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Distribution Pattern of Plant Populations of *Rhizophora stylosa* Community in Yingluo Bay of Guangxi

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Abstract This paper deals with the distribution pattern type, aggregative intensity, pattern scale and dynamics of plant populations of *Rhizophora stylosa* community in Yingluo Bay of Guangxi. The measured results show that *R. stylosa* population is an aggregated distribution, while the populations of *Kandelia candel*, *Bruguiera gymnorrhiza* and *Aegiceras corniculatum* appear as random distribution. The plant population distribution pattern changes, along with the population development and the succession of the community.

Key words *Rhizophora stylosa* community, population, distribution pattern

Since Gleason measured the non—randomness of distribution of plant communtiy, distribution pattern of plant populations in a community has been attracting more and more attention of plant ecologists[1,2]. Mangrove is a woody plant community growing along tropical and subtropical sea shore. Many studies on mangroves have been carried out, but no many have been done on population distribution pattern of mangroves in China[3]. The present paper attempts to detect and analyse spatial distribution pattern of plant populations of *Rhizophora stylosa* community, which is one of the main mangrove communities in China. The measured reasults will throw some light on some theoretical themes in plant population ecological studies of mangrove community, and are also of practical significance for mangrove community management, utilization and preservation.

1 Materials and Methods

The study area is located at Yingluo Bay (21°28′ N, 109°43′E), Guangxi. Situated in the seashore climate of northern tropical region, the mean annual temperature of the area is 22.4℃, the mean annual rainfall 1816.5 mm with maxima in May—September and the mean annual relative moisture 81.8%. The study plot was randomly located in *R. stylosa* community of Yingluo Bay, which is composed mainly of *R. stylosa* in association with *Bruguiera gymnorrhiza*, *Kandelia candel* and *Aegreras corniculatum*, fringed by some high—tidal mangrove species in landform. Physiognomy of the community with 3.5 to 6.5m in height shows deep green, regular. Tree crown density is about 90 per cent. Structure of the community is simple. It exits only as an arborous layer. Under the arborous layer, seedlings of *R. stylosa* are usually abundant, while those of *B. gymnorrhiza*, *K. candel* and *A.*

corniculatum are scarce.

A belt transect of 96m long with 32 contiguous 3 × 3m^2 quadrats was placed in the community. In each quadrat, the measurements of morphologic characteristics were taken on all individuals of the populations in the community. The observed data were used to detected and analyse the distribution pattern of the populations found in the community. Pattern type was determined by using the method of variance : mean ratio[1,4]. Aggregative intensity was detected by clumping index (I) and negative binomial paramater (K)[4]. Pattern scale was studied on the basis of the mean square block size graphs using variance analysis[2,4-7].

2 Results and Discussion

2.1 Pattern Type and Aggregative Intensity

It has been argued that distribution pattern, departure from randomness of distribution of populations within a community, reflects the determination of their occurrence and performance by one or few factors or groups of correlated fectors. The distribution pattern type of population has close relations with its biological and ecological characteristics, interpopulation relationship and habitat condition. The distribution pattern types of the populations in *R. stylosa* community are presented in Table 1. In which, the edificat population, *R. stylosa* population, shows aggregated distribution. This may play an important role for *R. stylosa* population in the with—standing tidal destruction, improving habitat condition and promoting self — restoration. Populations of *B. gymnorrhiza*, *K. candel* and *A. corniculatum* are random distribution because of their low population densities—382 n. /hm^2. , 104 n. /hm^2. and 69 n. /hm^2. respectively, and scattered distribution in the community. In addition, the important values of *B. gymnorrhiza* population, *K. candel* population and *A. corniculatum* population are low, 34. 4, 8. 0 and 6. 6 respectively, while that of *R. stylosa* population is 251. 5, that is to say, *R. stylosa* population can not only create the particular community environment, but also control the distribution pattern of other populations. It therefore seems more likely that environmental factor — situation and interpopulation competition are responsible for the formation of these distribution patterns.

