EFFECTS OF ENVIRONMENTAL FACTORS ON DIURNAL PERIODICITY OF TETRASPORE OUTPUT IN SOME RED ALGAE OF VISAKHAPATNAM COAST

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Abstract

Effects of environmental factors such as desiccation, salinity, light and temperature on the diurnal periodicity in liberation of tetraspores in Gelidium pusillum, Pterocladia heteroplatos and Gelidiopsis variabilis were studied. Desiccation of fronds, salinity and continuous dark or light at different intensities had no effect on the diurnal periodicity in spore output in these three red algae. The temperature of sea water was the primary factor controlling the peak output of spores. Peak liberation of spores was delayed for 4-12 hr in a day in G. pusillum and G. variabilis when the temperature of sea water was below 30°C.

Introduction

Information available on environmental factors influencing diurnal rhythm in spore release from red algae is very scanty (Katada et al., 1953, Umamaheswara Rao and Subbarangaiah, 1981 and Subbarangaiah, 1985). Effects of various environmental factors on the output of tetraspores from Gelidium pusillum (Stackhouse) Le Jolis, Pterocladia heteroplatos (Boergesen) Umamaheswara Rao and Kaliaperumal and Gelidiopsis variabilis (Greville) Schmitz have been published recently (Umamaheswara Rao and Kaliaperumal, 1983). The present paper deals with the effects of desiccation, salinity, light intensity and temperature on the diurnal periodicity of tetraspore liberation from these three red algae growing at Visakhapatnam.

Materials and Methods

Tetrasporic plants of G. pusillum, P. heteroplatos and G. variabilis were collected during afternoon spring tides from the intertidal region of Visakhapatnam coast in different months of the year 1977-78. As described earlier (Umamaheswara Rao and Kaliaperumal, 1983) fertile thalli were selected and used for spore liberation experiments. The experiments were commenced from 6 PM and the spores liberated into the petri dishes at 4 hr intervals were counted following the method given by Umamheswara Rao and Kaliaperumal (1983). For studying the effect of desiccation at room temperature, fronds and

