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Effect of environmental factors on oospore shedding in *Sargassum ilicifolium (*Turner) C.Agardh.

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Abstract

Sargassum ilicifolium is an alginophyte which occurs abundantly from November to March/ April months in the intertidal rocky surfaces of Visakhapatnam coast. Oospore shedding from this brown alga was studied in respect of effect of environmental factors such as desiccation, salinity and light intensity also on diurnal periodicity during 2007 and 2008. Maximum number of oospores were released when fronds were in submerged condition, exposed to 'dark condition and at 30 ‰ salinity. In the present study neither acceleration nor delay in the peak shedding of oospores in *S.ilicifolium* was found even after exposure to various desiccated periods, salinities and different light intensities.

Key words: *Sargassum ilicifolium*, Oospore shedding, Environmental factors, Visakhapatnam.

Introduction:

Sargassum species are commercially valuable for their uses in several food and non-food sector industries. Several authors studied the seasonal growth, oospore shedding and other aspects on this brown alga in different geographical regions of the world (Chauhan and Krishna Murthy, 1967; 1971; Prince,1980; Dawes, 1987; Umamaheswara Rao 1990; Ramalakshmi and Chauhan,1992; Subba Rangiah,1992; Appa Rao, 1998). Studies on sporulation play a vital role in the field of mariculture to generate the algal populations in the natural habitats. Several authors studied the spore shedding from *Sargassum* species in Indian waters (Chauhan and Krishnamurthy, 1971; Umamaheswara Rao and Kaliaperumal, 1976; Umamaheswara Rao,1990; Appa Rao,1998). In the present investigation studies were made on the oospore shedding from *Sargassum ilicifolium* in different environmental parameters.

Material and Methods

Visakhapatnam is situated on the east coast of India between the latitude 17˚ 40' 30'' and 17˚ 45' N longitudes 83˚ 16' 25" and 83˚ 21' 30"E. The coastline is sandy with outcrops of rocky boulders in different regions. Materials for this study were collected during the spring tide periods from VUDA park regions where large accessible boulders occur with dense growth of algae. *Sargassum ilicifolium* J.Agardh was collected for carrying out the laboratory experiments during the years 2007 and 2008. Experiments were conducted on the effect of environmental factors on spore shedding and diurnal periodicity of oospore shedding from this marine alga. In the experiments conducted to study the exposure to air, the fronds were blotted to remove the water on the surface of the fronds and exposed to air in the laboratory and also in the open air during the day time. At the time of conducting these experiments the temperature in the laboratory was 32± 2°C and the relative humidity varied from 62 to 67%. In the open air where these experiments were conducted, the temperature was 34±2 C and relative humidity ranged from 58 to 63%. At 15 minute intervals the materials thus exposed to air were transferred to Petri-dishes filled with seawater and the spore output was estimated after 24 hours as mentioned in the earlier works (Subba Rangaiah ,1983) Seawater collected from the inshore area was adjusted to 80‰ salinity by exposing to sun light to make up the stock solution. Lower grades were prepared from this stock solution by the addition of requisite quantity of distilled water. Spore output was estimated at 0‰, 10‰,20‰ 30 ‰ 40 ‰ 50 ‰ 60‰ and 70‰ salinities, maintaining the Petri-dishes at room temperature 32±2 C under 8 hours day length with 9 µ E m^{-2} s^{-1} day light fluorescent illumination. Effect of light intensity on oospore output were investigated at room temperature using light intensities of 0 (dark), 9 µ E m^{-2} s^{-1},18 µ E m^{-2} s^{-1}, 36 µ E m^{-2} s^{-1}. Based on the changes observed in the spore output per day, experiments on diurnal periodicity were conducted selecting certain periods of exposure to air (0,15,30,45,60 minutes), salinities (10.20,30,40,50 and 60 ‰), light intensities (0,9,18,36 µ E m^{-2} s^{-1}).

Results

Data collected on the influence of environmental factors such as exposure to air (desiccation), salinity and light intensity on the

spore output and diurnal periodicity were presented in the Fig. 1,2 and 3 respectively.

