

Reproductive Phenology of *Gracilaria verrucosa* (Rhodophyta) in Cheongsapo near Pusan, Korea

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The reproductive phenology of *Gracilaria verrucosa* was studied in Cheongsapo near Pusan, Korea. Among the life history phases, tetrasporic plants occurred dominantly in varying degrees of abundance throughout the year except from July to September. Cystocarpic plants increased rapidly during summer, and then recorded maximum abundance in July. Whereas, seasonal peaks of spermatangial plants were observed in April and September. However, they were less than cystocarpic plants in abundance. Vegetative plants dominated from December to May for long period, with a occurrence peak in February.

Even though fertile plants in both gametophytes and tetrasporophytes occurred throughout the year, their seasonal abundance suggests that the positive correlation between reproduction and water temperature is basically found in the reproductive pattern of *Gracilaria verrucosa*. The distributional aspect of life history phases appears to be related with differences of their longevity, fecundity or survivorship.

Key words: *Gracilaria verrucosa*, reproductive phenology, life history phases, Cheongsapo near Pusan, Korea

Introduction

As alternate gametophytes and sporophytes are involved in algal life history, these phases may be distributed in different proportions in both space and time (De Wreede and Klinger, 1988). This biological aspect, which may be geared to seasons, is basically due to reproduction (Kain and Bates, 1993). Therefore, it is of interest to understand how marine algal reproduction responds to the marked seasonal changes in natural conditions of the sea (Kain, 1989). Such detailed knowledge of the life-history phase in relation with reproduction is essential for much ecological work (e.g. Caswell, 1989), and for an aid in designing harvesting strategies in useful algae (Ang et al., 1990). So many ecological studies include seasonal records of the presence or absence of reproductive structures, usually on all the species in a community (e.g. Hooper et al., 1980; Mathieson et al., 1981).

Gracilaria is one of the most useful algae in the

world, combining the production of the valuable polysaccharide agar (Levring et al., 1969) and reproductive attributes favouring their cultivation. It is also very suitable as a food of abalone for a fast growth (Nelson, 1989). Accordingly, there has been some interests in the biology of this genus (Causey et al., 1946; Jones, 1959; Ogata et al., 1972; Edelstein et al., 1976). Also, it is essential to be aware of its biological aspects (Kain and Destombe, 1995), as planning to farm this red alga in new areas. In Korea, there is rarely information on *Gracilaria* population except for fragmentary reports by Koh (1969) and Kim et al. (1993).

This paper, as an information on the population dynamics, reports a reproductive phenology of *Gracilaria verrucosa* in Cheongsapo near Pusan, Korea.

Materials and Methods

Collections for this study were made at Cheongsapo near Pusan, Korea, by quadrat methods at monthly intervals, from December to

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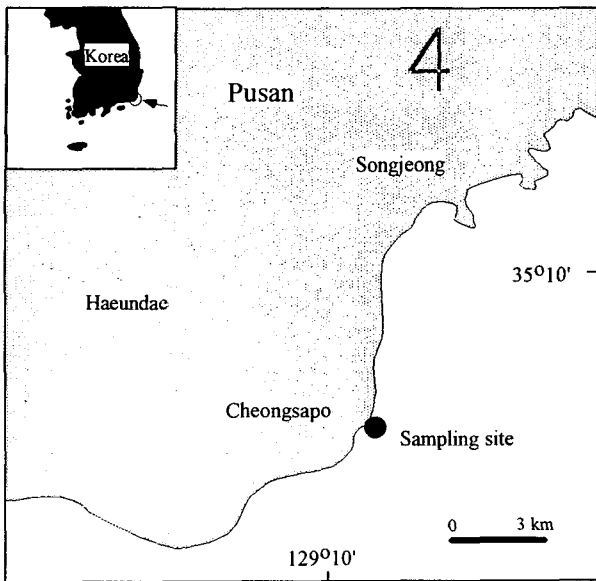


Fig. 1. A map showing the sampling site for this study.