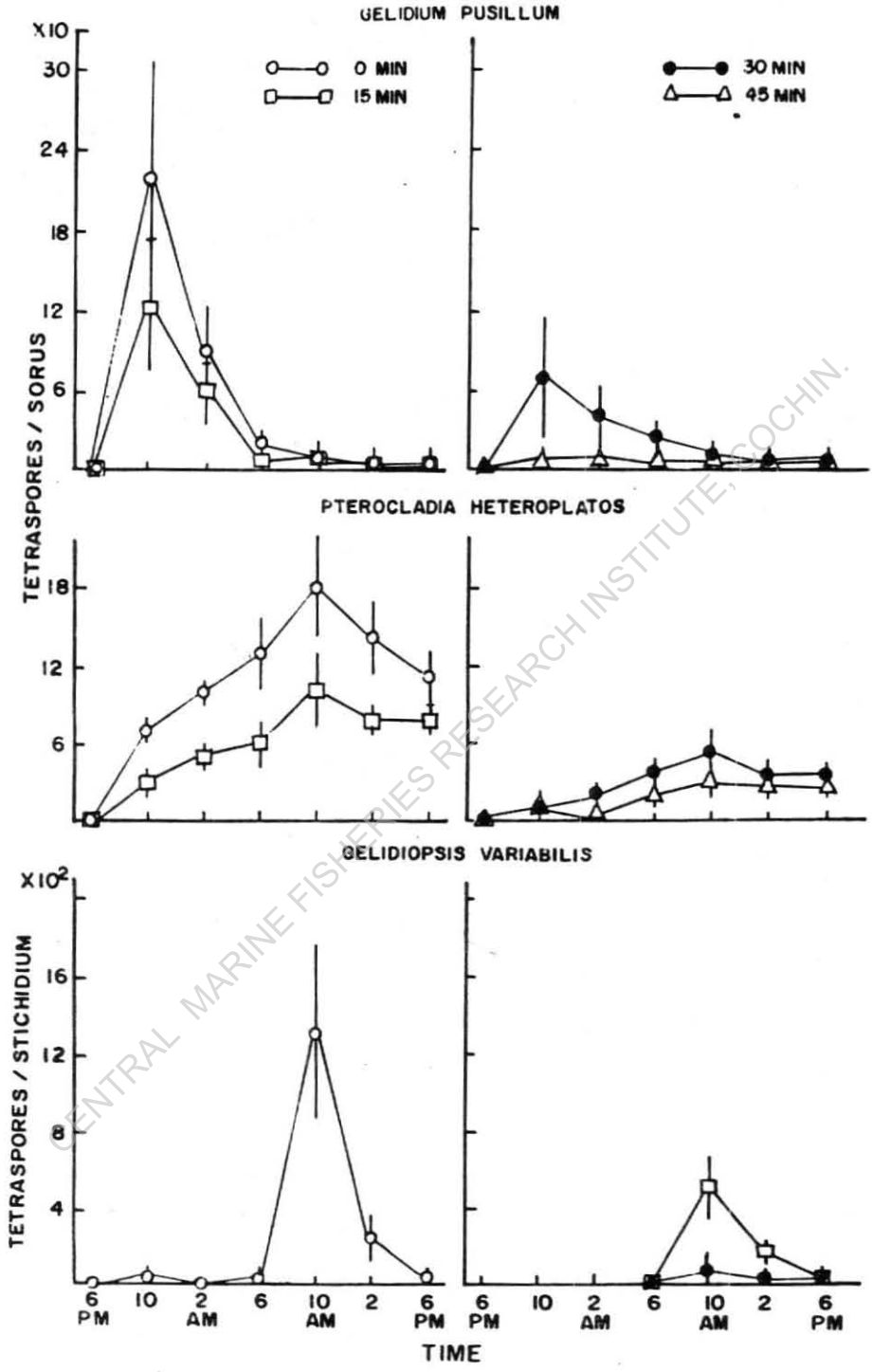

Fig. 1. Effect of desiccation on the diurnal periodicity of tetraspores in G. pusillum, P. heteroplatos and G. variabilis (Vertical lines show standard error to the mean value)

stichidia were first blotted with cloth and then the fronds of G. pusillum and P. heteroplatos were exposed to air for 15, 30 and 45 min. and stichidia of G. variabilis for 15 and 30 min. Control (0 min. exposure) were also maintained in all these experiments. After exposure to air the fronds and stichidia were placed separately in petri dishes containing sterile sea water.

Effects of salinity was tested using sea water of 20, 30, 40 and 50°/$_{oo}$ for G. pusillum and P. heteroplatos and 20, 30 and 40°/$_{oo}$ for G. variabilis. Desiccation and salinity experiments were conducted at room temperature (28 ± 2°C) near a light source of 500 lux to provide sufficient light from 10 AM to 6 PM. To test the influence of light intensity on diurnal rhythm in tetraspore output, experiments were conducted at 0,500,1500 and 3000 lux. The response of various temperature i.e. 15-35°C for G. pusillum, 15-40°C for P. heteroplatos and 25-35°C for G. variabilis with 5°C intervals was studied by keeping petri dishes in temperature controlled dark incubator. Mean values of 10 experiments conducted for each factor with G. pusillum and P. heteroplatos and 5 experiments with G. variabilis are plotted in Figs. 1 to 4 and the data are presented as tetraspores/sorus and tetraspores/stichidium.

Results

Data collected on the effect of exposure to air on the diurnal periodicity in tetraspore liberation are given in Fig.1. In G. pusillum collected during March-November, there were no differences in the diurnal periodicity between the control and fronds exposed for 15 and 30 min. with peak shedding in all the experiments from 6 PM to 10 PM. But in 45 min. exposure the quantity of spore output was very little and showed no definite peak in spore shedding. In P. heteroplatos maximum shedding of spores was found between 6 AM and 10 AM in the control experiemtns as well as in fronds exposed for 15 min. Though the spores liberated were less at different times of the day, spore output was slightly more from 6 AM to 10 AM or from 10 AM to 2 PM in the fronds exposed for 30 and 45 minutes. In G. variabilis collected during April-June peak sporulation was seen between 6 AM and 10 AM in the control experiments and in stichidia exposed for 15 and 30 minutes.