Factors influencing spore output: Exposure to air (Desiccation)

Figs. 1A and 1B shows the liberation of oospores in shaded and as well as in areas directly exposed to sunlight. Changes observed in the oospore output of *Sargassum ilicifolium* in control (O minute exposure) and at different periods of exposure to air at room temperature in the laboratory and in the sunlight are shown in Fig 1A and 1B. In experiments conducted in shade i.e in the laboratory, oospore shedding was seen upto 180 minutes exposure (Fig. 1B). Maximum spore output was observed in control where receptacles were submerged for 24 h duration and the number of oospores liberated decreased with increase in the duration of exposure of receptacles to air at laboratory temperature. The output of oospores was very low from the receptacles exposed to 120, 150 and 180 minutes respectively. Changes in oospore output were more marked when receptacles were exposed to sun light even for short periods of 5,10,15,20 and 25 minutes due to high temperature and low humidity. There was a sudden fall in oospore liberation from 0-5 minutes exposure. The shedding of oospores in *Sargassum illicifolium* after 25 minutes was inhibited in the fronds exposed outside the laboratory (Fig.1A).

Fig. 1: Effect of exposure to air on the Oospore output of S.ilicifolium

A: At open air temperature 32± 2^{0}C

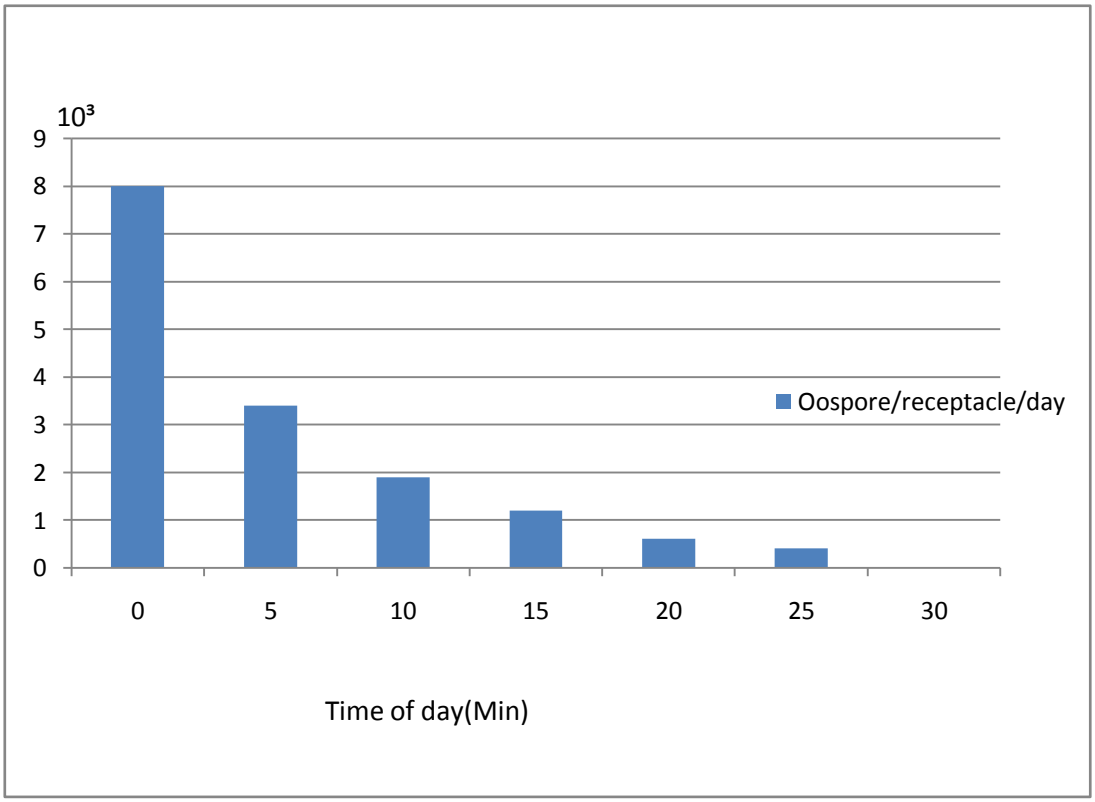
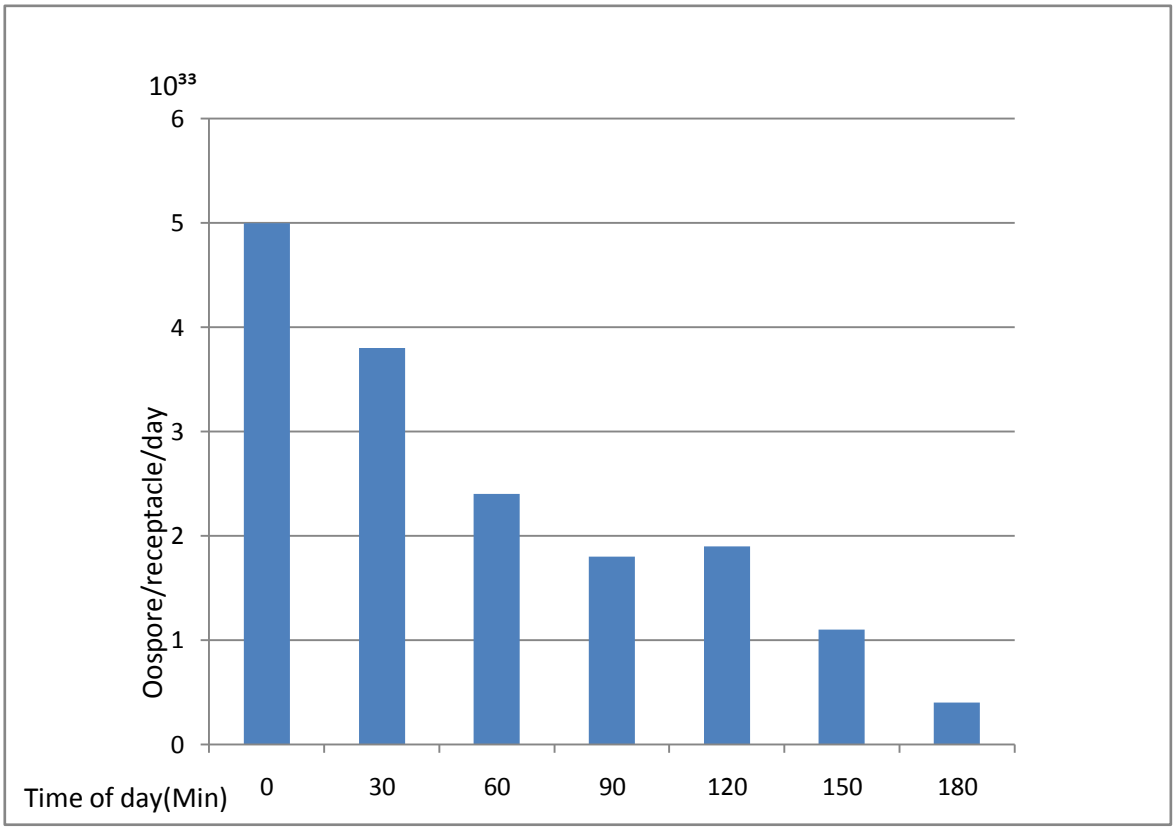


