

## Effect of salinity on physiology of *Gracilaria* spp. (Gigartinales, Rhodophyta)

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### ABSTRACT

*Gracilaria edulis* and *G.crassa* were subjected to different salinities such as 15, 25, 35 and 45 ppt in the growth chamber in controlled environmental condition. The effects of salinities on photosynthetic activities, absorption spectrum and the pigment constituents were recorded. The Photosynthetic activity ( $P_{max}$ ) reduced in all the treatments, when the plants were removed from the natural habitat. The decline was marginal in 35 ppt salinity (6.4%) compared to 15- 65 % in other salinities within 0-6 days of treatment in *G.edulis*. Similarly, in *G.crassa* the  $P_{max}$  declined by 4.3% in 35 ppt treatment compared to 53-75% in others during the same period. Further, from 6-12 days of treatment, there was a perceptible reduction in  $P_{max}$  activity in all the samples. The chlorophyll and the accessory pigment concentration increased in both the species at 35 ppt salinity. The absorption peak of the samples treated under hypo and hyper saline condition showed shifts from the original place.

### Introduction

Salinity is an important environmental parameter affecting distribution, growth, morphology and chemical composition of algae (Haug and Larson, 1958; Kim, 1970, Gessner and Schramm, 1971). The short and long term effects of salinity on the physiology of intertidal algae have been examined primarily in terms of their physiological accommodation to this stress (Munda and Kremer, 1977; Bisson and Kirst, 1979; Kauss, 1979; Kirst and Bisson, 1979; Reed *et al.*, 1980a, 1980b, 1980c; Coudret *et al.*, 1983). Photosynthesis and respiration have also been shown to be affected by salinity changes (Kremer, 1979a, 1979b; Yarish *et al.*, 1979). The present work deals with the change on physiology of two of the *Gracilaria* species subjected to different salinities.

### Materials and Methods

*Gracilaria edulis* and *G.crassa* were collected from Thonithurai, situated in the South east of Tamilnadu in between Palk Bay and Gulf of Mannar (9°17'N and 70°11'E) during the low tide in the morning. The plants were washed thoroughly in filtered seawater and transported to Madurai Kamaraj University. They were maintained in the growth chamber at 25°C with 16L:8D photoperiod to overcome the transportation stress. *Gracilaria edulis* and *G.crassa* were subjected to different salinities such as 15, 25, 35 and 45 ppt. Light and temperature were kept constant throughout the experiment.

The apical portion of the thallus were hung from the top inside the cylindrical oxygen electrode chamber (Hansatech, UK)

containing 2 ml of filtered seawater. Saturated white light of 100 w/m<sup>2</sup> was passed through the round bottom flask (10 cm diameter) from the slide projector (Photophone Ltd., India) before illuminating the chamber. The water inside the cylindrical tube was stirred continuously by a magnetic stirrer. The amount of oxygen evolved was monitored continuously at 25 °C. Mean of three consecutive readings were taken for calculation. Rate of photosynthesis and respiration were expressed as m mol O<sub>2</sub> evolved/g fresh weight / h.

Estimation of pigments such as chlorophyll (Chl *a*), phycoerythrin (PE), phycocyanin (PC) and allophycocyanin (APC) were carried out by standard procedures of Jeffrey and Humphrey (1975). Absorption spectra of the thallus were recorded at room temperature (25 °C) using Hitachi 557 spectrophotometer. The ground glass sides of matched cuvettes were kept in the light path so that reference and sample beams are scattered to the same extent. The slit width of measuring beam was narrowed down to 2.0 nm. All the observations were taken before treatment (BT), 6 days after treatment (6DAT) and 12 days after treatment (12DAT).

## Results

*Gracilaria edulis* showed decline in chlorophyll content at 15, 25 and 45 ppt salinities after 6 DAT ranging between 25-50% from the initial level. In *G. crassa*, the chlorophyll content declined by 21.6% and 27.9% in hypersaline (45ppt) and hyposaline (15 ppt) conditions respectively, whereas it increased in 25 and 35 ppt. On 12<sup>th</sup> day in *G. edulis*, the chlorophyll content declined in 15 and 35 ppt but increased in 25 and 45 ppt. In *G. crassa*, the chlorophyll content exhibited decline in all the treated samples after 12 days.

The accessory pigments in *G. edulis* at 25 and 45 ppt showed an increasing trend.

