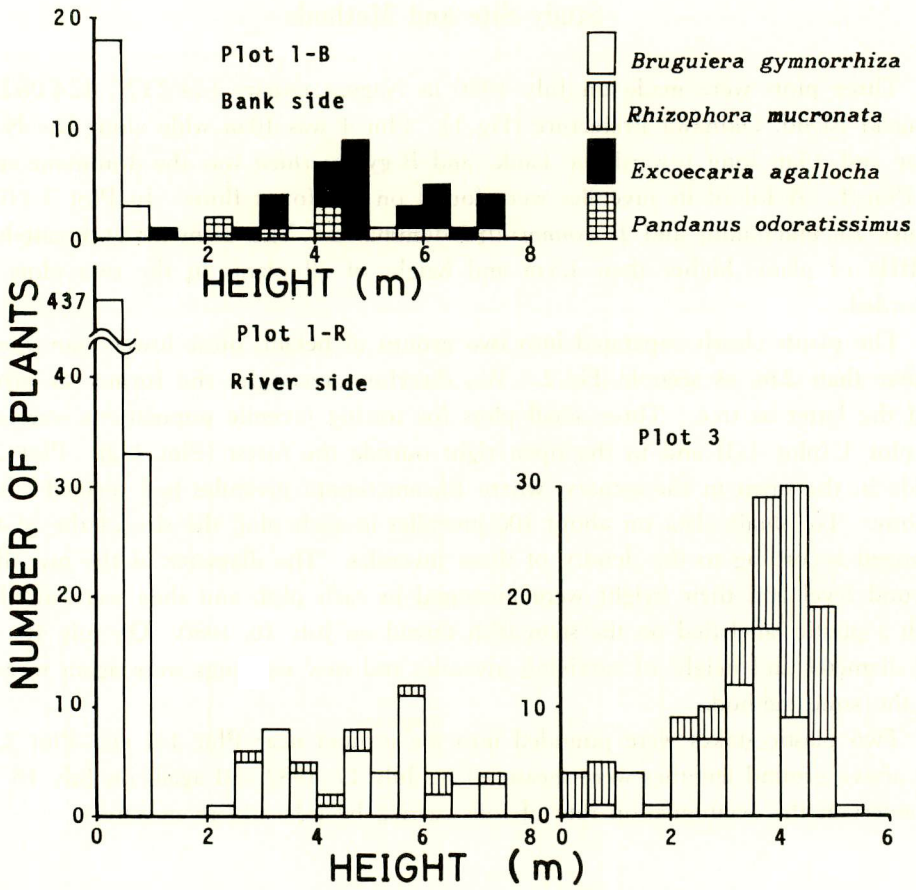

Fig. 2. Frequency distributions of tree heights in Plots 1 and 3. Since the species composition varied between on the side toward the river and on the bank side, Plot 1 was divided into two subplots of 100 m^2 on the side toward the river and 50 m^2 on the bank side.

Table 1. Basal area (m^2/ha) of mangrove forests.

Species	Plot 1				Plot 3	
	River side		Bank side			
	Live	Dead	Live	Dead	Live	Dead
Bruguiera gymnorrhiza	24.53	0.13	7.33		10.60	0.73
Rhizophora mucronata	5.19	9.19			20.37	1.22
Derris trifoliata	0.04		0.08			
Excoecaria agallocha			49.95	0.71		
Pandanus odoratissimus			9.72			
Clorodendron inerme			0.14			
Total	29.76	9.32	67.22	0.71	30.97	1.96

Table 2. The number and height of mangrove juveniles in July of 1980 and July of 1981.

Plot	Species	No. of juveniles		Survival ratio(%)	No. of new seedlings*	Mean height (cm)		size of Plot (m^2)	Rate of soil accumulation (cm/yr)
		1980	1981			1980	1981		
1-1	*B. gymnorrhiza*	100	15	15	0	42 (48)**	47	8	2.9
1-2	*B. gymnorrhiza*	83	22	27	0	56 (49)	62	30	No record
1-2	*Rh. mucronata*	17	16	94	0	116(115)	139		
2	*Rh. mucronata*	104	104	100	1	74 (74)	80	338	-0.1

* The number of seedlings germinated during two observations.

