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[Meeting Report]

The Ecogeography of *Kandelia candel* in Thailand, Hong Kong and Southern Islands of Japan

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ABSTRACT

The ecogeography of *Kandelia candel* (L.) Druce was studied comparatively in Thailand, Hong Kong and the southern islands of Japan. *Kandelia candel* can be found throughout the S.E. Asian and E. Asian region and although the species features quite strongly in the mangrove literature of China, Taiwan and Japan, its ecogeographic importance in mangrove distribution studies appears to be relatively neglected in the broader literature. This paper seeks to re-assess the importance of *Kandelia candel*, focusing on ecogeographic parameters such as its wide distribution, unique position as the mangrove marking the northern limit of global mangrove distribution and the related eco-physiological property of cold tolerance. *Kandelia* is studied in three ecogeographically isolated and biogeographical interesting places: tropical Thailand, cold snap prone, seasonal Hong Kong and the southern islands of Japan (Ishigaki and Iriomote).

Key words: *Kandelia candel*, Ecogeography, S.E. Asia

Introduction

Kandelia candel (L.) Druce is a true mangrove species (Aksornkoae *et al.*, 1992) with an interesting geography (Maxwell, 1995), enticing ecology, almost neglected genetics (Huang, 1996) and unsung forestry importance (Maxwell and Havanond, in press). While *Kandelia* has featured quite strongly in the mangrove literature of China and Taiwan (eg Li *et al.* 1975; Lin and Wei, 1983; Chen *et al.*, 1985 and Gao, 1988) and Japan (eg Nishihira & Urashi, 1976; Urashi *et al.* 1986; Suzuki and Saenger 1996) its ecogeographic importance in mangrove distribution studies appears to be under emphasied in the broader literature (Maxwell, 1995b). This neglect may reflect a paucity of ecological studies on the species. There is a lingering impression in much mangrove literature that *Kandelia* is unimportant. The assessment , based on available ecological studies, that *Kandelia* in nowhere abundant (Tomlinson, 1986) is almost certainly an expression of this impression. Likewise, the recent generalisation by Duke (1992) that the cold tolerance of *Avicennia marina* was seen in no other mangrove species in the world further illustrates that *Kandelia* Has been neglected in ecogeographic studies. *Kandelia* is outstanding in its cold tolerance: it occupies the northern limit of global mangrove distribution, at 31°23'N in the Kyushu Island of Japan (Nakasuga *et al.*. 1974; Chapman, 1975; Hosokawa *et al.*, 1977; Nakagoshi & Nehira, 1986; Maxwell, 1995b). At this northern latitude, cold shock is a noteable ecogeographic factor. Clearly *Kandelia candel* has a distinct chill tolerance. This property of the plant has been known for sometime (eg Sakai 1974; Sakai and Larch, 1987) but has not featured strongly in the research literature. Recently, Maxwell (1995b) using transplants from Brunei and Thailand, showed that even some tropical ecotypes

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of *Kandelia* can cope with winter chill shocks of around 2-5 ℃, which can occur in Hong Kong.

There are encouraging signs however, that the days of neglect for *Kandelia* may be over. Some extensive, in geographic terms, studies of *Kandelia* in Hong Kong and S.E. Asia have demonstrated the existence of ecotypes within this species (Maxwell, 1989, 1993, 1995b, 1996; Aksornkoae *et al.* 1992) and a fresh line of research probes ecotypicity at the enzyme genetics level (Huang, 1996). Very recently too, the ecobotanical status of *Kandelia* in Thailand has been re-assessed in the context of mangrove forestry (Maxwell & Havanond, in press).

It is against this background that the present paper reviews and reports upon recent work with *Kandelia* in Thailand, Hong Kong and the two most southern islands in the Japanese archipelago: Ishigaki and Iriomote. To facilitate feedback and discussion this paper is presented in review style as much as possible.

Materials and Methods

The methods were based on direct field visits, observation, inspection, measurement and transplant experimentation, most of which are described in detail in earlier papers (Aksornkoae *et al.*, 1992; Maxwell 1989, 1993, 1995b; Maxwell and Chope, 1995). In addition, the most recent work has involved a field expedition led by Professor Nakamura of Tokyo University of Agriculture to the southern islands of Japan, Ishigaki and Iriomote, of which Sonjai Havanond of Royal Forest Dept, Thailand and the present writers were members (October 18-20, 1997).

