

短報 Short Communication

Chill shock tolerance differentiates Hong Kong and Thai ecotypes of *Avicennia marina*

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On 22 December 1999, HKSAR experienced its coldest winter solstice on record, when temperatures fell to 6.7°C in urban areas and < 4.0°C in some elevated and exposed low lying areas in the countryside. This was followed by the coldest Christmas Eve ever recorded at the Hong Kong Observatory, which is located in urban Kowloon. On the night of 24 December 1999, the temperature reached 7.0°C and shattered the previous lows recorded on December 24 in 1904 and 1929, when the temperature was 7.1°C (South China Morning Post, 24 December 1999 and Hong Kong Observatory). Cold snaps have occurred before e.g. in 1893 (Skertchly, 1893) and 1948 (Bannister, 1948) with reports of frost-covered hills in January and, more recently, on December 28, 1991 when a low of 4.6°C was recorded at the urban site of the Hong Kong Observatory. On this occasion, in 1991, these unusually cold temperatures were quite widespread in the South China region, when the associated cold front extended from just southeast of Japan and the Ryukyu Islands to the southern tip of Taiwan and to the Vietnam coast, where Hanoi recorded 9°C (Peart and Dongshen, 1992).

In Hong Kong, such cold spells or snaps can have harmful effects on poultry and pond fish, resulting in mortalities (Cheng, 1970). In December 1999, the HKO issued a frost warning to alert farmers, especially vegetable crop growers to step up crop protection measures. In anticipation of a future cold shock, an experimental transplant of both local (Hong Kong) and tropical (Thai) seedlings of the mangrove *Avicennia marina* had been set up on 21 October 1999, at Kei Ling Ha Hoi (Three Fathoms Cove), a mangrove fringed Bay located along the Eastern Seaboard of HKSAR (22° 25' 08" N and 114° 17' 02E). A thermohydrograph (Sato, Sigma-II Model NS-11 No.7210)

was protected by a semi-open box cage made from drift wood and placed under coastal vegetation ~ 1.5 m above Mean High Water level within 20 m of the transplant site. Mature *Aegiceras corniculatum* and *Lycoecaria agallocha* trees of 2.4 and 3.3 m tall respectively, were adjacent to the transplant site. The *Avicennia marina* seedlings had been grown to the 6 to 8 leaf stage in a potting mix of sand, mud and small pebbles previously taken from the target transplant habitat (Kei Ling Ha Hoi, KLHH) in preparation for the transplant experiment.

The principal attributes of these seedlings are shown in Table 1 together with post December cold shock survival rates. As Table 1 shows, the results are dramatic. The seedlings displayed overt differences in symptoms of chill shock. The local seedlings exhibited some foliage dieback (around 3 out of 8 leaves showed marginal curling and discolouration especially in the youngest leaves) but retained a vertical stem and the ability to regrow replacement foliage. Those in the Thai group however, quickly succumbed to a post chill shock : they wilted with stem collapsing to a horizontal position and leaves blackening within 3 to 10 days following the chill shock.

Corlett (1992) and Maxwell (1993) had recorded similar foliage dieback patterns with *A. marina* at Mai Po and Tsim Bei Tsui (22° 29' 14" N and 114° 00' 51" E) in the north west New Territories of HKSAR. Using both Bruneian (north Borneo, 05° 02' N and 115° 01' E) transplants of *A. marina* and *Kandelia candel*, Maxwell (1993 and 1995) also demonstrated marked differences in chill tolerance at Mai Po (Hong Kong) between true tropical (Brunei) and subtropical (Hong Kong) ecotypes within these species. The differences being most pronounced with *Avicennia marina* : the

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Table 1 Differential survival rates of local and Thai ecotypes of *Avicennia marina* seedlings exposed to an overnight temperature of 3.8°C at Kei Ling Ha Hoi (KLHH) Sai Kung Hong Kong on 22 and 25 December 1999.

Ecotype	# in field (KLHH)	\bar{X} leaf no. per seedling (\pm SD)	\bar{X} stem length cm (\pm SD)	age of seedling (months)	no. surviving † (%)
Hong Kong*	10	6.7 \pm 0.4	19.13 \pm 1.19	5	10 (100%)
Thai	10	8.0 \pm 0.4	30.67 \pm 0.88	7	0 (0%)

* Hong Kong populations of *A. marina* propagules were obtained in August 1999 from both KLHH and Chok Keng in Sai Kung East Country Park. The Thai propagules were collected from Samat Prakan (13° N) near Bangkok, Thailand.