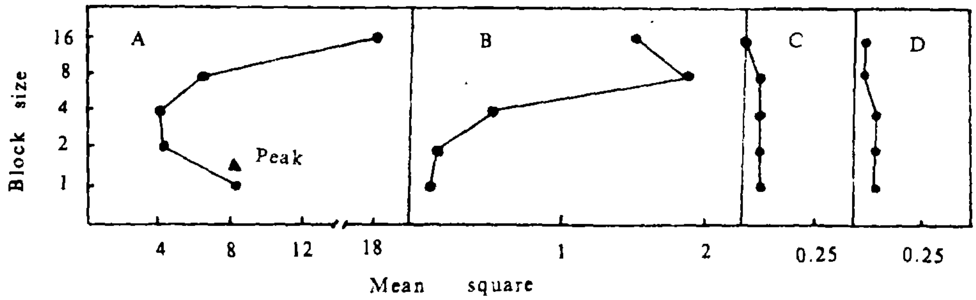
Aggregative intensity is usually used to detect the spatial aggregative degree of plant population in a community. The clumping index (I) and negative binomial parameter (K) of *B. gymnorrhiza*, *K. candle* and *A. corniculatum* populations are all negative ones (Table 1). This indicates that there are no spatial aggregative phenomena for the three populations in the community, and furtherly that the three populations deviate aggregated distribution. The index I the and parameter K of *R. stylosa* population are 1. 1241 and 2. 8913 respectively. Generally, if I is larger than 1 and K between 0. 5 and 3, the population shows aggregated distribution. The larger the value I with the smaller the value K, the larger the aggregative intensity of the population is, when the density of population preseves constant.

Table 1 Distribution pattern of plant populations of *Rhizophora stylosa* community in Yingluo Bay, Guangxi.

Population	*Rhizophora stylosa*	*Aegiceras corniculatum*	*Bruguiera gymnorrhiza*	*Kandelia candel*
Populatin size	104	2	11	3
Population density (n. /hm^2.)	3611	69	382	104
s^2	6. 9032	0. 0605	0. 2329	0. 0877
$\bar{x}$	3. 2500	0. 0625	0. 3438	0. 0938
$s^2/\bar{x}$	2. 1241	0. 9680	0. 6773	0. 9355
T	4. 4255	0. 1260	1. 2704	0. 2540
Result	Aggregate	Random	Random	Random
I	1. 1241	−0. 0320	−0. 3227	−0. 0645
K	2. 8913	−1. 9531	−1. 0658	−1. 4424
Pattern intensity	1. 1241	−0. 0320	−0. 3226	−0. 0650

2. 2 Pattern Scale and Intensity

The population which shows aggregated distribution usually posssesses quite a number of individuals in a community. Competition between individuals for inche may result in the formation of various patchnesses that distribute alternately. The size of the patchness means the pattern scale of population. The detection and quantification of pattern scale in plant communities has been studied by many scholors (e. g. Greig—Smith 1964; Kershaw 1973; Hill 1972; Mead 1972)[2]. The method used here was the measurement of the number of individuals of population in contiguous systematic samples. The data from the basic units were grouped into blocks of 2, 4, 8, etc. , samples and the total variance between units apportioned by the usual procedure of analysis of variance into amounts derived from the differences between units within blocks of two, between blocks of two within blocks of four and so on. The results were represented as a graph of mean square against block size. The peaks present in the graph equivalent to the mean dimension of scale of pattern. The mean square block size graph for the four populations in *R. stylosa* community is presented in Fig. 1, and whether the peaks exceed the 95% confidence limits or not are summarized in Table 2. *R. stylosa* population has a peak at block size 1, that is to say, it shows one scale of pattern. The position of the peaks indicates the scales of pattern, which corresponds to the size of quadrat at block size 1, i. e. , the scale is $3\times3m^2$. Populations of *B. gymnorrhia*, *Kandelia candle* and *Aegiceras corniculatum* have no peaks (or large variance) in the graph, i. e. they show no evidence pattern. This can be domenstrated by the fact that pattern intensity of the three populations are negative ones (Table 1) . It therefore comes to the conclusion that the three populations which have low densities do not aggregate to form patchnesses and they distribute randomly in the community mainly constructed by the dominant population, *R. stylosa* population



A: *Rhizophora stylosa* B: *Bruguiera gymnorrhiza*

C: *Aegiceras corniculatum* D: *Kandelia candel*

Fig. 1 Pattern scales of plant populations in *Rhizophora stylosa* community in Yingluo Bay, Guangxi

Table 2 Pattern analysis of plant populations in *Rhizophora stylosa* community in Yingluo Bay, Guangxi

	Bs	1	2	4	8	16	32
	N_k	16	8	4	2	1	
	UL/N_k	0.113	0.274	0.698	1.845	5.020	
	LL/N_k	0.027	0.034	0.030	0.015	0.000	
Rhizophora	S_k	552	419	385.5	369	356	338
stylosa	V_k	8.3125	4.1875	4.1250	6.5000	18.0000	
	M_k	3.2500	6.5000	13.0000	26.0000	52.0000	
	V_k/M_k	2.5576	0.6442	0.3173	0.2500	0.3462	
Bruguiera	S_k	11.0000	9.5000	8.2500	7.1250	5.3125	3.7813
gymnorrhiza	V_k	0.0938	0.1563	0.5625	1.8125	1.5312	
	M_k	0.3438	0.6875	1.3750	2.7500	5.5000	
	V_k/M_k	0.2728	0.2273	0.4091	0.6591	0.2784	
Aegiceras	S_k	2.0000	1.0000	0.5000	0.2500	0.1250	0.1250
corniculatum	V_k	0.0625	0.0625	0.0625	0.0625	0.0000	
	M_k	0.0625	0.0125	0.2500	0.5000	1.0000	
	V_k/M_k	1.0000	0.5000	0.2500	0.1250	0.0000	
Kandelia	S_k	3.0000	1.5000	0.7500	0.3750	0.3125	0.2813
candel	V_k	0.0938	0.0938	0.0938	0.0313	0.0312	
	M_k	0.0938	0.1875	0.3750	0.7500	1.5000	
	V_k/M_k	1.0000	0.5003	0.2501	0.0417	0.0208	

