Studies on the shedding of Carpospores in Gracilaria Corticata J. Ag.

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Introduction

Suto (1950 a, 1950 b) studied the relation between sporulation of seaweeds and seawater temperature. He observed that shedding of tetraspores started in *Gelidium* when the seawater temperature rose to 20°C and carpospores to 24°C Further he observed that there was an optimum temperature range for shedding of spores and abnormal temperature delayed or hastened shedding by about 20 days. Also, he noticed that shedding of monospores of *Gelidium amansii* increased during calm weather and decreased during rough weather. Segawa et. al,(1955 a,1955 b)and Jones (1957) studied the nature and mechanism of carpospore liberation in *Gracilaria verrucosa* (Huds) papenfs. Takeuchi et. al.(1956) studied the daily output of monospores from cultures of the *Conchocelis* phase of *Porphyra tenera* Kjellm. Oza and Krishnamurthy (1968) investigated the carposporic rhythm in *Gracilaria verrucosa* and reported a peak sporulation of the alga in December and a gradual decline during March - May.

In this paper observations on the nature of carpospore output in *Gracilaria corticata* J. Ag. and an estimate of the quantity of spores liberated by the alga during August to December 1969 are presented and discussed.

Materials and methods

Plants of *Gracilaria corticata* J. Ag. are found at the infralittoral fringe at Mandapam Camp, Gulf of Mannar during May. The population slowly migrates upwards and by December reaches a level of + 0.30 m above mean tide level. During August - December there is an intertidal population of this species which comprises

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vegetative and cystocarpic plants. By the end of January the population disappears from the intertidal zone.

Clean cystocarpic plants were collected and brought to the laboratory. They were immediately examined under a binocular microscope. Plants which had started shedding were easily identified by a white drop of mucilage exuding out of the cystocarp. These were discarded. This prevented partly shed plants from being studied for carpospore output. The plant thus selected was blotted, weighed and the number of mature cystocarps recorded. The time between collection and experimentation was 30 - 45 minutes.

For studying the shedding of carpospores, the method described by Oza and Krishnamurthy (1968) was used. The plant was immersed in filtered seawater collected from the same locality and suspended sufficiently high over a petridish to ensure uniform dispersion of the spores on the petridish. After 24 hours the plant was removed to another beaker similarly set up. The first beaker was then kept undisturbed overnight. Next morning the water was siphoned out and the petridish removed for counting. The experiment was conducted under prevailing laboratory conditions.

For counting the spores, the petridish was mounted on a grided translucent paper and placed under a low power binocular microscope. The abundance of carpospores shed prevented direct counting and hence counting of sampled squares was used. Thees squares were distributed in the form of an 'X'. From the mean value, the total number of carpospores shed was calculated. The total thus estimated had a standard error of $\pm$ 8.5%.

Results and discussion

Mature cystocarps of *Gracilaria corticata* are distributed unevenly on both sides of the fronds and are 1 to 1.3 mm in diameter. Immature cystocarps are always present at the apex of the fronds. Young cystocarps are solitary, but sometimes during the development two or three unite together and form a 'compound cystocarp'. Carpospores are reddish brown in colour and 20 - 30 μ in diameter.

The results of daily shedding of the carpospores during August - December, 1969 are represented in Fig. 1.

Figs. 2 and 3 illustrate the relation between the number of carpospores liberaed per cystocarp as well as per gram of wet weight of the alga in different months.

