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Occurrence of *Polysiphonia* epiphytes in *Kappaphycus* farms at Calaguas Is., Camarines Norte, Phillippines

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Abstract

This paper describes the occurrence of an epiphyte infestation of *Kappaphycus* farms in Calaguas Is. Camarines Norte, Philippines. In particular, percentage cover of 'goose bump'-*Polysiphonia* and 'ice-ice' disease, and some environmental parameters that influence the thallus condition of *Kappaphycus alvarezii* in Calaguas Is. were assessed during 3 separate visits and are discussed.

Commercial cultivation of *Kappaphycus* at Calaguas Is. began in the early 1990s. After five years of farming, the stock was destroyed by a strong typhoon. The area was re-planted the following year and production increased annually and reached its peak in 1998–1999. However, the following year, the first occurrence of a *Polysiphonia* epiphyte infestation occurred concurrently with an 'ice-ice' disease. Consequently, annual production and the number of seaweed planters declined rapidly, and this situation persists to the present time. This paper highlights the etiological factors and their consequences.

Results show that farm-site selection is critical for the success of *Kappaphycus* production. Characteristics of water movement and light intensity in farming areas contributed to the occurrence and detrimental effect of the phenomenon described as 'goose bumps': a morphological distortion of the host seaweed due to the presence of a *Polysiphonia* sp. epiphyte. A strong inverse correlation was observed between the occurrence of *Polysiphonia* and water movement: areas with low water motion registered a higher % cover (65%) of *Polysiphonia* than those in more exposed areas (17%). Although 'goose bump'-*Polysiphonia* infestation and 'ice-ice' disease pose a tremendous problem to the seaweed farmers, the results of this limited assessment provide a useful baseline for future work.

Introduction

Kappaphycus alvarezii (also colloquially called "cottonii"), a kappa carrageenan-producing seaweed is commercially cultivated in the tropics, notably in the Philippines, Indonesia, Malaysia and Fiji Islands. The increasing demand for carrageenan on world markets due to its diverse product applications, makes *Kappaphycus* an important marine commodity. Despite this seaweed being the Philippines' major carrageenan-containing marine plant, there are still raw material production problems that consequently affect the end product. These problems are mainly 'ice-ice' disease and epiphyte infestation. Local warm-water events are also detrimental to productivity.

'Ice-ice' disease of *Kappaphycus* was reported as early as 1974 in the Philippines by Trono (1974). Uyenco (1977) and Uyenco et al., (1981) described the occurrence of pathogenic micro-organisms and stressed the interplay of ecological and physiological conditions of the seaweed. Their findings were confirmed by Largo et al. (1995a,b) in the laboratory, who reported that *Vibrio-Aeromonas* complex and *Cytophaga-Flavobacterium* complex induce 'ice-ice'

disease when the plant is stressed by either low salinity or low light intensity. The lytic activity of the bacterium which digests epidermal cells and destroys chloroplast, resulted in initial bleaching of the infected part. Furthermore, Largo et al. (1995b) reported the gradual hydrolysis of the thallus starting from the cortical layer and ending with the medullary cells, leading to full necrosis (tissue death). Much has been reported on 'ice-ice' disease, however, information on epiphyte infestation is very limited: for references to epiphytic filamentous algae see Ask (1999), Ask and Azanza (2002), and Hurtado et al. (2001). The impact of *Polysiphonia* epiphytes was briefly reported in *Kappaphycus* farms in Calaguas Is., Camarines Norte, Philippines and other parts of the Bicol region by Largo (2002) and Critchley et al. (2004). The filamentous, red *Polysiphonia* epiphyte creates small, elevated pores or 'goose bumps' on the surface that are actually sites of penetration from the cortical to the medullary layers of the host plant. Although superficially morphologically similar to reproductive sporangia, these structures are not reproductive and are perhaps somewhat similar to 'galls' in higher plants.

The occurrence of *Polysiphonia* epiphytes in Calaguas Is., observed since 2000, has resulted in tremendously reduced biomass production of *Kappaphycus* in the formerly productive cultivation area. Even now, only a few people continue to farm *Kappaphycus* since the *Polysiphonia* outbreak. The infestation is persistent rather than periodic. Other than the reports of Ask (1999) and Ask and Azanza (2002) no other documentation of *Polysiphonia* epiphytism is known for other parts of the Philippines. There is also little quantification of the impact on seaweed biomass and crop value which epiphytes may have, although there are anecdotal reports on the occurrence of *Polysiphonia* in western Visayas and Luzon.

The present study results from a call for assistance from the NGO community (US Peace Corps, J. Schubert pers. comm.) to assess the occurrence of this epiphyte further and to determine the environmental conditions that trigger its occurrence. Results of this study will provide benchmark information for future work.

Materials and methods

The study was conducted at Calaguas Is., Camarines Norte, Philippines (14°24′–14°30′N and 122°54′–123°1′E). Calaguas Islands is a group of small islands off Vinzons, Camarines Norte, facing the Pacific Ocean. It is made up of 3 barangays namely, Banocboc, Pinagtigasan and Mancawayan. Two pronounced seasons are experienced in this area: the wet season brought by the south-west monsoon trade wind and the dry season brought by the north-east trade wind. The former season experiences frequent to moderate rainfall except when there are typhoons and calm seas, while the latter experiences moderate to strong wave action brought by north-east trade winds.

Three visits (February, May and November 2003) were made in four farming areas: Banocboc, Sugod (protected and exposed areas) and Pinagtigasan. In each farming area, 10–25 samples of seaweed material were taken randomly, placed in labelled bags and the fresh weight determined using a digital balance. The presence of 'goose bumps', meso-epiphytes (<1 mm long) and 'ice-ice' disease was estimated as % cover using a scale of 1–10 (1 = 10%, 2 = 20% . . . 10 = 100%).

Environmental parameters were determined on site, for each sampling time. Light intensity (μmol photons m^{-2} s^{-1}) and water movement (m s^{-1}) were measured with a LI -250 light meter and FP7 water flow meter, respectively. Water temperature, salinity, turbidity, and total dissolved solids were measured using a YSI 650 MDS.

Correlation analysis (R^2) between the percentage cover of meso-epiphytes and some environmental parameters was determined at the 5% level of significance. The colloquial name 'goose bump' *Polysiphonia* is retained since it is descriptive and easily understood by the fisherfolk (Figure 1a and b).

Results

The selection of the farming site was a critical factor in *Kappaphycus* production. Water movement and light intensity in the farming area contributed to the occurrence of 'goose bumps' and *Polysiphonia*. Protected areas (Banocboc, Sugod (protected) and Pinagtigasan) registered a higher % cover (15–65%) of *Polysiphonia* than the exposed areas (Sugod, exposed) (17%) (Figure 2 a–c). A strong correlation between the % cover of 'goose bumps'-*Polysiphonia* and light intensity, R^2 = 0.63 to 1.0) and water movement (R^2 = 0.61 to 1.0) was observed at each of the sampling sites. Other water parameters showed no correlation with the occurrence of 'goose bumps'-*Polysiphonia.* Results of the correlation analysis between light intensity – water movement and 'goose bumps'-*Polysiphonia* infestation showed