Results and Discussion

1.Introduction

Thailand is addressed first because it is thought that the ecogeography of *Kandelia* in tropical Thailand presents a useful frame of reference and perspective for a mangrove species such as Kandelia which, in its biogeography, spans the hot wet tropics, the monsoonal tropical fringe climates of Hong Kong and the subtropical/ warm temperate conditions which exist at its northern geographic limits in Japan.

2.The ecogeography of *Kandelia candel* in Thailand

2.1 The general setting

Kandelia candel does not appear to be common in Thailand but was found as an established mangrove component in the riverine systems of both the La-Un River (Ranong Province) and Tapi River (Surat Thani). In the Tapi River situation *K. candel* was an understory species within a mixed mangrove consisting of *Nypha fruticans, Avienia alba, Rhizopora apiculata* and *Sonneratia caseolaris.* In the La-Un riverine environment, which may represent typical *Kandelia candel* habitat or ecological setting today in Thailand, this species was associated with *Aegiceras corniculatum, Rhizophora apiculata, Sonneratia griffithi, Avicennia officinalis, A. alba and Bruguiera parviflora. Typically, Kandelia candel* in La-Un shared a pioneer, river edge niche with *Sonneratia griffithi and Avicennia officinalis and or A. alba. Kandelia candel* was reported in Cahnthaburi (Southeast coast region) But it was not easily encountered here (Aksornkoae, 1979); Likewise, the species can be occasionally encountered at other sites including Kapoae (Kapur) (Aksornkoae, 1982) Phang Nga and Krabi (Havanond, observation) and at Phuket (Hou, 1970).

2.2 The Si Kim tributary of the La-Un River: a special case in the ecogeography of *Kandelia candel* in Thailand?

During survey associated with propagule dispersal and crab predation experiments conducted in the field with *Kandelia candel* (Maxwell, 1993) a through study was made of a small tributary of the La-Un River called the Si Kim. This involved c. 2km of waterways. In this area *Kandelia candel* was a prominent riverine species, typically occupying the pioneer position and relatively easy to find as 2-3m tall tree with a dbh of ~10.5 cm (Maxwell, 1995b) This Si Kim tributary of the La-Un R. was comparatively undisturbed and may give us an eco-botanical insight into the biological potential of the species in Thailand.

2.3 The Thai Kandelia candel: a special ecotype

(a) Introduction

Comparative studies with *K. candel* in terms of ecotypicity were addressed in detail in an earlier paper (Maxwell, 1995b). The Thai populations of *K. candel* were outstanding in many ways. In the context of the present paper just two examples will be used to illustrate this point, upon which a discussion will be built in the next section. The examples are:

- Leaf length (lamina) ⎫ biosystematic attributes,
- propagule length ⎭

These examples will be addressed below.

(b) Leaf and propagule lengths

These are summarized in Table 1.

At can be seen from an inspection of the data in Table 1, the Thai ecotype of *Kandelia* is noteworthy in terms of size of leaf and propagule.

2.4 Thai ecotypes of *Kandelia candel* in Hong Kong

As reported and described in Maxwell (1993, 1995b and 1996) Thai propagules were transplanted from the La- Un riverine site to Mai Po WWF reserve in Hong Kong.

These Thai ecotypes of *Kandelia* were studied for overt parameters such as leaf size, leaf number and stem height while growing at Mai Po. Importantly this site, like many in Hong Kong, is subject to cold stress in the distinct cool, dry winters that characterize Hong Kong. Interestingly, the Thai ecotype at Hong Kong not only retained its superiority in terms of size, number and stem height (Table 2)over a 23-month period, it also showed resistance to chill shock (overnight winter temperature fell to -4 ℃ during the study period). By mid 1993, three of the nine Thai *Kandelia* transplants were still alive. This was despite the cold shock.