** The figure in parenthese is the mean height of juveniles surviving until 1981.

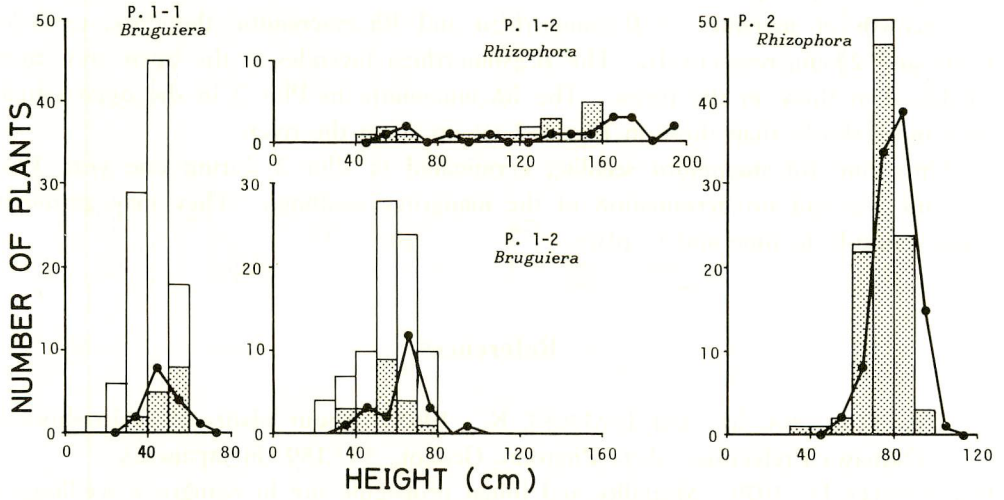

Fig. 3. Frequency distributions of height of juvenile mangroves in 1980 (columns) and in 1981 (lines with circles). The shaded columns indicate the number of surviving juveniles from July 1980 to July 1981.

2. The density of the *B. gymnorrhiza* of Plot 1-1 in the closed forest was 12.5/m^2 in 1980, and decreased to 1.9/m^2 in 1981. Fifteen percent of the juveniles survived for one year on the dark forest floor. The survival ratio of *B. gymnorrhiza* in the open near the forest was higher than that on the forest floor. The survival ratio of *Rh. mucronata* in the open was much higher than that of *B. gymnorrhiza*. Only one juvenile of *Rh. mucronata* was lost in the two plots. *Rh. mucronata* seemed to establish themselves in the open estuary easier and earlier than *B. gymnorrhiza*.

The exact age of the juveniles could not be determined. The *B. gymnorrhiza* juveniles in Plots 1-1 and 1-2 were roughly estimated to be less than 2 years old in 1980, because we could easily distinguish the newly grown stem from hypocotyl. The *Rh. mucronata* juveniles in Plots 1-2 and 2 might be older than those of *B. gymnorrhiza*,

as the former were taller than the latter. The difference of age in two species, if any exists, may affect the survival ratios.

The height distributions of the juveniles were shown in Table 2 and Fig. 3. The mean height of all juveniles of *B. gymnorrhiza* in Plot 1-1 in 1980 was 42 cm, and that of the juveniles which would survive for one year was 48 cm in 1980. These values indicate that the larger juveniles tend to survive.

The adjusted mean height of the juveniles that survived for one year increased by 1.9 cm after we compensated for one year accumulation of detritus on the forest floor near the Plot 1-1 of 2.9 cm. The forest floor is inundated with brackish water at high tide, and inorganic and organic matter is deposited from the sea and the land. In Plot 1-2, the mean height of the *B. gymnorrhiza* juveniles surviving until 1981 was smaller than those that died during the year. The reason why the smaller juveniles could survive in the open is not yet understood. The accumulation rate of sediments in Plot 1-2 is thought to be the same as in Plot 1-1, though it was not measured. The growth of juveniles of *B. gymnorrhiza* and *Rh. mucronata*, therefore, exceeded 13 cm and 23 cm, respectively. The *B. gymnorrhiza* juveniles in the open grew more quickly than those in the forest. The *Rh. mucronata* in Plot 2 in the open estuary grew more slowly than those in Plot 1-2 set up along the river.

Only one *Rh. mucronata* seedling germinated in Plot 2 during one year. Plots 1-1 and 1-2 had no germination of the mangrove seedlings. They may germinate heterogenously in time and in place.

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