However, at 15 and 35 ppt it showed varied responses. At 35 ppt both phycocyanin and allophycocyanin content increased, but in 15ppt only allophycocyanin showed increase by 9.9%. Phycoerythrin registered decline in both the treatment (Fig.1). In *G. crassa*, the accessory pigments were found to increase in all the treated samples except for a decline in phycoerythrin content at 15 and 45 ppt by 19.1% and 7.0% respectively (Fig. 2). After 12 days, the accessory pigments in all the treatments declined in both the species but *G. crassa* showed more pronounced decline than *G. edulis*.

The photosynthetic activity was found to decrease in *G. crassa* and *G. edulis* after 6 and 12 days of treatment and such decrease was more pronounced in low salt concentration. In all the treatments, the activity declined gradually from 6-12<sup>th</sup> days of incubation. In 35 ppt, the decline was marginal being 6.41% in *G. edulis* and 4.09% in *G. crassa* on 6<sup>th</sup> day of treatment whereas in 15 ppt, the photosynthetic activity declined drastically in both the species of *Gracilaria*. At 45 ppt, the decline was marginal initially and pronounced on 12<sup>th</sup> day. In *G. crassa* the decline was found to be 90% on 12<sup>th</sup> day (Table 1).

Room temperature absorption spectra of fresh and treated *G. edulis* and *G. crassa* showed prominent peaks at 676, 621, 565, 495 and 433 nm (Fig.3). On 6<sup>th</sup> day of treatment, in *G. edulis* the small peak at 541 nm becomes prominent at 25, 35 and 45 ppt, but reduced at 15 ppt. The absorption peak in samples incubated at 35 ppt was better preserved than other when the spectra were normalized at 433 nm (Fig.4). On 12<sup>th</sup> day of treatment at 15 ppt, the peaks at 565 and 495nm were shifted to 563 and 493nm respectively and in 35 and 25 ppt, they were shifted to 560 and 491 nm respectively. In addition, the peak at 541 nm were prominent on 6<sup>th</sup> and 12<sup>th</sup> day of treatment (Fig.5).

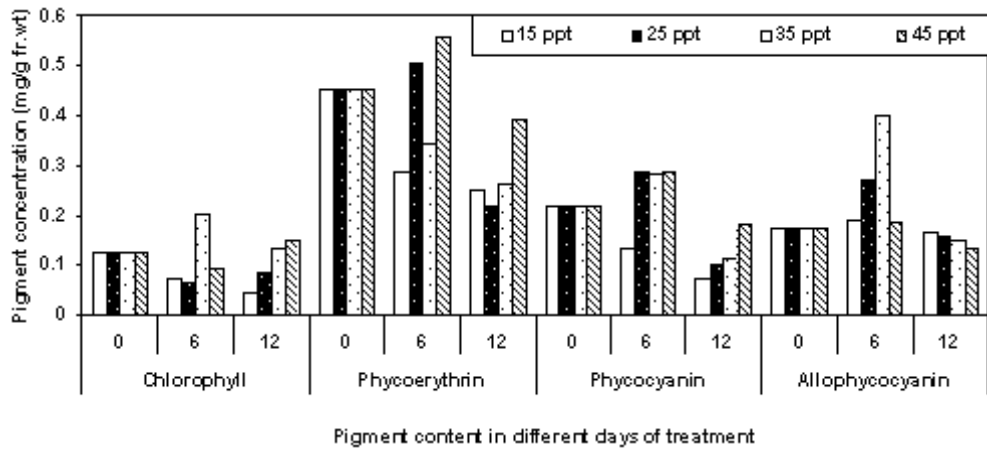


Fig. 1. Effect of salinities on the photosynthetic pigments of *Gracilaria edulis*

