POND CULTURE OF MACROALGAE, *GRACILARIA CYLINDRICA* AND *GRACILARIA VERRUCOSA* IN INDONESIA, WITH NOTES ON GASTROPOD PESTS

Eddy Soekendarsi
Department of Biology, Hasanuddin University, Ujung Pandang 90245, Indonesia

ABSTRACT

Using traditional methods, *Gracilaria cylindrica* and *Gracilaria verrucosa* are commonly cultivated in ponds located in the south eastern parts of South Sulawesi. *G. cylindrica* has thick, cylindrical branches. *G. verrucosa* has slender broad-based branches. An illustrated taxonomic account is presented. Three species of herbivore gastropods, *Clithon* sp., *Neritodryas* sp., and *Clypeomorus* sp., occur naturally in the pond areas. The snails easily develop into pests. To reduce the problem, farmers must daily clean cultured *Gracilaria* by hand. Polyculture of *Gracilaria* and milk fish reduce problems with fouling epiphytes.

INTRODUCTION

Algae of the genus *Gracilaria* are among the non-traditional fishery resources gaining importance in a number of coastal communities in South Sulawesi. The seaweed has a considerable economic potential.

Farmers culture *Gracilaria* in ponds connected to the surrounding sea and brackish water. Naturally occurring organisms may enter the ponds through channels so this type of cultivation (tambak) is never free from herbivorous molluscs and fish, or fouling organisms such as epiphytic microalgae. The farmers must work hard to manually clean the *Gracilaria*.

Species of *Gracilaria* cultured in ponds in South Sulawesi have not been recorded (Verheij & Prod'homme Van Reine 1993). The aim of this investigations is to identify the commonly cultured *Gracilaria*, and to identify some of the gastropod pests feeding on the cultured algae.

MATERIAL AND METHODS

Samples were collected from ponds in three regions; Palopo, Sinjai and Takalar. All samples were preserved in formalin (5 units) mixed with saline water (95 units) (Trono & Fortes 1988) and brought to Botany Laboratory, Department of Biology, Hasanuddin University for identification. Samples were also identified by Bogoriensis Museum, Bogor, West-Jawa.

Farmers were interviewed to provide data on pond culture, productivity, market prices, fertilizer, common grazers, and fouling organisms.

Dissolved oxygen, acidity, salinity, turbidity, water and air temperature were measured directly in the ponds by using a water quality checker.

RESULTS

Algae

Two species were cultured: *G. verrucosa* and *G. cylindrica*. Almost all farmers cultured *G. cylindrica* imported from Bali and Surabaya (Capital City of East Jawa Province). Material for culture of *G. verrucosa* was collected locally from nature.

Gracilariaceae are branched plants, even bushy, the branches slender to coarse, terete to strap-shaped, firm and often cartilaginous; axes developing from apical cells, forming a parenchymatous medulla and a narrow small-celled assimilative cortex which may bear delicate colourless hairs.

Taxonomic account of cultured species

Gracilaria Greville, 1830

Plants usually bushy from a small discoid base, terete or flattened, fleshy to cartilag-

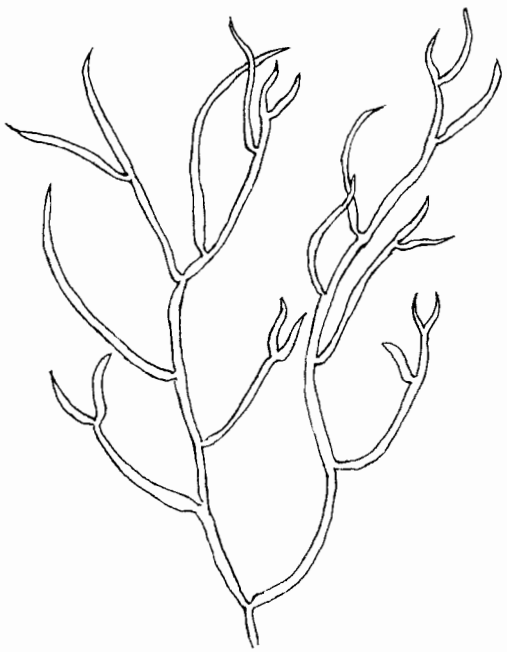

Figure 1. *Gracilaria cylindrica* Børgesen.