Fig. 1: Effect of exposure to air on the Oospore output of S.ilicifolium

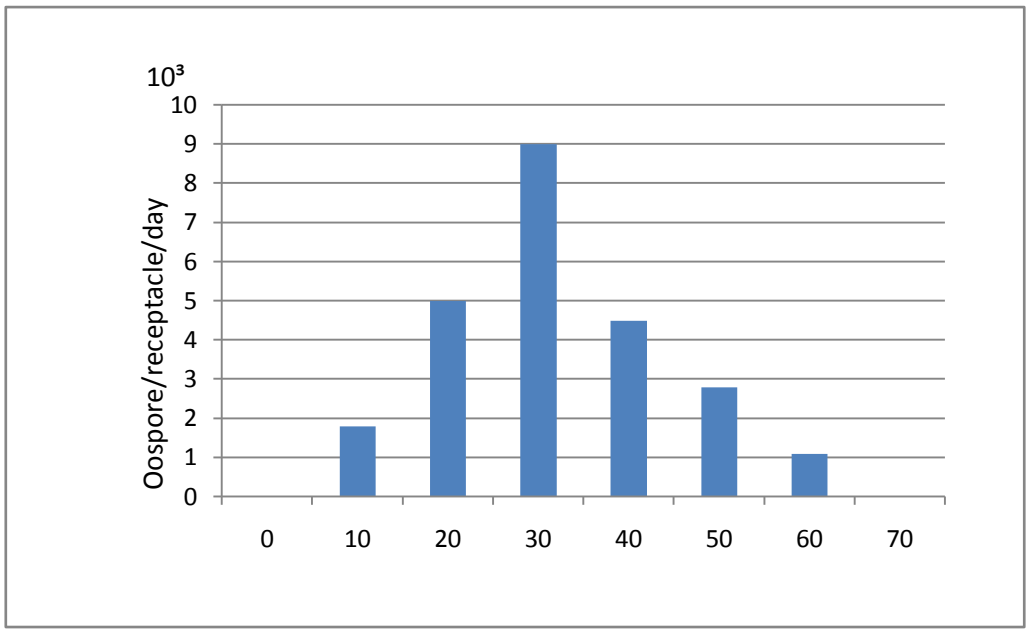
B: At open air temperature 28± 2^{o}C



Salinity

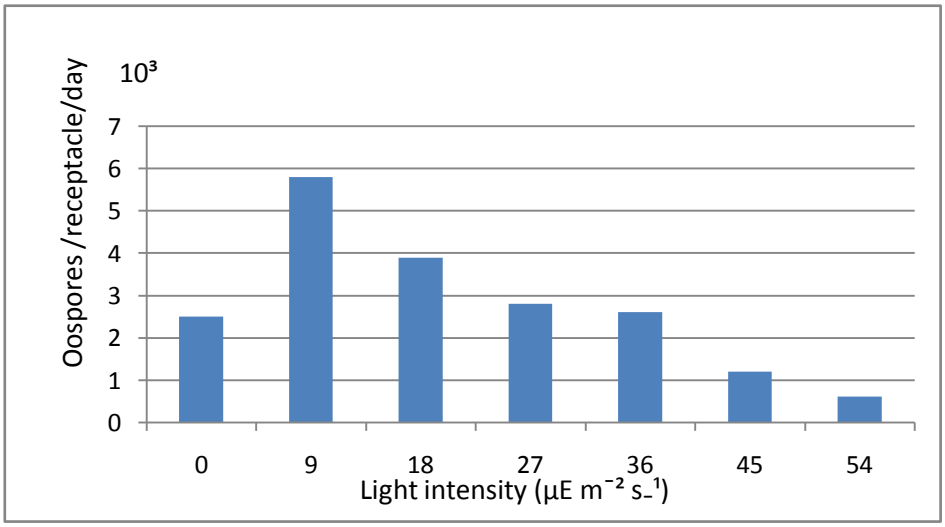
Effect of salinity on oospore output of *Sargassum ilicifolium* was presented in Fig. 2. Oospore output varied markedly in different salinities of seawater tested and there was no liberation at 0 ‰ and 70 ‰ salinities. The oospore liberation was observed from 10 to 60 ‰ with minimum number of oospores at 10 and 60 ‰ salinities. Peak out put of oospores was found at 30 ‰. But considerable number of oospores were also seen liberating from the receptacles at 20 ‰ and 40 ‰ salinities (Fig.2).[1]Light Intensity:

Fig.-2:Effect of salinity on the Oospore output of *S.ilicifolium*



The quantity of oospores liberated from the receptacles of *Sargassum ilicifolium* exposed to dark to seven different light intensities raging from 0 µ E m^{-2} s^{-2} to 54 µ E m^{-2} s^{-1} are presented in Fig. 3. Oospore out put was varied in different photon flux densities raging from 0 µ E m^{-2} s^{-1} to 54 µ E m^{-2} s^{-1}. Peak shedding of oospores was found at 9 µ E m^{-2} s^{-} and considerable number at 18 µ E m^{-2} s^{-1} flux intensity and from there onwards the quantity of oospores liberated decreased gradually.