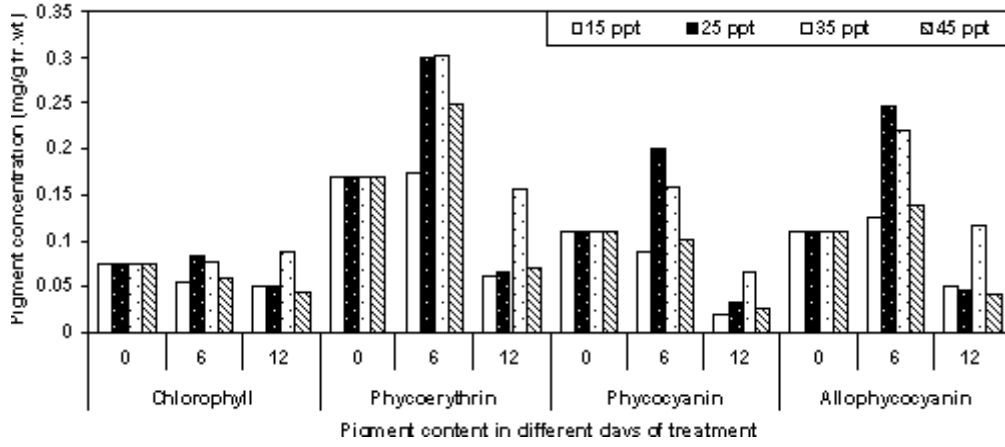


Fig. 2. Effect of salinities on the Photosynthetic pigments of *Gracilaria crassa*

Table 1. Effect of salinities on the photosynthetic activity of *Gracilaria spp.*

Species	Treatment (ppt)	Photosynthetic activity (m mole/g fw/h)			% of Change	
		0 day	6 days	12 days	0-6 days	6-12 days
<i>G.edulis</i>	15	26.54	9.12	8.00	-65.3	-12.3
	25	26.54	14.97	8.33	-43.6	-49.4
	35	26.54	24.84	9.09	-6.4	-63.4
	45	26.54	22.56	8.62	-15.0	-61.8
<i>G.crassa</i>	15	18.33	4.55	3.38	-75.2	-25.7
	25	18.33	7.83	3.21	-57.3	-59.0
	35	18.33	17.58	7.69	-4.1	-56.3
	45	18.33	8.62	0.84	-53.0	-90.3

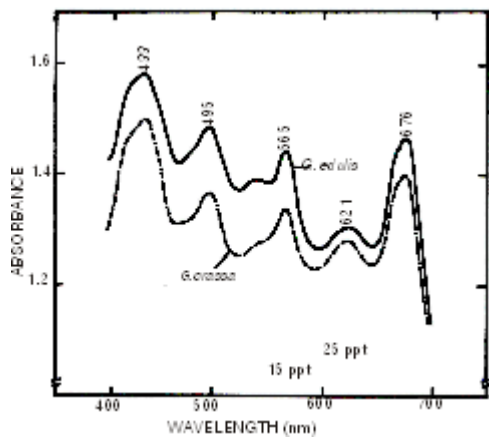


Fig. 3. Room temperature absorption spectra of *Gracilaria* spp. before treatment

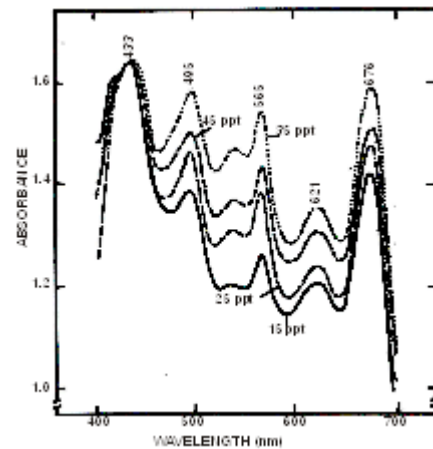


Fig. 4. Room temperature absorption spectra of *Gracilaria edulis* under different salinities on 6 days after treatment

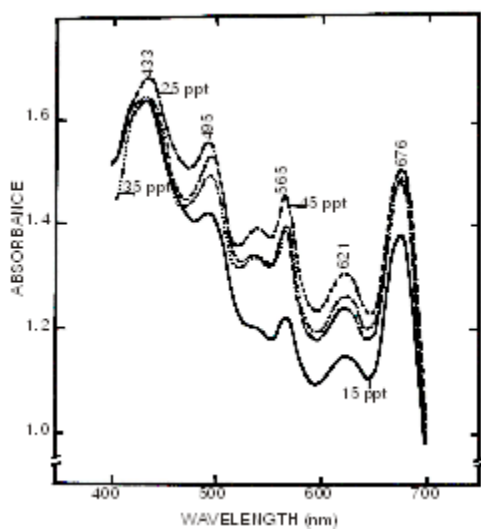


Fig. 5. Room temperature absorption spectra of *Gracilaria edulis* under different salinities on 12 days after treatment

