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INFLUENCE OF SALINITY ON THE RATES OF PHOTOSYNTHESIS AND RESPIRATION IN *ULVA INDICA* ANAND.

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Abstract

Rates of gross photosynthesis and respiration were measured in a littoral green alga, *U. indica* in normal sea water (36 °/oo S) after 1 h treatment with salinities between 0 – 80 °/oo, at 28°C. The seaweed showed very low photosynthetic activity after exposure to salinities below 30 °/oo and higher than 70 °/oo. A similar treatment with salinities between 40 and 60 °/oo accelerated the rate of photosynthesis. An exposure to fresh water resulted in extremely retarded respiratory activity, which increased over the control on treatment with salinities between 10 and 40 °/oo. An exposure to 50 °/oo and higher salinities gradually suppressed the rate of respiration.

Introduction

Several efforts have been made to investigate the effect of salinity on gas exchange of marine plants (Ogata, 1963; Ogata & Matsui, 1965; Nath, 1966; Nellen, 1966; Hammer, 1968; Gessner, 1969; Ogata & Takada, 1969; Ogata & Schramm, 1971; Shameel, 1973; Ohno, 1976; Lehnberg,1978). Our knowledge about the influences of this important ecological determinant on the seaweeds in the marine environment is insufficient. Direct responses of the photosynthetic and respiratory systems to direct salinity regimes have not been thoroughly analysed. In this study an attempt has been made to measure the effect of salinity on the rate of O_2 exchange in a green seaweed, *U. indica*.

Materials and Methods

Ulva indica Anand was collected in the upper littoral from the ledge of conglomerate rocks at Paradise Point near Karachi, northern Arabian Sea. The alga which is endemic to the coast of Pakistan, provides an ideal material for the study of photosynthetic and respiratory activities due to its small (upto 2 cm long), two celled thick and leaf like thallus. Freshly collected clean, healthy and $1^1/2$ cm long thalli were selected, kept in water with different salinities (0 - 80 °/oo) for 1 h in complete darkness and were then brought back into normal sea water (36 °/oo S). Some of these were kept in sunlight and others in darkness for 1 h, in order to determine the rate of gas exchange at 28°C.

Amount of O_2 production or uptake was measured by the Winkler method (Grasshoff, 1976), and the rates of phtosynthesis and respiration were calculated. Values obtained in terms of mg O_2. g dry wt^{-1}. h^{-1} were compared with those of the control and expressed as percent of control. They are arithmetic means of 8 independent values; standard deviation was also calculated in each case and expressed diagrammatically.

Results and Discussion

An increased photosynthetic activity was observed in the thalli exposed to salinities (S) between 40 and 60 °/oo (Fig. 1). A treatment with 30 °/oo S almost remained without any effect, but the lower salinities adversely damaged the photosynthetic mechanism. Transfer of alga from saline to fresh water decreased the photosynthetic activity to almost zero. Salinities higher than 60 °/oo gradually reduced the subsequent rate of gross photosynthesis. The suppressed photosynthetic activity noticed in treatments with low salinities might have resulted from fast and extreme loss of ions due to extremely high ionic pemeability, as noted in *Fucus virsoides* and some other algae (Gessner, 1969; Ohno, 1976). A decrease in the rate of photosynthesis shown after exposure to very high salinities might have been due to osmotic stress.

Gessner (1969) observed that the photosynthetic activity of a littoral brown alga, *Fucus virsoides* was not affected by a 1 h exposure to low and high salinities. *U. indica* is also a littoral seaweed, growing on the rocks subjected to strong wave action (Saifullah & Nizamuddin, 1977). It has a very thin thallus and presumably ions are washed out by diffusion affecting the living system adversely. In contrast, *F. virsoides* has a very thick

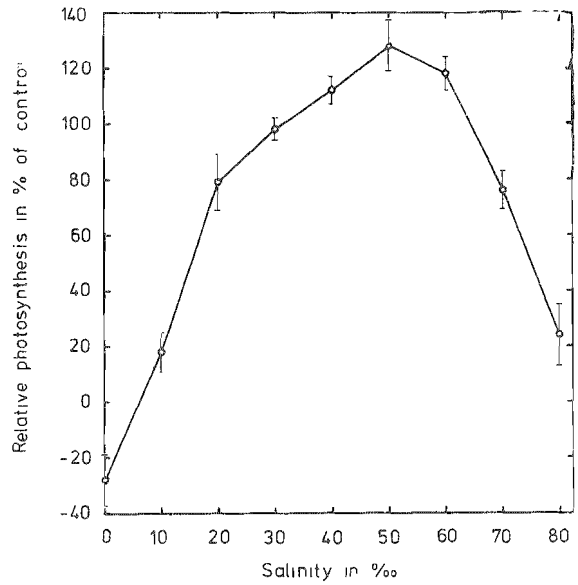

Fig. 1. Rate of gross photosynthesis in *Ulva indica* determined in normal sea water (36 °/oo S) after 1h treatment with various salinities at 28°C

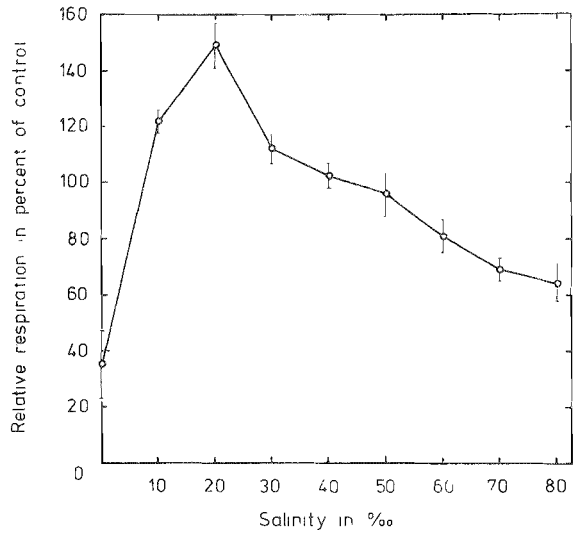

Fig. 2. Rate of respiration in *Ulva indica* measured in normal sea water (36 °/oo S) on 1h exposure to different salinities at 28°C.

thallus with anatomical differentiation, in which ions are thrown out primarily from the "free space" without affecting the living system as observed in *F. serratus* (Gessner & Hammer, 1968).

Respiration in *U. indica* was found to be more affected than photosynthesis on treatment with different salinities (Fig. 2). The thalli kept in fresh water showed an extremely reduced rate of respiration, while an exposure to diluted sea water (10 – 30 °/oo S) increased the respiratory activity. The treatment of thalli with the medium close to sea water (40 °/oo S) remained without any appreciable effect. On pretreatment in concentrated sea water (50 80 °/oo S) the respiratory rate was found to decrease with increasing salinity.

Reduced rate of respiration on treatment with fresh water indicates its lethal effects on algal cells. Although the thalli were replaced in sea water, yet no regeneration took place. Long exposures killed the alga. It is interesting to observe that several hours' exposure of *F. virsoides* to aerated distilled water does not affect its metabolism in sea water (Gessner, 1969). This may be due to the difference in the construction and anatomy of the thalli of both the seaweeds.

Salinity is a complex ecofactor and its effect can, to a high degree, be modified by co-factors such as light, temperature, nutrition and pH. Previous observations on the effect of salinity on O_2 exchange of marine algae have indicated a number of different responses (Gessner & Schramm, 1971), which may be due to differences in the experimental conditions. Responses to salinity also vary with the different algal material. Salinity not only acts via total osmoconcentration, but also affects via ionic influences, due to which various seaweeds may react differently.

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