Fig. 3: Effect of diferent photon flux densities on the Oospore output of *S.ilicifolium*

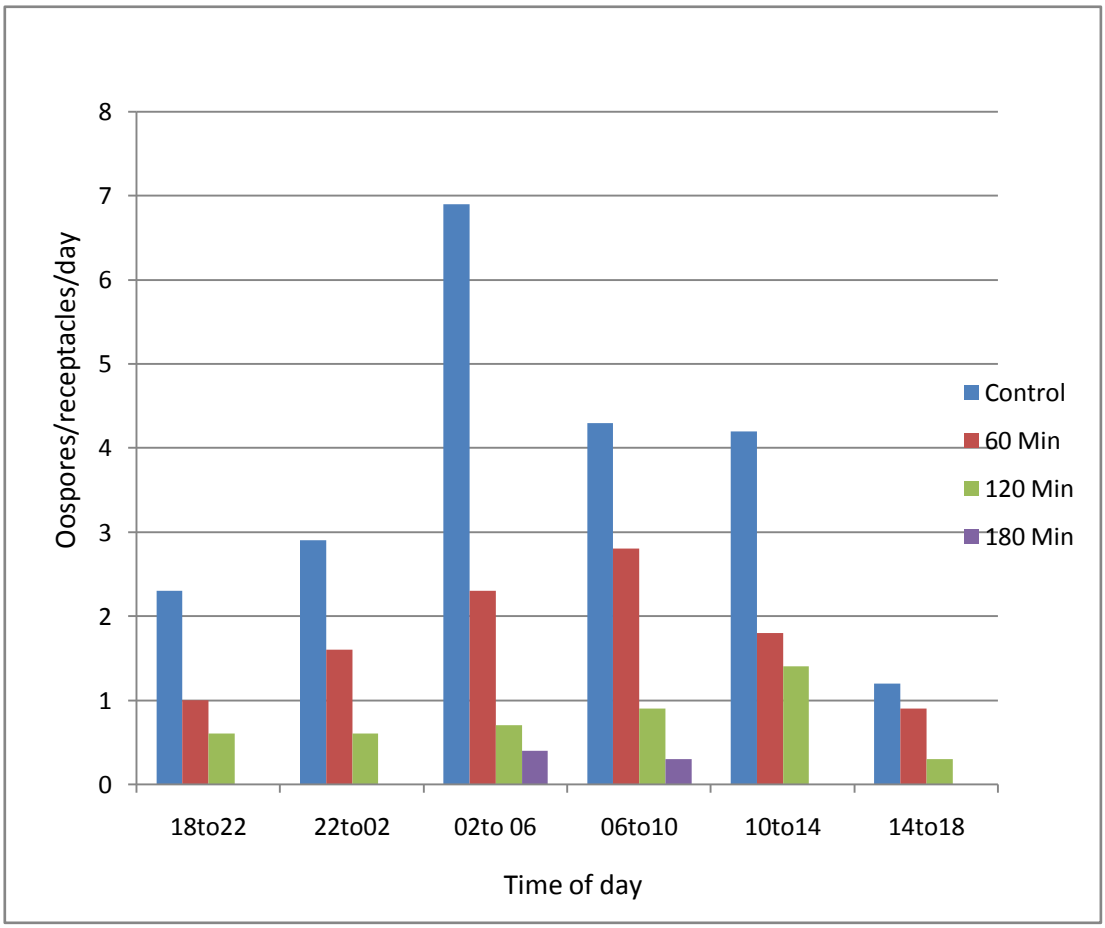


Factors influencing diurnal periodicity:

Exposure to air (Desiccation)

Data obtained on the diurnal periodicity by exposing the receptacles of *Sargassum ilicifolium* from control (submerged condition) to 180 minutes. Peak shedding of oospores was observed in the receptacles of 0 minute exposure between 0200 h and 0600 h without any change in the normal shedding period (Fig.4). Whereas the receptacles exposed to air under shade (room temperature) from 60 to 180 minutes, peak shedding of oospores was delayed. For instance at 60 minutes exposure, 4h delay was observed in the peak shedding of oospores (shifted from 0200-0600 h to 0600h-1000h). At 120 minutes exposure, peak output of oospores was observed between 1000 and 1400 h with further increase in the duration of exposure (180 minutes) peak output was not observed up to 1800h. In fact in receptacles exposed for 180 minutes oospore output was not seen up to 1400 h (Fig.4).