Fig.2 shows the effect of salinity on diurnal periodicity in tetraspore shedding. In G. pusillum collected in February and March, the peak output of spores was observed from 10 PM to 2 AM at 4 different salinities ranging from 20 to 50°/$_{oo}$. In P. heteroplatos at 20°/$_{oo}$ the spore output was low and more or less same quantity of spores was dischargedat different times of the day. There was a gradual increase in spore output at 30°/$_{oo}$ from 6 PM to 2 PM with more number of spores between 2 AM and 6 AM and thereafter the output decreased. Similar trend was found at 40°/$_{oo}$ with more quantity of spores from10 AM to 2 PM. The spore output values were very low at 50°/$_{oo}$ and it was some what irregular. In G. variabilis collected in March, peak spore output was found in 20°/$_{oo}$ between 6 PM and 10 PM. At 30°/$_{oo}$ more number of spores were liberated from 6 PM to 10 PM and from 6 AM to 10 AM. At 40°/$_{oo}$ peak period of sporulation was between 10 AM and 2 PM.

Results obtained on the diurnal periodicity of tetraspore output in dark and at different light intensities are plotted in Fig.3. In G. pusillum collected in January and in February peak output of spores was found between 10 PM and 2 AM in dark, 500,

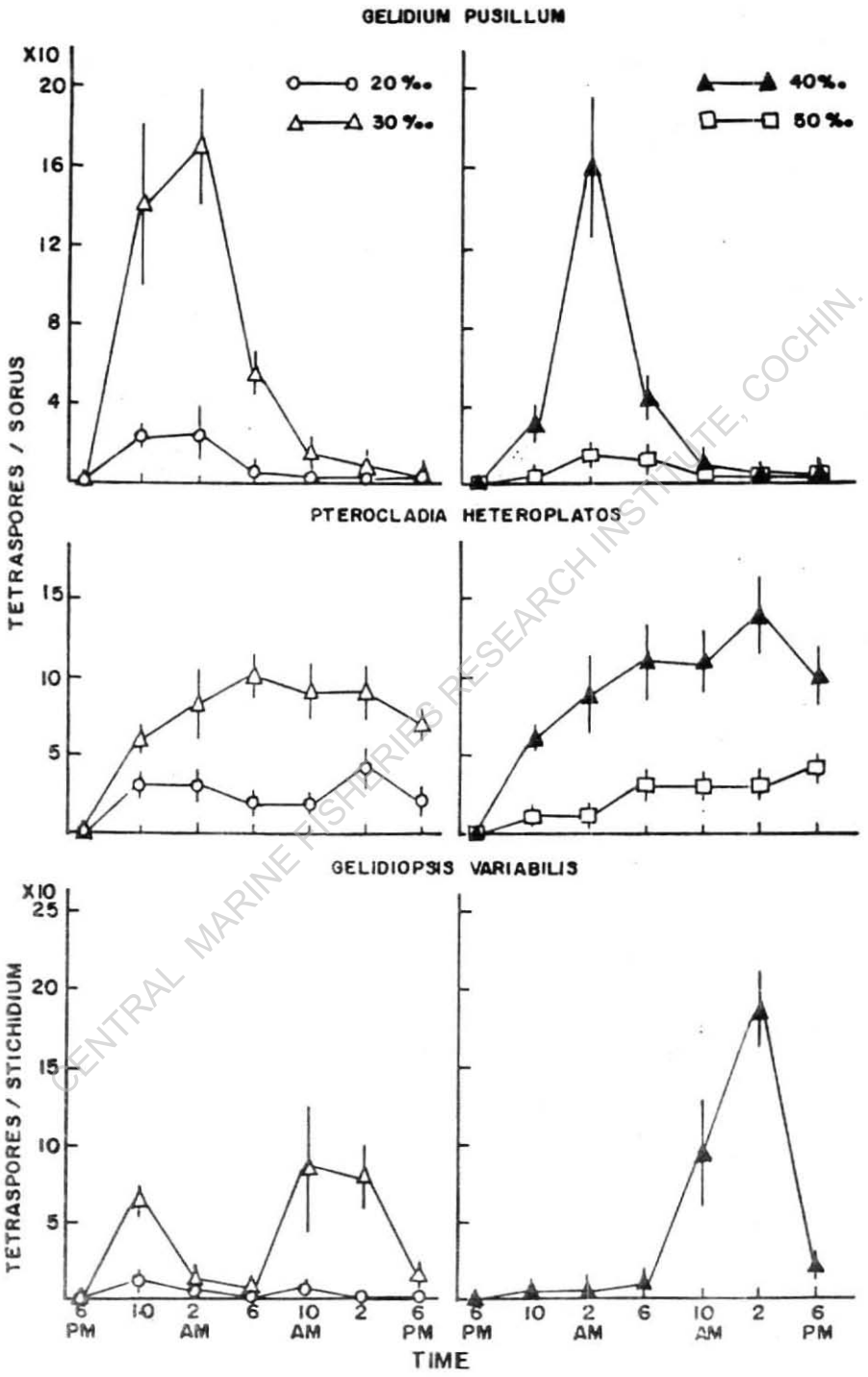

Fig. 4. Influence of temperature on the diurnal periodicity of tetraspores in G. pusillum, P. heteroplatos and G. variabilis