Table 1. Mean lengths of K. candel leaves and propagules from Iriomote Is., Hong Kong and Thailand

Attribute	Iriomote Is ⁼(Urauchi R.)	Hong Kong *	Thailand (La-Un R.)*
Leaf length(cm)	8.5 ± 0.2	7.9 ± 0.1	15.0 ± 0.11
Propagule length (cm)	-	20.71 ± 0.26	46.89 ± 0.60

* From: Maxwell(1995b)

⁼ Data from field expedition in October, 1997.

\- not available

Note: all differences were very significant in terms of one-way ANOVA and Bonferroni correction for multiple comparisons.

Table 2. Comparative growth in terms of stem height, leaf numbers and size of Hong Kong and Thai transplants of Kandelia candel at Mai Po after a 23 month period (1.6.89-20.4.91) (After Maxwell, 1993)

	Ecotype	
Parameters	Hong Kong	Thailand
(1) Stem height (cm)	51.25±19.74	107.25±39.94
(2) No. leaves per plant	73.5 ±20.3	114.00±26.48
(3) leaf size (length only) (cm)	10.6 ± 0.56	15.0 ± 0.52

3. The ecogeography of *Kandelia* in Hong Kong

Ecogeographically the ~270 ha of mangrove in Hong Kong consist of small trees (<3m tall) and dwarf shrabs of which *Kandelia* is the most frequently encountered and ecodominant species. The Mai Po marshes in Deep Bay between the HKSAR (Special Administrative Region of Hong Kong) and Shenzhen Special Economic Zone PRC are perhaps best known (Yipp *et al.*, 1993) but to a large extent this extensive stand of *Kandelia*-dominated mangrove is the result of human activity in terms of sediment creation and gei wai (fish and shrimp pond) construction (Irving & Morton, 1988; Lee, S. Y., 1989; Maxwell 1993). Pockets of mangrove occur on some islands and along the eastern seaboard of Hong Kong in relatively undisturbed protected coastal inlets and bays such

as Chek Keng in the extensive Sai Kung East Country Park region. Here the seawater is relatively more saline than that associated with the Pearl River and Deep Bay- Mai Po. Squat, quite old (~30 years) bonzai-like shrubs can be found in a range of substrata including fine marine mud deposits and beds of stones associated with disused paddy fields and seasonal high velocity stream deposits (Maxwell, 1993).

Mangroves in particular and coastal environments generally in Hong Kong are subject to a whole range of environmental demands and pressures. Coastal land building or "reclamation" schemes continue unabated and the future of some mangrove- inhabitated bays remains uncertain. Yet despite this pressure from land-hungry development projects, there have been some gains in mangrove areas in recent years eg off site mitigation associated with a public golf course development of an near-shore island resulted in an ambitious mangrove re-planting and ecosystem creation scheme (Maxwell, 1995a).

Essentially, *Kandelia* in Hong Kong is a co-dominant species with *Avicennia marina* and or *Aegiceras corniculatum*. Totally, eight mangrove species are recognised of which *Bruguiera gymnorrhiza* is a biogeographically interesting but numerically minor component. It is possible that the cold tolerance of both *Kandelia and Avicennia marina* ecotypes in Hong Kong have helped these species to expand ecogeographically in Hong Kong at the expense of the more tropical *B. gymnorrhiza*.

Experimental work on the subject is currently being conducted by the senior author with Japanese transplants of *Rhizophara stylosa* and *Bruguiera gymnorrhiza* from Iriomote Island, at a remote site in the eastern Sai Kung region of Hong Kong.

The exact eco-physiological basics of dwarfness in Hong Kong mangroves remains to be elucidated and transplant experiments such as those currently underway or described earlier (Maxwell, 1995b) may prove to be important in this question. Likewise, work done on enzyme genetics along the lines of that reported for *Kandelia* in the Ryukyu Archipelago by Huang (1996) offers a signpost of future inquiry.