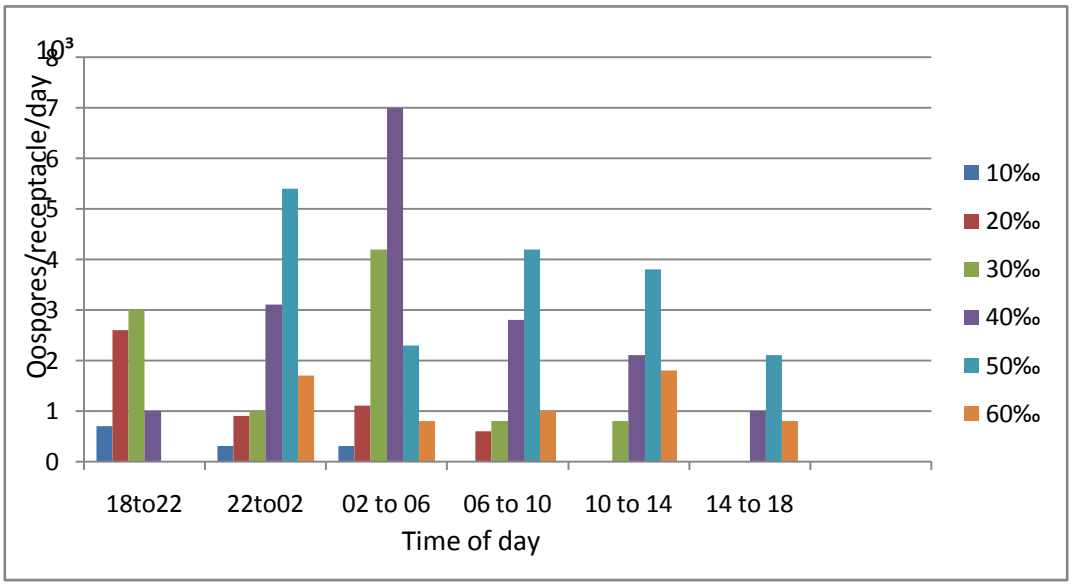
Fig.-4 Effect of exposure to air on diurnal periodicity in the liberation of Oospores of *S.ilicifolium*



Salinity

Influence of six different salinities on the diurnal periodicity of oospore release is depicted in Fig. 5. The peak output of oospores was observed in *Sargassum ilicifolium* between 0200 and 0600 h in salinities ranging from 20- 40‰ salinity without any shift in the time of peak shedding of oospores in a day. But at 60‰, the diurnal variations are not prominent since very less number of oospores was liberated from the receptacles.

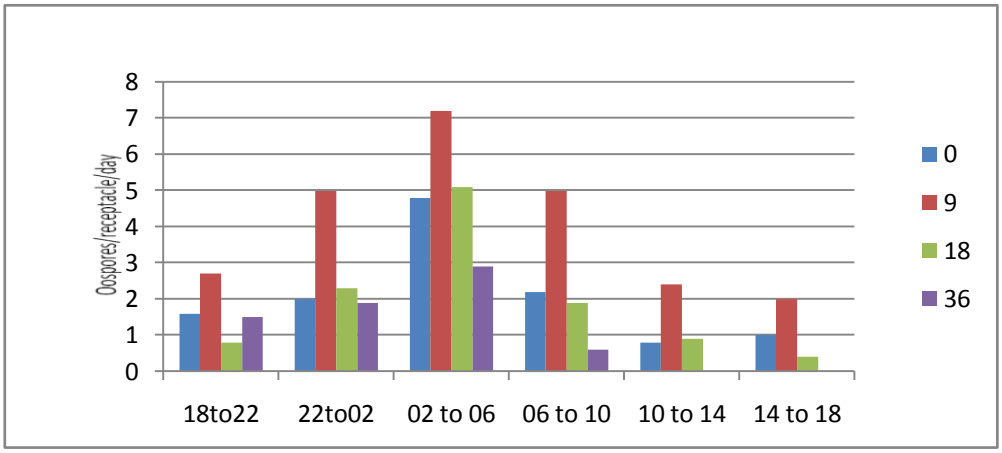
Fig.-5 Effect of salinity on diurnal periodicity in the liberation of Oospores of *S.ilicifolium*