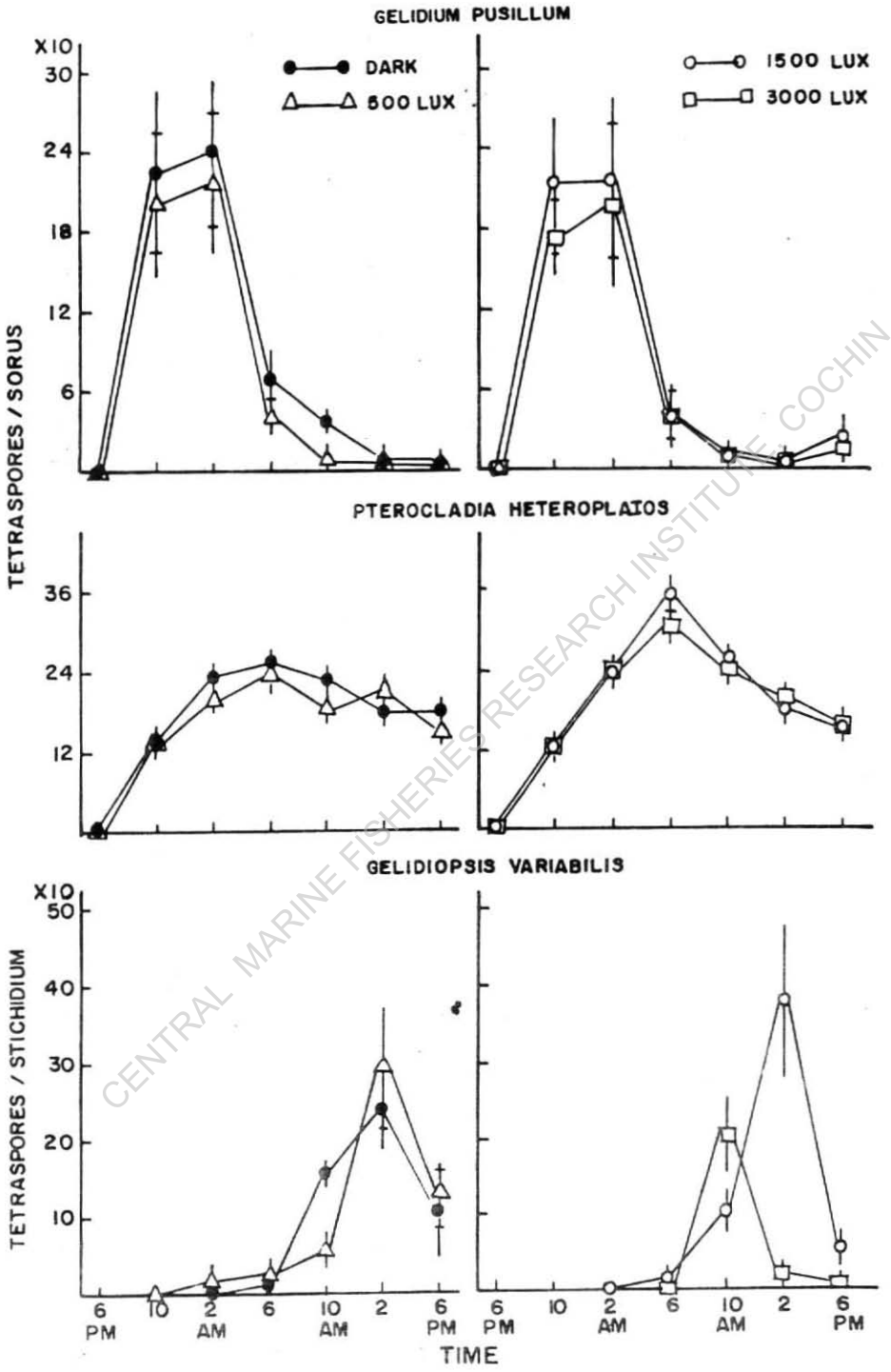

Fig. 3. Influence of light intensity on the diurnal periodicity of tetraspores in G. pusillum, P. heteroplatos and G. variabilis