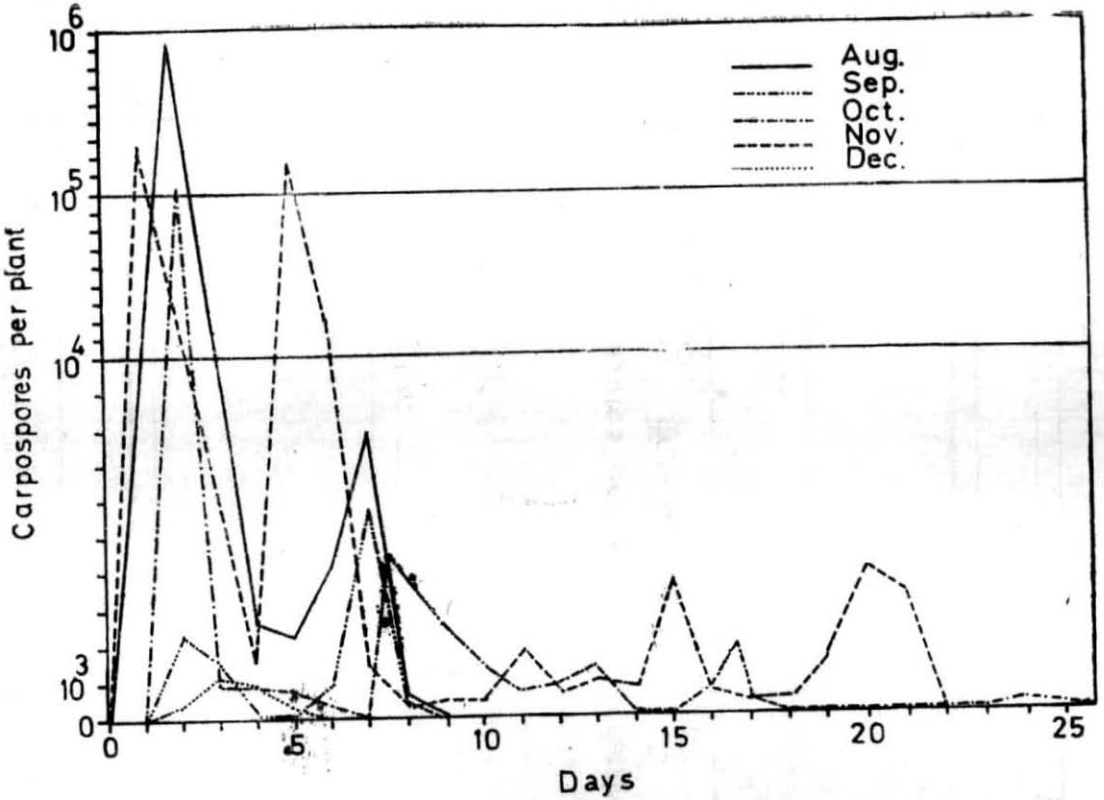

FIG.1

Total number of carpospores liberated by individual plants during August - December 1969. The graph illustrates the rhythm in shedding.

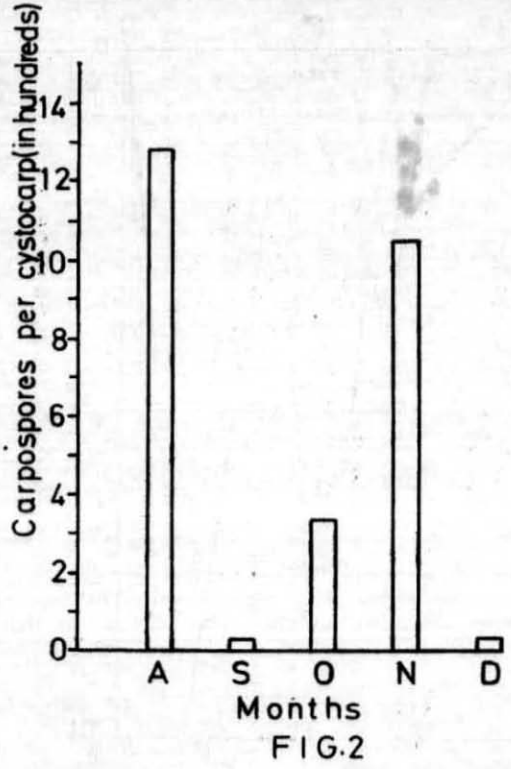

FIG.2

Total number of carpospores liberated per cystocarp during August - December 1969

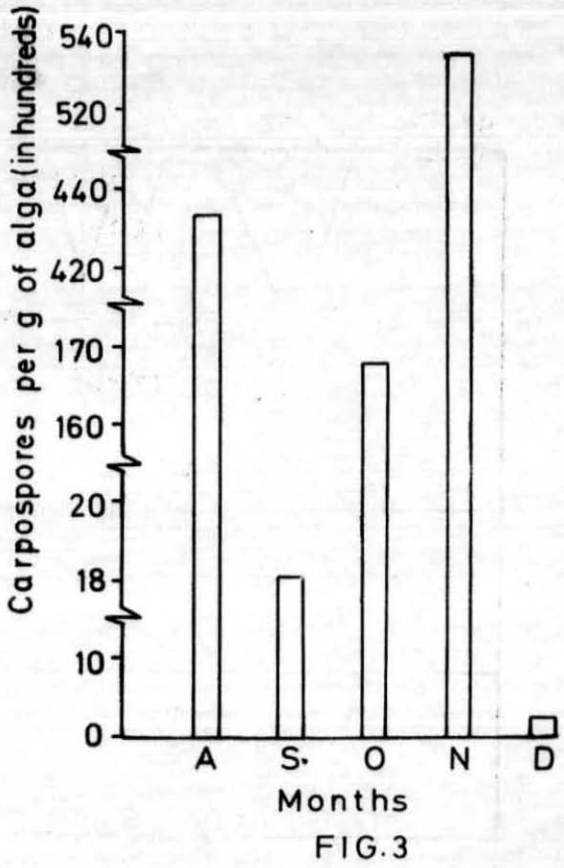

FIG.3

Number of carpospores per gm. wet weight of alga during August - December 1969

Data on the number of cystocarps, total number of carpospores liberated, total number of days of shedding and the average monthly temperature maxima are given in table 1.