Light intensity

Diurnal periodicity in the liberation of oospores from the receptacles kept in dark and in three different photon flux intensities viz. 0, 9 µ E m^{-2} and 18 and 36 µ E m^{-2} s^{-1} are presented in the Fig. 6. The peak shedding of oospores was observed between 0200h to 0600h in dark as well as at photon flux densities of 9,18, 36 µ E m^{-2} s^{-1}, without any change in the pattern of diurnal curves. Prominent peak with more number of oospores were obtained at 9 µ E $m^{-2}$and from 9 µ E $m^{-2}s^{-1}$ onwards the number of oospores shed, decreased gradually. Though the number of oospores liberated in dark, and at photon flux densities of 18 and 36 µ E m^{-2} conspicuous peak of shedding rhythms were observed between 0200 and 0600h.

Fig.-6 Effect of different photon flux densities on diurnal periodicity in the liberation of Oospores of *S.ilicifolium*



Discussion

In any ecosystem growth and survival of the organisms depend on certain important ecological parameters. In the present study oospore shedding abilities of *S.ilicifolium was* influenced by some environmental factors such as exposure to air, salinity and intensity of light. Withstanding ability of different marine algae to these environmental parameters depend on the vertical distribution of algae on rocky surfaces. eco-physiological investigations of spore shedding on Indian marina algae was studied by several authors (Subba Rangaiah, 1983; 1984; 1985a;1985b; 1986) and studies on spore shedding of brown algae was fragmentary (Umamaheswara Rao and Sanjeeva Reddy, 1982; Narasimha Rao.1989; Narasimha Rao and Subba Rangaiah,1991; Appa Rao.1995; 1998). In the present study oospore shedding in *S.ilicifolium* was observed only for 25 min exposure outside the lab and 180 min inside the lab. These observations on *S.ilicifolium* agrees with the findings on S. vulgare (Appa Rao,1998) and also depends on the distribution of this alga in the intertidal habitat.

Salinity of the seawater influences oospore shedding in *S.ilicifolium* The optimum salinity range observed for the maximum shedding in *S.ilicifolium* was 30 ‰ Several studies reveals the effect of salinity on spore shedding and observed different optimum ranges (Subba Rangaiah et al, 1975; Umamaheswara Rao and Sanjeeva Reddy, 1882 ; Subba Rangaiah, 1983;1985b; 1986;Narasimha Rao.1989; Appa Rao,1995; 1998). Oospore liberation in *S.ilicifolium* occurred in the light intensities ranging from 0 to 54 μ E m^{-2} s^{-1} with peak shedding at 9 μ E m^{-2} s^{-1}. Similar trend was reported by Narasimha Rao and Subba Rangaiah,1991; Appa Rao,1995 and Subba Rangaiah and AppaRao ,1998).

Matsui (1969) observed that the time of peak liberation of spores in the fronds of *Gloiopeltis* species exposed to air for 2 to 6 h was accelerated by 10 h. In the present study in *S.ilicifolium* peak liberation of oospores in a day varied with the time of exposure of the receptacles after 60 minutes, a delay was observed (Fig. 4). In the previous studies made by Appa Rao (1998) on *S.ilicifolium* and *S. vulgare* also showed delay in the peak shedding of oospores for about 4 h in the receptacles exposed for 60 min and 8 h delay in the receptacles exposed for 120 min. Variations in the salinity did not effect diurnal periodicity pattern in the members of Dictyotales and species of Sargasssum (Umamaheswara Rao and Sanjeeva Reddy, 1982; Appa Rao, 1998). The observations of the present investigation agrees with the above findings. When the receptacles of *S.ilicifolium* exposed up to 36 μ E m^{-2} s^{-1}, there was no change in the peak period of shedding of oospores (Fig.6). In this respect the present study agrees with the results of Umamaheswara Rao and Sanjeeva Reddy (1982), Appa Rao(1998). It is interesting to note that the quantity of oospores liberated in *S.ilicifolium* of the present study is almost less than half when compared to the studies made by Subba Rangaiah (1983 a) in the same alga almost 30 years back. This change may be due to increase in the temperature (2-3ºC) in the nature, and indiscriminate discharge of industrial effluents in to the sea. If this process continues, we do hope that in future there will be a drastic change in the seaweeds of Visakhapatnam towards decrease in the vegetation as well as in spore shedding capacities. So, we request the Government and NGO s to take necessary steps to conserve the seaweeds of Visakhapatnam by taking proper steps.