Note: Bs—Block size; UL—Upper limit; LL—Lower limit; N_k—Freedom; S_k—Square sum; V_k—Mean square; M_k—Mean value.

2. 3 Pattern Dynamics

It has been confirmed that the distribution pattern of population changes, along with the development of population and the succession of community. The study on pattern dynamics of mangrove population is of great significance for mangrove community and ecosystem. Here, We just analysed the pattern dynamics of *R. stylosa* population. *R. stylosa* population is one of the edificat and the dominant populations of mangrove communities in China and south — east Asia. The pattern dynamics of *R. stylosa* population was analysed by using the method of substitution of space for time[4]. At first, individuals of the population were sorted out into three groups: (1) seedling group; (2) young tree group, i. e. a group of individuals with single stem, breast — high diameter smaller than 5cm and prop — root height smaller than 0. 8m; (3) adult tree group, i. e. a group of individuals with remarkable degenerative stem. Then, the distribution pattern of each individuals group was measured by using the method of variance : mean ratio[4]. The measured results are presented in Table 3. It is found that the seedlings and the young tree group show aggregated distribution, while the adult tree group is an random distribution. This fact reflects that *R. stylosa* population shows aggregated distribution in its dispersal and development stages, and tend to be randomly distributed during its maturing and degenerative stages.

R. stylosa is viviparous, that is, the seed germinates within the fruit while it is still attached to the parent tree. When full developed, the viviparous seedlings without roots and leaves drop from the parent trees, many of them can get into the mudsoil beacause they are stick — like and heavy, and the mudsoil in the community is sticky and thick. Under the protection of the well — developed prop roots of the parent tree, most of the viviparous seedings got into the mudsoil can take rooting and become seedlings with 4 to 8 leaves. They distribute aggregately beneath parent trees. But the young tree group is not the simple or even — aged continuum of the seedling group. There are not evident correlations between the distribute pattern of seedling group and that of young tree group . In fact, the young tree group is an uneven — aged one. There are differences between young trees in many aspects, such as the height and the diameter of trees or the number and the height of prop roots. Although there are lots of seedlings beneath the parent trees , the seedlings are often so delicate that they can only survive in the places where the habitat conditions are best for their growth and development. Therefore, under the stress of environment factors, only a few seedlings can survive and become young trees, The growth of the young is restricted by the shade and root competition of adult trees. As the canopy of adult trees becomes broken through injury or death, the young trees are able to make their way through the openings until they finally reach full overhead light. So the reproduction starts quickly in gaps in the community, establishment under cover of an overstory requires a long period of time. This is why *R. stylosa* community includes individual trees of both large and small size and with wide and narrow crown.

Adult trees distribute randomly in the community because of their low densities and the intensive interindividuals competition. Interindividuals competition includes competition for nutrition, space and light. Competition between different individuals for the use of the same limited resources usually has a negative effect on the individuals involved. Adult individuals possesses well — developed prop roots, which can be quite capable of occuping space. Other individuals are prevented by the prop roots from growing beneath or even nearby. As a result, some individuals would adapt themselves to different of life, under the stress of environmental pressure. Thus population would select one individual over another and by such natural selection, high—efficient individuals always replacing low—efficient ones in particular environmental conditions.

Table 3 also shows that the aggregated intensity and pattern intensity of *R. stylosa* population change, along with the population development.

Table 3 Spatial pattern of several individual groups of *R. stylosa* population

Individual group	Seedlings	Young tree	Adult tree
Group size	427	56	48
Group density ($n./hm^2.$)	14826	1944	1667
s^2	64.1683	5.7419	0.9031
$\bar{x}$	13.3438	1.7500	1.5000
$s^2/\bar{x}$	4.8089	3.2811	0.6022
T	14.9957	8.9807	1.5663
Result	Aggregate	Random	Random
I	3.8089	2.2811	−0.3978
K	3.5034	0.7672	−3.7695
Pattern intensity	3.8088	2.2811	−0.3979

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