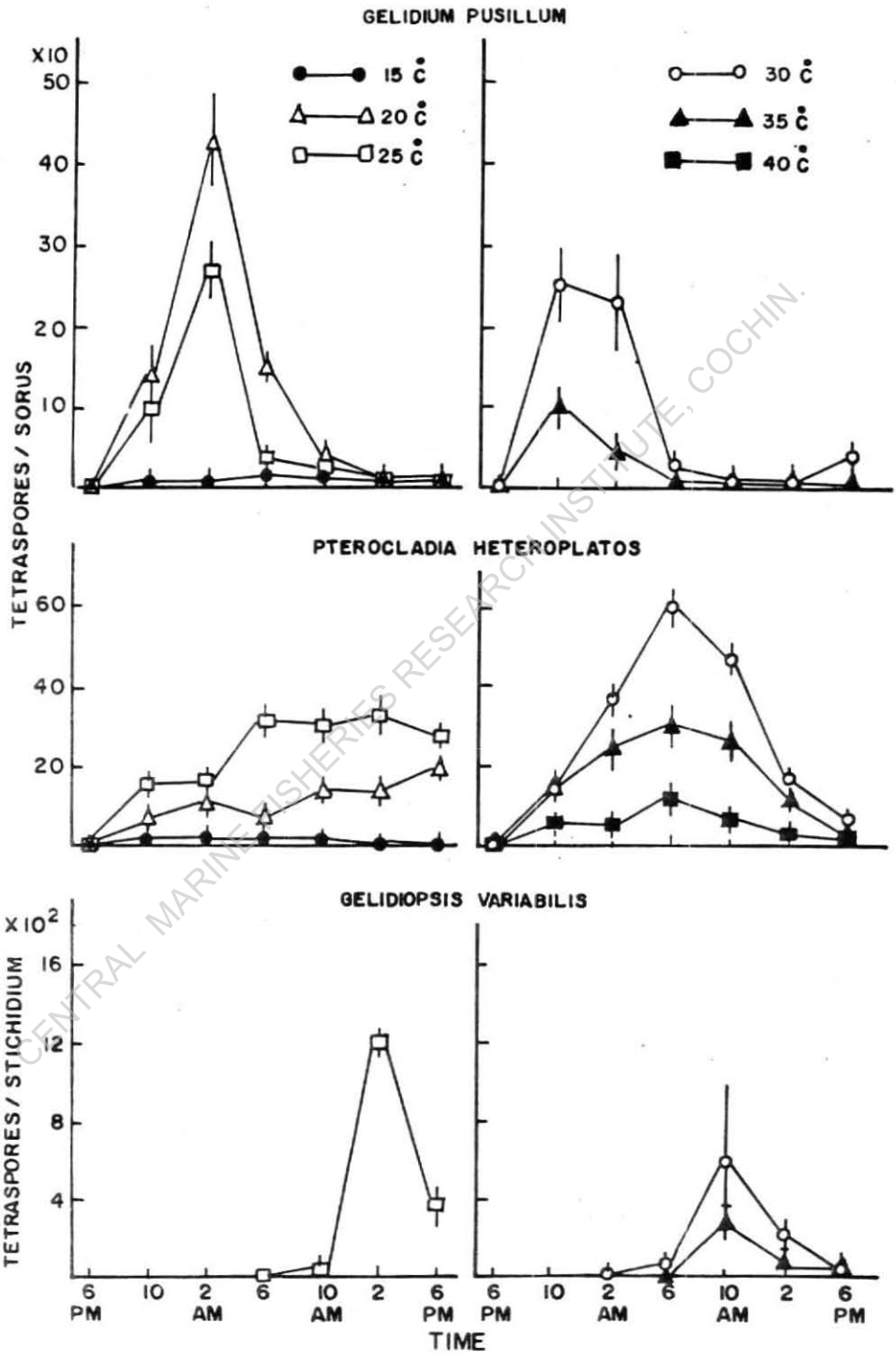

Fig. 2. Effect of salinity on the diurnal periodicity of tetraspores in G. pusillum, P. heteroplatos and G. variabilis

1500 and 3000 lux light intensities. In P. heteroplatos also no variation was found in dark and in three light intensities tested and maximum number of spores was found between 2 AM and 6 AM. In G. variabilis collected during December-February the diurnal periodicity obtained were similar in dark, 500 and 1500 lux with peak shedding of spores between 10 AM and 2 PM. But in the experiments conducted at 3000 lux light intensity maximum shedding of spores was observed 4 hr earlier i.e. from 6 AM to 10 AM.