References

Chauhan,V.D. and Krishnamurty,V. (1966) Observations on the out put of oospores their liberation, viability and germination in *Sargassum swartsii*(Turn.)C. Ag. Salt Research and Industry 3: 11

Chauhan,V.D. and Krishnamurty,V. (1971) Ecology and seasonal succession of Sargassum swartzii (Turn) C. Ag. Indian waters. Phykos 10: 1-11.

Dawes, C.J. (1987) Physiological ecology of two species of Sargassum on the west coast of Florida, Bull. Mar. Sci. 40:198-209.

Matsui,T. (1969). Studies on the liberation and germination of spores in Gloiopeltis tenax (Turn) J. Ag. And G. furcata. Post. Et.Rupr. J. SKI

Narasimha Rao, G.M. (1989).Effect of environmental factors on spore shedding from *Rosenvingea nhatrangensis* Dawson. Mahasagar Vol. 22(3): 135-137.

Narasimha Rao, G.M. and Subba Rangaiah, G. (1991). Control of spore shedding from some marine algae of the Visakhapatnam coast, India. Br. Phycol. J. Vol.26: 356-360.

Prince, J.S. (1980) The ecology of *Sargassum pteropleuron* Grunow in the waters off South Florida II.Phycologia 19: 190-193.

Subba Rangaiah,G. (1983). Seasonal growth, reproduction and spore shedding in *Gracilaria corticata* J. Agardh of the Visakhapatnam coast. Proc. Indian Natn. Sci. Acad., B49: 711-718.

Subba Rangaiah.G. (1984). Growth, reproduction and spore shedding in *Gracilaria textorii* (Sur.) J. Ag. of the Visakhapatnam coast. Phykos.,23: 246-253.

Subba Rangaiah, G. (1985a). Spore shedding in *Gracilariopsis sjoestedtii* (Kylin)Dawson (Rhodophyta, Gigartinales). Proc. All India symp.mar. plants, their biology, chemistry, utilization (ed. Krishnamurthy,V. and Untawale, A.G.)Seaweed Research and Utiln. Assoc. India:pp. 59-64.

Subba Rangaiah, G. (1985b). Influence of temperature on diurnal periodicities of tetraspores of some members of Gigartinales (Rhodophyta) Seaweed Research Utiln.8:23-27.

Subba Rangaiah.G. (1986). Effects of environmental factors on the shedding of monospores from *Porphyra vietnamensis* Tanaka et. Ho of the Visakhapatnam coast. Phykos., 25: 29-35.

Subba Rangaiah.G. (1992). A persistent endogenous circadian rhythm of liberation of eggs in Fucus serratus. British Phycological winter meeting, Birmingham, January., 6-9.

Subba Rangaiah.G., Umamaheswara Rao, M. and Rao, B.G.S. (1975). Effect of salinity on spore shedding in *Gracilaria corticata*. Curr. Sci., 44: 717-718.

Umamaheswara Rao, M. (1990). Autecological and Eco-physiological studies on marine algae of Visakhapatnam and Mandapam coast. Perceptives in phycology (M.O.P. Iyangar Centinary celebration) Ed. V.N.Raja Rao. 323-335.

Umamaheswara Rao, M. and Kaliaperumal, N (1987). Effect of thermal stress on spore shedding in some red algae of Visakhapatnam coast. Indian J. Mar.Sci., 16: 201-202.

Umamaheswara Rao, M. and Reddy, R.B.S. (1982). Influence of desiccation, salinity and temperature on the libneration and germination of tetraspores of *Dictyota dichotoma*. Seaweed Research and Utiln. 5: 5-9.

Umamaheswara Rao, M. and Subba Rangaiah, G. (1986).Effect of environmental factors on the shedding of tetraspores of some Gigarinales (Rhodophyta). Proc. Symp. Coastal Aquaculture. 4:1199-1205.