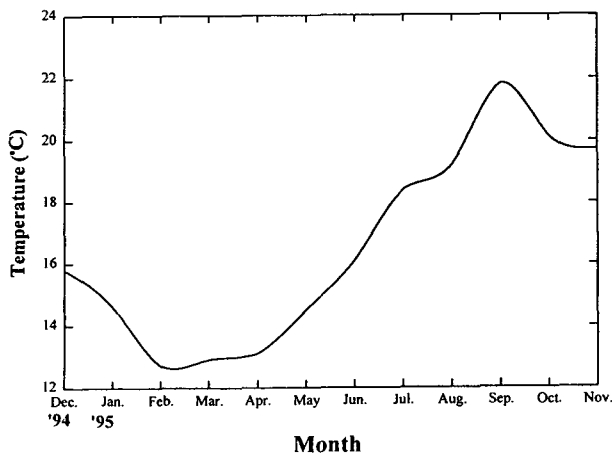


Fig. 2. Monthly fluctuations of seawater temperature in Dongbackseum, Pusan from December to November in the examined year.

November in the examined year (Fig. 1). The sampling site, which is in an area exposed to wave, was located in a gently sloping intertidal zone.

On returning to the laboratory, reproductive phases (i.e. vegetative, cystocarpic, spermatangial or tetrasporic) of the sampled plants were determined under a microscope. After that their fresh weight and number for each phase were measured.

Seawater temperature data were obtained from Institute of Fisheries Science of PKNU (Pukyong National University) near this study place. Monthly seawater temperature varied from the minimum of 12.7°C occurring in February and the maximum in September of 21.8°C with a yearly mean (Fig. 2).

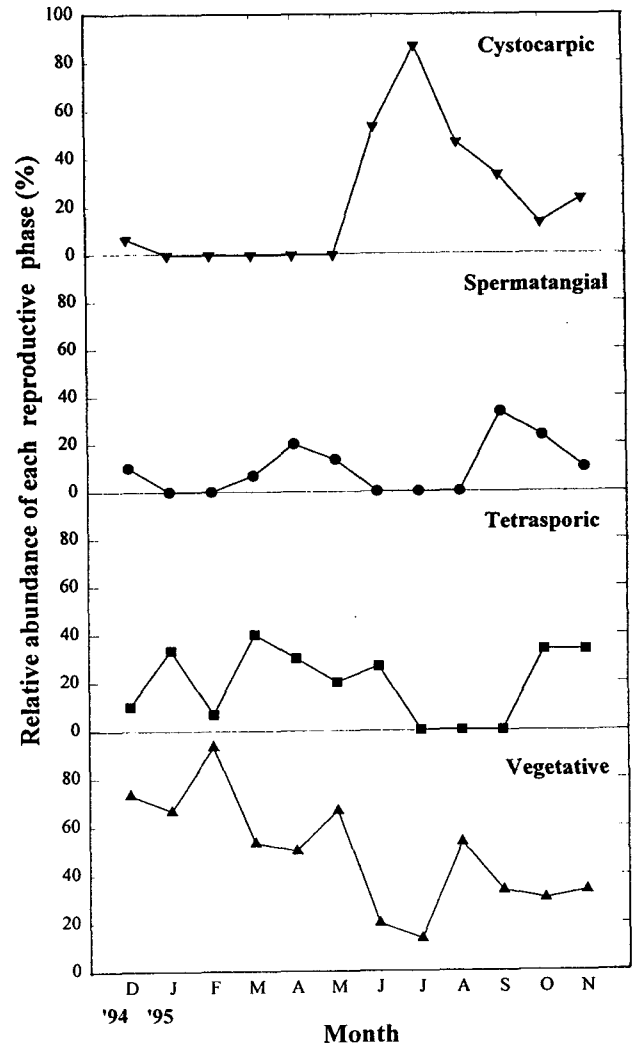


Fig. 3. Monthly variation in relative abundance of each life history phase of *G. verrucosa* in Cheongsapo near Pusan, Korea.