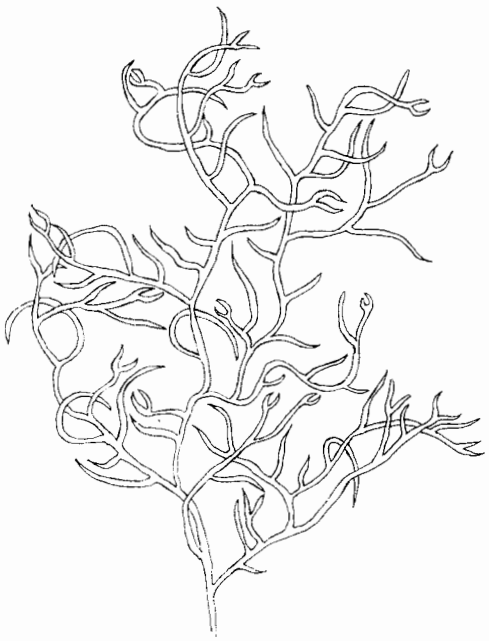

Figure 2. *Gracilaria verrucosa* (Hudson) Papenfuss.

inous, dichotomously, irregularly, or proliferously branched.

Gracilaria cylindrica
Børgesen (Fig. 1)

Gracilaria cylindrica Børgesen 1913-20, Taylor 1928.
Gracilaria blodgettii Børgesen 1909.
Gracilaria secundiramea MazJ & Schramm 1870-77; Muray 1889.
Plocaria compressa p.p. MazJ & Schramm 1870.

Description: Plants erect, to 30 cm tall, fleshy, rose-red in color, relatively sparingly and simply branched, less often bushy; terete throughout; the primary axis tapered to a short and slender stipe, but in general cylindrical; branchlets simple, radially alternate, generally long, usually very sharply constricted or pedicellate at the base and occasionally elsewhere, cylindrical, often arcuate and sometimes blunt at the tips, about as thick as the primary axis; structurally showing a very broad medulla of large, rather thin-walled cells.

Local distribution: Palopo, Sinjai, Takalar regions.

Gracilaria verrucosa (Hudson)
Papenfuss (Fig. 2)

Gracilaria verrucosa (Hudson) Papenfuss 1954.
Gracilaria confervoides Greville 1833; Harvey 1853, 1861; MazJ & Schramm 1870-77; Dickie 1874a,b; Hemsley 1884; Hauck 1888; Murray 1889; Collins 1901; Vickers 1905; Børgesen 1913-20; Collins & Hervey 1917; Howe 1918b; Hoyt 1920; Schmidt 1923, 1924; Taylor 1928, 1929b, 1930, 1933, 1935, 1936, 1941a,b, 1943, 1954; Sanchez 1930.
Gracilaria confervoides v. *cappilaris* Vickers 1905.
Gracilaria tuberculosa p.p. MazJ & Schramm 1870-77; Murray 1889.
Sphaerococcus confervoides Martens 1870.
Sphaerococcus confervoides v. *setaceus* Mar-

tens 1871.
Sphaerococcus divergens Zeller 1876.
Description: Plant bushy, 10 - 30 cm tall, with age often becoming free; texture firmly fleshy, colour dull purplish red to purplish, greyish, or greenish translucent; branches repeatedly dividing, alternately or occasionally nearly dichotomously branched, with numerous lateral proliferations, terete throughout, tapering to the ultimate branchlets.
Local distribution: Sinjai regions.

Herbivorous gastropods
Species in three genera of gastropods may enter the culture ponds through channels constructed for irrigation of the ponds. The snails occur naturally in mangroves and in the channels. Two genera in the family Neritidae, *Clithon* Montfort, 1810, and *Neritodryas* Martens , 1869, and one genus in the family Cerithiidae, *Clypeomorus* Jousseaume, 1888, were identified (descriptions by Dharma 1988).