† no. surviving refers to number alive (erect stems, normal non-blackened/discoloured foliage on 25 Feb. 2000, when the experiment was deemed completed).

Bruneian transplants, which were three years old in 1991, defoliated and died following the December, 1991 cold snap. This response contrasted with the local, Hong Kong, ecotype of *A. marina* which exhibited some foliage discoloration and dieback especially in the young foliage, but was able to recover. Interestingly, the *Kandelia* transplants, which came to Hong Kong from Thailand and Brunei (Maxwell, 1993 ; 1995) survived, despite exhibiting some foliage dieback. As with the local *Avicennia marina* ecotypes, those of *Kandelia candel* were able to cope with these limited cold snaps. The full ecogeographic and eco-physiological dimensions of these observations remain to be elucidated. In review literature (e.g. Hutchings and Saenger, 1987 ; Sakai and Larcher, 1987 and Lüttge, 1997) and even in the limited research literature (e.g. Sakai and Wardle, 1978 ; Markley et al, 1982) the chill tolerant species of *Avicennia*, i.e. *A. marina* and *A. germinans* tend to be treated and discussed as if they were single uniform species, especially with respect to ecotypicity. Today, the notion of ecotypicity including differential cold tolerance remains with few exceptions (e.g. Maxwell, 1993 ; 1995) a relatively neglected area.

Some recent papers hint at the possible biogeographic limits and associated cool temperature tolerance of mangroves at their extreme latitudinal ranges (e.g. Suzuki and Saenger, 1996). Recent work reported by the writer (Maxwell, 1999) before the Academic An-

nual General Meetings of JAM together with this present paper, may help to stimulate more interest in chill shock on mangroves. At present, aspects of this Hong Kong based investigation of differential chill shock tolerance in geographically isolated populations of *Avicennia marina* are ongoing. The report here is essentially a topical progress report on work that is continuing. These findings do however, underscore the unique nature of Hong Kong as a biogeographically special place. For example, where else in the tropics are such cold snaps (of \sim 4-5°C) experienced at sea level as they did on 22/23 Dec 1999 ? The answer is probably no where else ! At present (winter of 2000 / 2001) more chill shock experiments are underway. These involve the New Zealand as well as Hong Kong and Thai populations of *Avicennia marina*. A full report of this work will be the subject of an additional paper.

It is sincerely hoped that this short communication will perhaps encourage scientists in the Japanese biogeographic region to, for example, conduct transplant experiments with mangroves from the global northern limit at Kiire (31° 22N), Kyushu Japan (Suzuki and Saenger, 1996) to both subtropical (e.g. Hong Kong) and tropical locations (e.g. Thailand) and investigate both cold and hot thermal tolerance regimes. As suggested by Maxwell (1993, 1995 and 1999) field based studies of mangroves at their biogeo-

graphic extreme is a fertile area of research. With projected extreme changes in climatic patterns in the future, such work may have considerable importance to our knowledge of the sustainable conservation and management of coastal vegetation resources worldwide.

Acknowledgements

The author would like to thank Professor T. Nakamura of the Academic Frontier Research Centre, Tokyo University of Agriculture and President of JAM for inviting me to two inspirational experiences at JAM Academic Meetings in 1999 and 2000. In addition, I would like to thank Professor Ren Kuwabara and Ms. Kaoru Yamanaka, both of Faculty of Bio-Industry, Tokyo University of Agriculture, Yasaka, Abashiri, Hokkaido for inspiring cooperative field work at Ishigaki during July 2000. I record my thanks too, to Dr. Sonjai Havanond, Director of Mangrove Forest Research Division, Royal Forest Dept, Bangkok, Thailand for his never ending help in mangrove matters and on-going international support. The Research and Development Scheme at Open University of Hong Kong which helps to sustain my discipline-based academic research is also acknowledged with gratitude. Finally, I acknowledge the untiring help from my expert word processor at School of Science and Technology, OUIIK, Ms Laluna Ip.

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