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Impacts of Light on Rooting of Mangrove *Kandelia candel* Propagules*

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Abstract The process of rooting of propagules is one of the critical aspects for discussing the ecological expansion of mangrove populations. By the experiments of culture, we found out that this process was controlled by light in the viviparous hypocotyl of *Kandelia candel* . This discovery supplies a favourable access to explain why the floating propagules of *K. candel* can remain alive for a long time on the sea and be successfully dispersed by tides.
Key words mangove, viviparous hypocotyl, rooting, light—growth inhibition

Kandelia candel (L.) Durce is a commom mangrove species in China and South—East Asia . This species 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 (hypocotyl) drop from the parent trees, some of them are dispersed by tidal waters, some of them get into soil to root.

Possessing features of rapid rooting, salt regulation, ionic balance, buoyancy and nutritional parasitism (Saenger 1982), vivipary has been commonly regarded as a reproductive adaptation for mangroves to marine environment. It was reported that hypocotyl floating on the sea could remain alive for two or three months, and this was part for the explanation of why the mangroves could distribute world—wide despite of few number of their species (Lin 1988). However, if a hypocotyl floating on the sea rooted as fast as it did in the soil, the seedling with young leaves would ill—develope or die for lack of both oxygen and light, and this would further limit its long—distance distribution by tides. So ,maybe the hypocotyls floating on the sea rooted uncompletely or even did not root at all until they reached suitable habitats such as mudsoil. This process was possibly dominated by some ecological factors which exist on the sea but absent in the soil. The paradox of our previous knowledge and the suppose led us to discovery of the light dormancy of hypocotyl in *Kandelia candel*.

1 Materials and Methods

The mature hypocotyls of *Kandelia candel* were randomly collected in May 27, 1992 from their

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parent trees. Every treatment group consists of 10 hypocotyls. Room culture was applied and glass bottle served as container and dark environment was made by a piece of black paper around the bottle (Fig. 1). Except group 5, all groups were incubated in a room with natural room light of approximate 13 hours in light and 11 hours in dark. The temperature of room air fluctuated between 28℃ and 31 ℃ during experiment. Group 5 was cultured in a large sandy pond out door. In order to compensate the evaporated sea water and to keep constant salinity, distilled water was added once a day to maintain the initial volume of substratums. The sands and sea water supplied for culture were taken from sea beach without any prior treatment, and the size of sands was 0. 2 to 2. 0 mm in diameter.

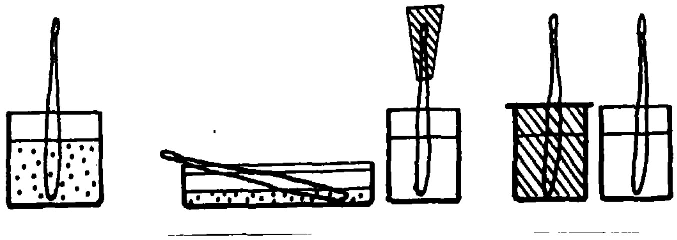

Fig. 1 Lab culture methods to reveal the influences of light on the rooting of *Kandelia candel* hypocotyl

2 Results

Under the similar conditions of moisture, temperature and salinity, only when the parts capable of rooting were prevented from light, could the hypocotyl root rapidly. The re—blocked hypocotyl also rooted in 4 days even following 10—day culture under light rooting (Table 1). The room culture indicated that the rooting of hypocotyl was inhibited by light, just like light dormancy which could be eliminated in dark. Although roots grew faster in sands than in mere sea water (Table 1, Fig. 2), it was the fact that the hypocotyls took the same time to begin rooting, and suggested that whether or not a hypocotyl could root and how fast the roots grow after root are radically in different physiological stages (root). As for the rooting stage in the present experiments, light was the limit factor, and the richer mineral nutrients in the sandy culture might have been responsible for the rapider root growth.

The hypocotyls in group 3 didn' t root, elucidating that the light sensor was not the upper buds (cotyledon) but the lower place (root part) that is endogenously capable of rooting. In group 4 the roots appeared on the sand lateral, absented on the water lateral, and the whole hypocotyl dramatically became brush—like (Fig. 2) . This gave a direct evidence that the effect of light inhibition was not deliverable, just produced and acted *in situ* .