Water quality
Dissolved oxygen in the ponds ranged from 2.7 to 3.5 mg l^{-1}, acidity from 7.1 to 8.1, salinity from 25-35 ‰, and water temperature from 27.7-30.3 °C

DISCUSSION

Verheij & Prod'homme Van Reinne (1993) found 6 species of *Gracilaria* during an investigation in the Spermonde Archipelago, South Sulawesi: *G. arcuata, G. blodgettii, G. coronopifolia, G. eucheumoides, G. salicornia*, and *G. verrucosa*. They concluded, however, that identification of *G. verrucosa* still needs critical comparison with type material and relevant collections. In the present study, *G. verrucosa* from the Sinjai region was identified at the Bogoriensis Museum, Bogor.

According to one aquaculturist in Sinjai, *G. verrucosa* was the only species he could culture. But *G. verrucosa* collected from nature had low growth rate. In addition, the cultured algae were easily fouled by epiphytic algae, *eg Enteromorpha* sp., and *Chaetomorpha* sp. Epiphytes can seriously reduce the growth of *Gracilaria* by overgrowing the thallus. Therefore, the farmers of *Gracilaria* commonly practice polyculture by having *Gracilaria* and *Chanos chanos* (milk fish) together in one pond. Milk fish are claimed to reduce the growth of the epiphytes (pers. com.). Farmers use urea, cattle manure, and/or poultry manure (20-25 kg per hectare) to fertilize *Gracilaria*. Fertilizers are applied only after water change.

If not controlled, herbivorous snails can destroy the *Gracilaria* cultivation in short time. The snail *Clithon* sp. feeds by sucking out the cell content of algal branches. After feeding the sucked *Gracilaria* thallus becomes white in colour, but the morphology of the alga is still complete. *Clithon* sp. is not considered as harmful to algal culture as *Neritodryas* sp., and *Clypeomorus* sp. These two species eat the thallus tips of *Gracilaria*. To reduce the problem the farmers must daily clean the algae by hand.

The farmers also noted that the herbivorous fish, *Siganus siganus,* has the potential to threaten culture of *Gracilaria* due to intensive feeding on the algae.

Rhodophyta containing agar and carrageenan are widely cultured in South East Asia. One of the most economically important genera is *Gracilaria*. The dried seaweed is sold to large international traders and then exported to Japan, America, and Europe. The production of *Gracilaria* is quite variable. Farmers in South Sulawesi harvest from 1-3 tonnes dry weight per hectare. The market price, when farmers sell to the local businessmen, are 600-800 Rp per kg (1 US$ = 2500 Rp.). According to one farmer (pers. com. 1997), *Gracilaria cylindrica* has a high quality of carrageenan and hence fetches a better price compared with *Gracilaria verrucosa*.

In South Sulawesi, ponds for culture of *Gracilaria* have a water depth from 50-80 cm compared to 30-60 cm in the Philippines (Trono & Fortes 1988). Dissolved oxygen

ranged from 2.7 to 3.5 mg l^{-1} in the ponds. The optimum amount of dissolved oxygen for *Gracilaria* is 2.9 mg l^{-1}. The acidity was similar in all ponds and ranged from 7.1-8.1 units. According to Aslan (1991) and Romimohtarto (1987), the optimum acidity for *Gracilaria* is 8 to 8.5. Salinity ranged from 25-35 ‰. The optimum salinity is 25 ‰ according to Aslan (1991) and Romimohtarto (1987). Water temperature ranged from 27.7 to 30.3 °C. Romimohtarto (1987) found optimum water temperatures in the range of 20-28 °C. The present measurements of water quality are in good agreement with optimum values mentioned above. In addition, a good drainage system and freshwater supply is needed to maintain a slightly brackish water in the ponds, 20-30 ‰ salinity (Trono & Fortes 1988).

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