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Barnacle infestation on the bark of *Kandelia candel* (L.) Druce and *Aegiceras corniculatum* (L.) Blanco

Introduction

Barnacle infestation and bio-fouling can negatively impact on mangrove seedling survival (Maxwell, 1995; Chen & Po, 1997; Tam, 2003). They contribute to eco-physiological stress e.g. reduction in photosynthesis and gaseous exchange impedance in saplings and mature plants (Maxwell, 1993; Li *et al*., 1998; Han *et al*., 2004). The adhesive cement produced by barnacles upon stem settlement may also diffuse into sapwood and be deleterious to tree or shrub growth (Santhakumaran & Sawant, 1994).

Barnacle problems such as these have long annoyed mangrove foresters in plantation work (e.g. Perry, 1988; Aksornkoae, 1993; Field, 1996; Hong, 1996). Yet very few studies have focused specifically on barnacle attachment or settlement on mangrove surfaces (e.g. Maxwell, 1984; Maxwell, 1986; Li *et al*., 1998; He & Lai, 2001; Mo *et al.*, 2003; Han *et al*., 2004 and very recently Li, 2005).

The 2004 tsunami was a rare but devastating geophysical event, which affected many countries of the Indian Ocean. In its wake, the importance and wisdom of mangrove forest preservation, restoration and plantation gained a new urgency and relevance (Havanond, 2005; Havanond & Maxwell, 2005).

Findings from our recent study on the differential rates of infestation and establishment of the barnacle *Fistulobalanus albicostatus* on *Kandelia candel* and *Aegiceras corniculatum*, two ecologically dominant mangroves in Hong Kong (Photo 1), indicate that bark texture and to a lesser extent, mangrove tree or shrub morphology may play an important role in the success or otherwise of barnacle attachment and degree of harmful bio-fouling.

Investigation protocols

Studies conducted in Hong Kong (1987-1993) by Maxwell and more recently (2002-2004) by Li indicated a clear gap in barnacle *F. albicostatus* infestation on *K. candel* and *A. corniculatum.*

Photo 1 : Differential barnacle infestation on *A. corniculatum & K. candel.*

In this recent study, ten similar sized trees (1.0-1.2 m tall) of *K. candel* and *A. corniculatum* on the western (less saline) and eastern (more saline) seaboards of Hong Kong were selected for barnacle infestation quantification by direct observation (Li, 2005). The aim of the study was to test the hypothesis that *F. albicostatus* preferred *A. corniculatum* stem surfaces to those of *K. candel.*

Results and discussion

Micromorphological characteristics of *K. candel* and *A. corniculatum* bark, and the degree of barnacle infestation were clearly separated ($p<0.001$) (Figure 1). This result is consistent across sites ($P = 0.0003$). The barnacle *F. albicostatus* showed distinct settlement preference for *A. corniculatum* stem bark which has a texture akin to shark skin. In contrast, the stem bark of *K. candel* is silky smooth in texture and tends to become powdery and shed in flakes (Aksornkoae *et al*., 1992; Maxwell, 1993), presenting a surface, which appears to discourage cyprid settlement. Barnacle larvae find smooth substrata difficult to adhere to and show a preference for rough surfaces (Li *et al.*, 1998; Faimali *et al*., 2004). Similar behaviours were observed with post-settlement juveniles of the bivalve mollusc, *Macomona liliana*, which actively left fine ashed sediments (Cummings *et al*., 1993). Such sediments have a microtexture similar to *K. candel* stem bark.

In contrast, densely packed concave lenticels conspicuous on the trunks of *A. corniculatum* seem to encourage barnacle settlement. This preference for roughness and microcrevices by barnacles and the rejection of smooth surfaces (e.g. glass) were also noted by Walters and Breckle (1996) and Faimali *et al.* (2004).

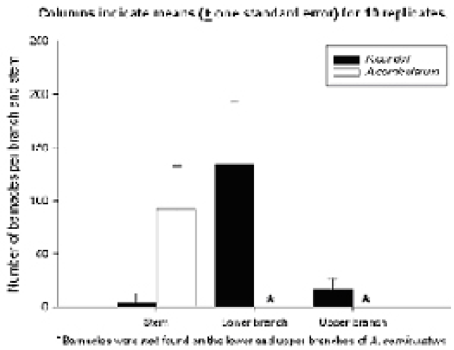

Figure 1 : Barnacle attachment on *K. candel* and *A. corniculatum* in Hong Kong.

Cyprids tend to avoid lethal height and dryness at the broad exploration phase (Hills *et al.*, 1998) for permanent attachment. This may partly account for lower barnacle density on the upper branches of *K. candel.* As *K. candel* branches were higher than the short stem of *A. corniculatum*, the chances of *K. candel* branches being submerged at adequate frequencies and durations are less than that of *A. corniculatum* stems. On upper branches, as one would expect, desiccation tolerance of barnacles is highly challenged (He & Lai, 2001). There is a slight surface texture difference between mature stem and branch bark in *K. candel*, the latter lacks the flaky and especially powder stage of mature stem bark.

Improved understanding of the relationships between barnacles such as *F. albicostatus* and their selective settlement responses to different mangrove bark textures are important in enhancing long- term success rates in mangrove restoration and plantation.

The differences in bark texture between *K. candel* and *A. corniculatum* were highlighted in this paper but the concept has relevance beyond these species to many others of eco-economic importance. Recently, the adverse impacts of ‘attached benthos’ or bio-fouling mangrove fauna especially barnacles and bivalves on mangroves was reported in Vietnam by Hoang and Nhuong (2004). Sadly, they did not specify the mangrove species involved.

As shown by us in this paper, the bio-fouling impact was most potent on seedlings less than 2 years old and declined with stem maturity. Seedlings greater than 2 years with bark surfaces and stem mass are better able to cope with the barnacle problem. We hope that more studies on bark and bio-fouling might be encouraged by these findings and that seedling age might be given more emphasis in the restoration and plantation of mangrove forests.

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