Fig. 4 shows the influence of temperature on the diurnal perodicity of spore liberation. In experiments conducted with G. pusillum during August-November at 15°C the number of spores liberated at different times of the day was very low and relatively more spores were liberated from 2 AM to 10 AM. At 20 and 25°C an increase in spore output was observed from 6 PM with a clear cut peak betwen 10 PM and 2 AM. Thereafter a sudden decline in the sporulation was found and the values obtained for the rest of the day were very little. At 30 and 35°C maximum shedding of spores occurred between 6 PM and 10 PM. In P. heteroplatos at 15°C the spore output was very low at different times of the day with high value from 6 PM to 10 PM. At 20 and 25°C more number of spores was seen from 2 PM to 6 PM and from 10 AM to 2 PM respectively. At 30, 35 and 40°C maximum quantity of spores was liberated between 2 AM and 6 AM. In experiments conducted with G. variabilis in December and January, peak output of spores was observed from 10 AM to 2 PM at 25°C. At 30 and 35°C maximum shedding was seen 4 hr earlier than at 25°C i.e. between 6 AM and 10 AM.

Discussion

Regular diurnal periodicity in spore shedding with peak discharge of spores during night time in G. pusillum and during day time in G. variabilis was observed. The pattern of the diurnal curves varied seasonally in these two red algae and 4 hr delay in peak shedding of spores was found during winter months from December to February/March. But in P. heteroplatos there was no regular diurnal periodicity in spore output and seasonally also there was no variation in the pattern of diurnal curves (Umamaheswara Rao and Kaliaperumal, 1987).

In Gloiopeltis species fronds exposed for 2-6 hr liberated spores even 10 hr before the daily peak liberation (Matsui, 1969). But this type of accelerating effect was not seen in G. pusillum, P. heteroplatos and G. variabilis as observed in Gracilaria corticata, G. textorii, Gracilariopsis sjoestedtii and Hypnea valentiae (Umamaheswara Rao and Subbarangaiah, 1981). Salinity had no effect on diurnal periodicity of spores liberated from members of Gigartinales (Umamaheswara Rao and Subbarangaiah, 1981). Similar results were obtained in the present study with G. pusillum and P. heteroplatos (Fig. 2). But in G. variabilis the pattern of diurnal periodicity altered in 20% and 30% and in these two salinities spore output was high betwen 6 PM and 10 PM and from 6 AM to 10 AM (Fig. 2). More detailed studies are needed to understand the variations observed in G. variabilis at salinities below 30%.

The periodicity of sporulation in G. pusillum and P. heteroplatos within a day did not alter in dark and in three different light intensities tested in the present study (Fig. 3). It is in agreement with the findings of Katada (1955) on Gelidium amansii and Umamaheswara Rao and Subbarangaiah (1981) on Gracilaria corticata, G. textorii, Gracilariopsis sjoestedtii and Hypnea valentiae. But in the experiments conducted with G. variabilis

during December to February, peak liberation of spores was advanced by 4 hr between 6 AM and 10 AM at 3000 lux while normal pattern in the daily liberation was observed in dark, 500 and 1500 lux from 10 AM to 2 PM (Fig.3).

Temperature plays a vital role in regulating the spore shedding in a day in G. pusillum, P. heteroplatos and G. variabilis unlike in Iridophycus cornucopiae (Fukuhara, 1957). Peak liberation of spores was delayed by 4 hr at 25°C and 20°C and by 8-12 hr at 15°C in G. pusillum and for 4 hr at 25°C in G. variabilis (Fig. 4). The four hour delay in peak output of spores observed in Gracilaria corticata and Hypnea valentiae below 30°C (Umamaheswara Rao and Subbarangaiah, 1981) is in conformity with the results obtained in the present study on G. pusillum and G. variabilis below 30°C, though the time of peak shedding varied in these algae. In Gelidium amansii the time of peak shedding of spores varied depending upon the seasonal changes in sea water temperature (Katada et al., 1953 and Katada, 1955). The experimental evidence collected in the present study agrees with the results obtained on Gelidium amansii. The differences in the period of peak liberation of spores in fronds of G. pusillum and G. variabilis treated for short periods at 0, 20 and 40°C (unpublished) further confirm the relationship between the diurnal rhythm and sea water temperature.

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