The experiments enable us to come to the assumption that perhaps there was certain biochemical matter in the epidermis of *Kandelia candel* hypocotyl, which could be induced or activated by light to inhibit rooting and removed in dark to allow rooting.

3 Discussions

So far, a few of data are available on the negative impacts of light on rooting of terrestrial plant propagules, and fewer on marine plants. The present experiments firstly reveal that the rooting of *Kandelia candel* hypocotyl is inhibited by light, and supply an important approach to explain those questions we have mentioned above.

It has been well—known that there is light in the upper layer of the seawater, which was likely so strong as to inhibit the rooting of the hypocotyl on the sea. Consequently, avoiding fatal growth in the unfavorable habitats, the floating hypocotyl could remain alive even after far spread. Once their root parts get into favourable substrates, they could establish themselves by fast rooting which is triggered by being free from the light. In the stands, we observed that most of the fallen hypocotyl didn' t establish, but stranded on the intertidal zones. Most of the stranded remained un—rooted until being taken away by tides, and a few of them appeared brush—like roots on the lateral where they closely contacted with the soft bottom. Our investigations along the seashores far from mangrove forests indicated that almost all of the tide—brought hypocotyls didn' t root, and those rooted hypocotyls were likely the seedlings that used to grow in the soil and were removed by the tidal waters. Conclusively, taking advantage of light dormancy, the hypocotyls increase their survival possibility more or less because anchorage of the seedlings must be maintained in order to survive. In this mean, soil serves as nothing but gives an information to trigger rooting through the absence of light.

Table 1 Lenght (mm) of roots during varied laboratory light culture of *Kandelia candel* hypocotyl

Group	I	II	III	IV		V
Mean lenght of hypocotyl (cm) (±SD)	21.7 ±2.5	22.0 ±1.8	21.8 ±1.8	21.2 ±2.0		21.6 ±1.8
Culture method	light	dark	buds blocked	laterals: water	laterals: sands	sandy pond
Light conditions on root part	light	dark	light	light	dark	dark
1～3 days	0	0	0	0	0	0
4 days	0	1～3	0	0	1～3	1～3
10 days	0	3～5	0	0	5～22	15～20
4 days more after being re—blocked	1～3	—	1～3	—	—	—

If the phenomenon of the light dormancy is prevalent in the other viviparous mangrove species is still in doubt, because there has been a report on *Rhizophora mangle* propagules indicating their roots appeared within 10 to 17 days in spite of whether or not the propagules were floating or stranded, in light or in shade (Banus and Kolehmainen, 1975). However, prior to the report Teas and Montgomery (1969) once concluded that contact with substrate was important prior to root formation of mangrove seedlings, this viewpoint well correspondes with our results.

The present paper merely reported the results of the tentative experiments, actually there are many interesting questions required studies in detail, such as the photoperiod and phesiological mechanisms of the light dormancy, the available observations on the hypocotyl floating on the sea, and the popularity of the similar phenomenon in the other viviparous mangrove species, etc.

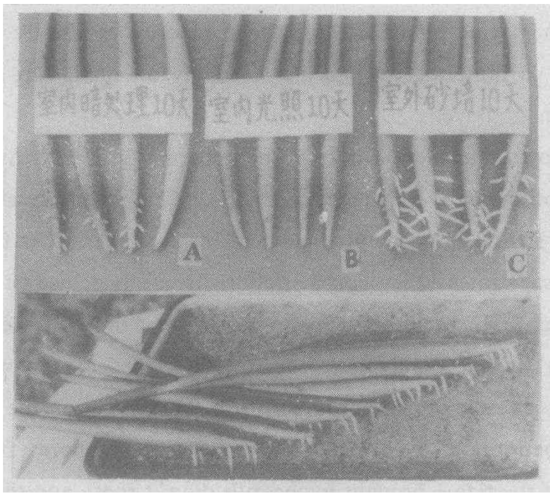

Fig. 2 Roots of varied laboratory light culture for 10 days

Top: A group 2 in dark; B group in light; C group 5 in sandy pond.

Bottom: group 4, show the brush—like roots.

Note: the seedlings have been put up to show the roots on the sand lateral.

4 Acknoledgment

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