4. The ecogeography of Kandelia in Ishigaki and Iriomote Islands, Okinawa Prefecture, Japan.

Both Ishigaki and Iriomote Islands lie at 24 ° N latitude. As such they are two degrees further north than Hong Kong (22 ° N) and some 14 ° further north from the main sites for *Kandelia* in Thailand, at the La-Un River, Ranong Province (10 ° N). In these southern Japanese islands, *Kandelia* has been described as existing as dominant vegetation (*Kandelia candel*- dominated vegetation) or as part of another community such as Bruguiera gymnorrhiza and especially *Rhizophora stylosa* (Suzuki and Saenger, 1996) The recent expedition the these islands in October 1997 (Materials and Methods) could not confirm these assessments by Suzuki and Saenger (1996). In some cases these authors assign *Kandelia* to the status of 'second dominant species' eg in the mangrove community of Ishigaki Island described as a *Bruguiera gymnorrhiza-Kandelia candel* community, *Kandelia* is given as the 'second dominant' species. This may be correct but it tends to elevate the status of *Kandelia* too high, for the species is not an obvious and conspicuous component of the typical mangrove vegetation on these Islands.

During the present field work which involved on site inspections by boat and on foot of five important mangrove forests on Iriomote Island (Urauchi, Sonae, Shiina, Maira and Nakama rivers), The observations pointed to Kandelia as a community member but typically phytosociologically and numerically insignificant when compared to *Rhizophora stylosa* and *Bruigera gymnorrhiza*. Even *Sonneratia alba* and *Avicennia marina* were more prominant ecogeographically than *Kandelia*.

These observations in no way downgrade the importance of *Kandelia candel* in terms of mangrove forest biodiversity. Ecogeographically, however, *Kandelia* was not assessed as occupying a position of overt prominance of Iriomote Island.

Very similar comments and conclusions were made for *Kandelia* on the neighbouring island of Ishigaki with *Bruguierra gymnorrhiza* and *Rhizophora stylosa* both outclassing *Kandelia candel* in ecogeographic status.

More new information on biosystematics (Table 1) and the ecogeographic significance of mud redox status on these Islands is at present being processed and will be the subject of subsequent papers. As suggested in Table 1, the

Japanese Kandelia's studies appear to be closer in biosystematic terms to those of Hong Kong than Thailand.

Conclusion

Clearly, the ecogeography of *Kandelia* deserves more attention. Many considerations point to this conclusion including:

**Kandelia* is the only species in a unique unispecific genus within the family Rhizophoraceae
*Both Tropical (Thai) and cool-selected populations (Hong Kong) of *Kandelia* display cold shock tolerances
**Kandelia* may well become an important mangrove candidate species in ecological restoration programmes (Where the twin attributes of ecogeographic versalitity and cold tolerance are important) at the fringes of mangrove distribution
*The eco-genetical aspects of this widespread species offer attractive avenues for phylogenetic and biogeographic research eg are the observed biosystematic differences in geographically isolated populations of *Kandelia* in Thailand, Hong Kong, Iriomote, Ishigaki Islands genetically fixed or ecologically induced?
**Kandlia* may be a useful mangrove species in less desirable or ecologically difficult areas- especially if viewed as economically unattractive by local people who are not used to harvesting this species as a source of fuel (charcoal).

Finally, our recent work in the remote southern islands of Japan have reinforced our beliefs that Kandelia is a mangrove species that offers much of interest to workers in the S.E. Asian and E. Asian regions.

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Dedication

This paper is dedicated to the International Society of Mangrove Ecosystems (ISME) in celebration of its motivational role in global mangrove research and international exchange in all matters relating to mangrove science.

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[會議論集]

泰國、香港和日本南方諸島之水筆仔生態地理學研究

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摘 要

水筆仔分佈在東亞和東南亞這廣大的區域裡，在中國、台灣和日本研究紅樹林的報告中多有描述。比較起來，生態地理方面的研究報告卻相對地少。本篇是研究泰國、香港和日本南方西表島、石垣島等地水筆仔的生態地理學報告，針對它在分佈上的範圍廣闊，在地理上具標示紅樹林北限的特殊地位和在生理生態上能耐受低溫的相關性，重新評估這個物種的重要性。本研究選取的地點分別在：位於熱帶的泰國、有短暫低溫期的香港和位在日本南方的小島，各踞一處，各有代表不同生態和生物地理學上的意義。

關鍵詞：生態地理、紅樹林、水筆仔