Table 1 Shedding of Carpospores in *Gracilaria corticata*

Month	Fresh weight of plant (g)	No. of mature cystocarps	Total no. of carpospores liberated	No. of carpospores shed per mature cystocarp	No. of carpospores per g. of wet weight	Total no. of days of shedding	Average monthly temperature maxima (°C)
August	20.1	680	866700	1274.5	43335	8	31.5
September	6.1	370	11075	29.932	1315.5	8	31.9
October	10.0	500	167440	334.88	16744	26	31.4
November	10.4	530	553285	1043.93	53200.4	21	29.3
December	9.45	74	2260	30.54	239.15	6	28.2

The daily observations on the output of carpospores in *Gracilaria corticata* show definite peaks. Shedding started on the first or the second day of the experiment The maximum number of spores were liberated at this time. By the third or the fourth day the number of spores became reduced and again by the sixth or seventh day it reached another peak. Subsequent peaks of less amplitudes were observed at intervals of 4-5 days till the plant started decaying. These peaks reflect (1)the state of maturity of the cystocarps and (2) the successive maturation of younger cystocarps. Carpospores, when mature, are liberated in two or three days. After that there is a time lag for the development of the next crop of carpospores during which the shedding slows to a minimum. The second crop also is liberated in two to three days and this accounts for the second peak. Another reason for such peaks is that immature cystocarps are in the process of development and when they attain maturity they liberate their carpospores. This phenonmenon gives rise to the rhythm in spore shedding.

The observations on monthly shedding of carpospores show that the maximum shedding was in plants collected in November. Shedding lasted over a long period. 26 days in October and 21 days in November respectively. The minimum number of spores and the shortest duration of shedding was observed in plants collected during December. This indicates that the peak of sporulation is found during October and November after which it decreases. This coincides with the observations made in the natural habitat where the population reaches maximum growth during October-November

with the cystocarpic plants dominating. In December, very few plants were found growing at this level and by January the whole population had completely bleached and was lost. This bleaching may be due to the over exposure of the plants to the increasingly bright sunlight as well as to the longer emersion of the plants. The gulf becomes very calm by the middle of November and during this reversal of the season, the lack of waves on the shore causes greater desiccation of the plants in rhe intertidal region since wetting of these plants by waves is absent. The importance of the duration of submersion and emersion has been discussed by Doty (1946), Dellow (1950), Beveridge and Chapman(1950), Guiler(1951), Carnahan(1952), Krishnamurthy (1969) and Rama Rao (1962).

The variation in seawater temperature during these months did not seem to have any effect on carpospore liberation.

The total number of cystocarps per gram of wet weight gave higher values during September - November, and lowest in December. This relation cannot be generalised because (1) only mature cystocarps are counted before the experiment, and (2) the tips of the fronds bearing immature cystocarps are often lost by the 'cropping of them by browsers like *Pyrene zebra* (Gray), thus reducing the wet weight of the plant and giving many of the immature cystocarps no chance to mature and liberate carpospores. Such croppings are very common at the infralittoral fringe at Mandapam Camp.

The number of carpospores shed per cystocarp depends on the maturity of the cystocarp also. Since the formation of the cystocarp and hence the carpospores is a gradual process and since the relation between the number of cystocarps and the fresh weight is not constant, a correct relation between the number of carpospores, the weight of the plant and the number of cystocarps, is difficult to arrive at. Figure 2 represents the number of carpospores shed per mature cystocarp and fig. 3 the number per gram wet weight of the alga. From the figures it appears that there are two periods of peak sporulation, one in August and another in November. But this is only apparently the case. The unusually high value for August is due to the fact that the plant observed was large with a high wet weight but the number of cystocarps was comparatively low. Against this should be considered the fact that in August very few cystocarpic plants are present in the population. The output reaches the maximum in November after which it suddenly drops and records the minimum during December. The low value in September is due to the fact that the alga weighing 6.1 g. had 370 mature cystocarps, but the low value in December is due to the lowest number of cystocarps viz. 74 on a plant weighing 9.446 g., liberating a total of 2260 spores.

From the above it is clear that the cystocarpic plants of *Gracilaria corticata* J. Ag. show a peak sporulation during October - November. From August to November the activity increases gradually, reaches the peak, and in December drops suddenly and by January the whole population bleaches and dies out on the intertidal region.

The peak season for sporulation in cystocarpic plants of *Gracilaria verrucosa* was during December, with a gradual decline during March to May, as reported by Oza and Krishnamurthy (1968). It is interesting to note that in warmer waters of the Gulf of Mannar this season starts earlier in the year by August with peak during November. A detailed investigation on the carposporic output of *Gracilaria verrucosa* at this southern latitude will be necessary for accurate comparison.

Summary

The nature of carpospore output in *Gracilaria corticata* J. Ag. was studied in the laboratory.

Observations on daily shedding of carpospores showed that there was a pattern of shedding with peaks at intervals of 4 - 5 days.

Cystocarpic plants show a gradual increase in sporulation during August - November which peaks in November and drops in December. By January the whole population disappears from the intertidal region

Acknowledgement

The authors wish to express their sincere thanks to Dr. D. S. Datar, Director, Central Salt & Marine Chemicals Research Institute, Bhavnagar for his continued encouragement and facilities for the study. One of us (M. Mohan Joseph) is grateful to the Council of Scientific and Industrial Research, New Delhi for the award of a Junior Research Fellowship.

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