Results and Discussion

The *Gracilaria* population was formed on large cobbles and rocks embedded in coarse sand in the intertidal zone of the examined area. Seasonality in the occurrence of reproductive plants was observed in the *Gracilaria* populations, even though fertile plants in both gametophytes and tetrasporophytes occurred throughout the year. Their seasonal abundance appears to be related with water temperature (Figs. 2, 3 & 6).

Among the gametophytes, cystocarpic plants increased rapidly during summer, and then recorded maximum abundance in July. In the winter, they released mostly carpospores, having only residual cystocarpic structure. Whereas, seasonal peaks of

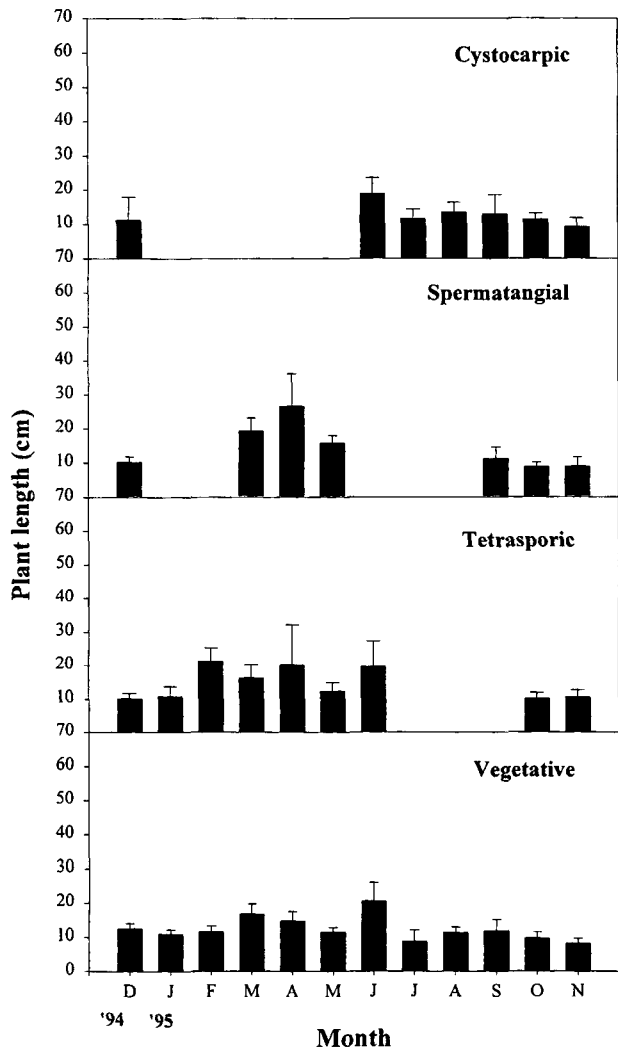


Fig. 4. Monthly variation of plant length for each reproductive phase of *G. verrucosa* in Cheongsapo near Pusan, Korea.