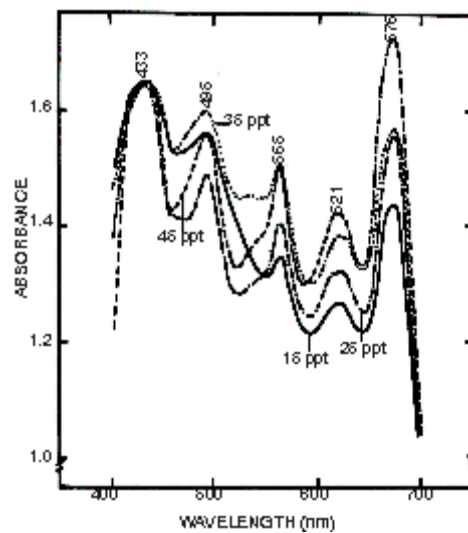


Fig. 6. Room temperature absorption spectra of *Gracilaria crassa* under different salinities on 6 days after treatment

In *G. crassa* at 45 ppt, the absorption peaks at 676 and 621 nm were prominent on 6<sup>th</sup> day of treatment whereas at 35 ppt the peak maxima was observed at 495 nm. In 45 ppt, the peak at 676 nm was shifted to 674 while that of 621 to 624 nm in the samples treated with 35 and 15 ppt respectively. The peak at 541 nm

was not very prominent (Fig.6). After 12 days of treatment, the peaks at 676, 621, 565 and 495 nm became prominent in 35 ppt. The peak at 676 nm was shifted to 679 in 15 and 25 ppt samples and to 672 nm in 35 ppt sample. Similarly, a shift of absorption peak at 565 nm to 562 nm for 15 ppt and to 563 nm for 25 ppt was noticed. The

peak at 495 nm was found shifted to 497 nm in 15 and 25 ppt but at 35 ppt the peak at 433 nm showed drastic shift to 441 nm. In samples treated with 45 ppt, the level of major peaks showed drastic reduction. (Fig.7).

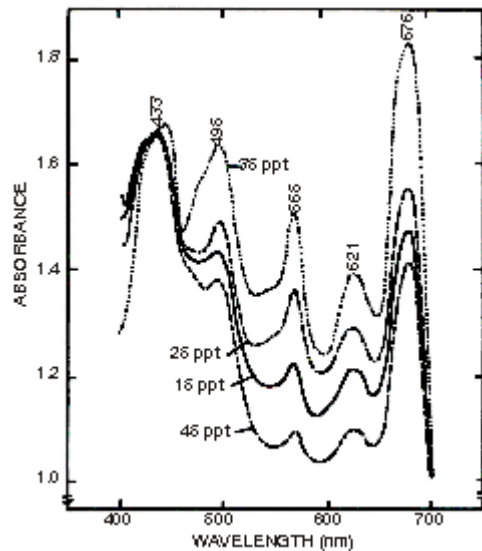


Fig. 7. Room temperature absorption spectra of *Gracilaria crassa* under different salinities on 12 days after treatment

## Discussion

The photosynthetic activity of *Gedulis* and *G.crassa* declined gradually from 0-12 days of treatment under different salinities. The decline in photosynthetic activity at a function of time was evidenced for all the experiments conducted indicating that such changes may be due to gradual decline of dissolved carbon content in the stagnant seawater. Among the different salinities tried, high photosynthetic activity was noticed under 35 ppt in *Gedulis* followed by 45 ppt. Although prolonged incubation retarded the photosynthetic activity drastically in all the treated samples, those kept in 35 ppt maintained higher activity. The low photosynthetic activity was evidenced under low salinity. This is in conformity with several

earlier studies (Yarish *et al.*, 1929; Coudret *et al.*, 1983). It was also been reported by Dawes *et al.* (1998) that in comparison with other subtropical and warm temperate species of *Gracilaria*, *G. cornea* had lower levels of pigment, but similarly high photosynthetic efficiency, demonstrating shade adaptation. It had only limited tolerance to salinities below 20 ppt as found out in the present experiment. There is also report indicating that photosynthetic and respiratory rates declined at higher salinity in *Griffithsia monilis* (Kirst, 1981). Macler (1988) suggested that *Gelidium coulteri* can grow even at 50 ppt salinity but with the net surplus photosynthesis due to utilization of carbon fraction and increase in photorespiration.

Absorption spectra of thallus of *G.edulis* and *G.crassa* showed variations under treatment of different salinities. The prominent peak at 676, 565, 495 and 433 nm are attributed to the major photosynthetic pigments. In *Gedulis*, the major peaks at 565 and 495 nm were shifted to a certain extent could be attributed to changes in chlorophyll and phycobilin pigments.

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