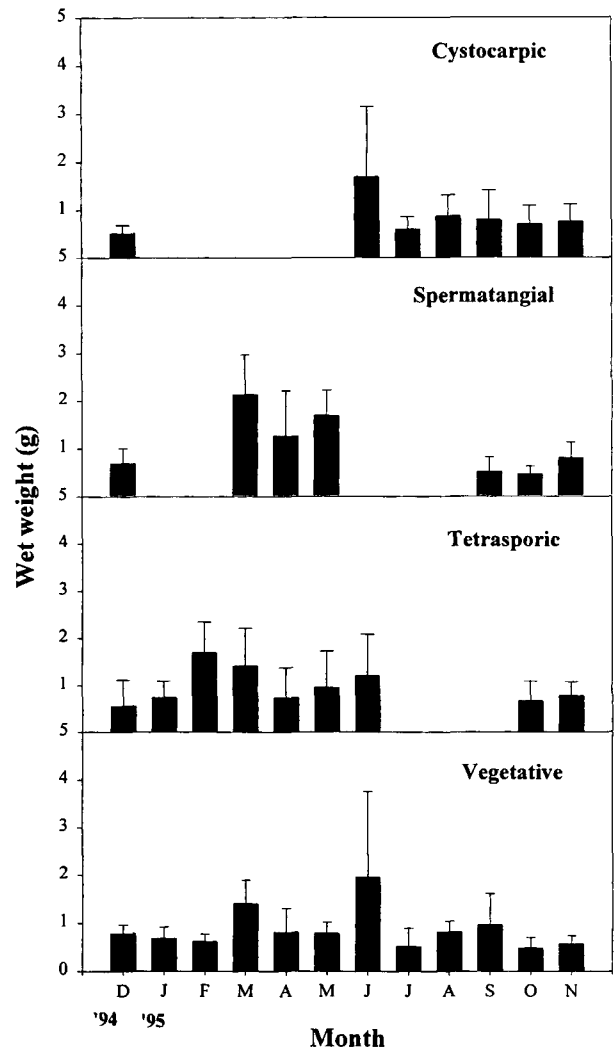


Fig. 5. Monthly variation of wet weight of plants for each reproductive phase of *G. verrucosa* in Cheongsapo near Pusan, Korea.

spermatangial plants were observed in April and September. However, they were less than cystocarpic plants in abundance. Tetrasporic plants occurred dominantly in varying degrees of abundance except from July to September. Vegetative plants dominated from December to May for long period, with an occurrence peak in February (Fig. 3).

The plant length and weight in each reproductive phase were also examined (Figs. 4, 5). Their monthly variation in each reproductive phase was similar to that in abundance.

Recently, Kain and Destombe (1995) reviewed seasonality of *Gracilaria* species from widely different geographical areas. They found that fertility, outside the tropic, was seasonal with a summer peak and within the tropics most plants

were fertile throughout the year. As suggesting that seasonal changes of plants with reproductive structures have been correlated with temperature, this reproductive pattern was found in Cheongsapo population of *G. verrucosa* (Fig. 6). Some authors (Kim et al., 1993; van den Hoek 1982a, b; Yarish et al., 1984, 1986) also reported this positive correlation between reproduction of *Gracilaria* and water temperature. However, it is notable that fertility was maximal in July rather than September with high water temperature throughout year (Fig. 6). This may suggest some possible explanations caused by wind and rain, as stated by Hay and Norris (1984) and Trono and Azanza-Corrales (1981). In this area, inhibition of reproduction by reduction of light penetration due to disturbance

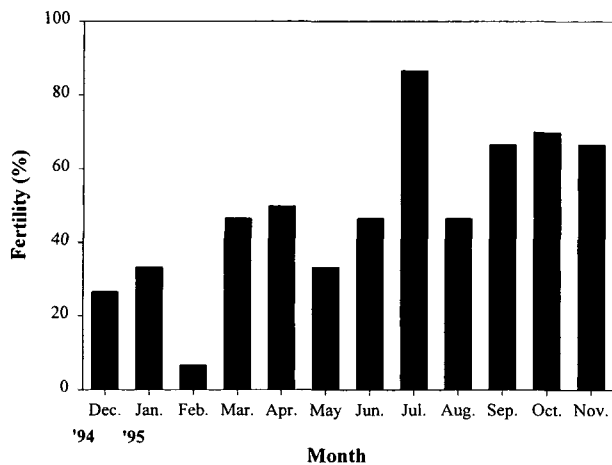


Fig. 6. Monthly variation of fertility of *G. verrucosa* in Cheongsapo near Pusan, Korea.

of sediment and by low salinity in rainy season appears to be one of major affecting factors on the reproductive aspect.

On the other hand, it has been known that the life history phase are distributed in different proportion (De Wreede and Klinger, 1988). This biological aspect was also observed in the population of *Gracilaria verrucosa* examined in this study. As mentioned above, tetrasporic plants among the life history phases dominated throughout the year except from July to September, in which cystocarpic plants showed peak. Spermatangial plants occurred abundantly in April and September. This distributional aspect of life history phases appears to be related with differences of their longevity, fecundity or survivorship, as commented by Kapraun (1978).

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