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SEASONAL EGG LIBERATION AND POTENTIAL OUTPUT OF *HORMOSIRA BANKSII*

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Abstract

Seasonal variation and potential output of egg liberation in the fucalean species *Hormosira banksii* (Turner). Decaisne was investigated. Eggs were produced throughout the year but the reproductive capacity was seasonal. A good liberation of eggs was observed from July-October (winter to early spring) when the mean sea water temperature was 14°C where eggs produced were healthy, morphologically as well as physiologically and fertilization in the laboratory showed a high synchrony. Liberation of eggs was low at high temperature (17.5-22°C) during December-February and most of the eggs were apparently not healthy often disintegrated when released from the conceptacles and viability of the eggs was also low with abnormal growth.

Introduction

The production of gametes is a prerequisite for experimental works. In fertilization experiments, *Fucus* (Levring, 1952; Abe, 1970; Pollock, 1970; Brawley *et al.*, 1976a, 1976b; Callow *et al.*, 1978) and *Hormosira* (Osborn, 1948; Levring, 1949; Forbes & Hallam, 1978, 1979; Begum & Taylor, 1979; Clarke & Womersley, 1981) have proved to be ideal plants since they reproduce all the year round. Both male and female gametes are liberated simultaneously outside the parent plants which provide an ideal situation for controlling fertilization and embryogenesis.

In *Sargassum enerve* and *S. horneri* Tahara (1909) reported simultaneous liberation of eggs not only in a given plant but also in all the plants of a locality on a particular day with fixed interval after the highest spring tide, although the interval varied with species. Tahara (1913) also reported periodic and simultaneous liberation of oogonia among individuals of the same species in the same locality in *Sargassum* spp., and *Cystophyllum* sp. Inoh (1930) also reported similar results in *Sargassum* sp.

The knowledge of the existence of periodicity in the fucalean members is limited to those genera which reproduce only at certain times of the year. No information is available on genera like *Hormosira* and *Fucus*, which reproduce throughout the year although extensive work has been done on *Fucus* but no data is available regarding the quantitative egg production. The quantitative egg production and seasonal potential output in *Hormosira banksii* per day was examined upto the stage of empty conceptacle for total output potential of eggs in *Hormosira* in different seasons of the year.

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Material and Methods

Plants were collected from Goat island Bay at Leigh, New Zealand and experiments were conducted at the Marine Research laboratory, Leigh, Auckland, New Zealand.

The experiment was conducted in the first week of each month of the year to monitor the seasonal variation in daily egg liberation. Plants were separated into male and female by observing hand sections under the microscope. Epiphyte were removed with a soft brush. The plants were washed 2-3 times with cold sea water and kept in Petri dishes with sea water filtered through a 0.45 µm Millipore filter and kept at room temperature under continuous light provided by four cool white fluorescent lamps. The sea-water containing the released eggs was changed daily in the morning and the number of eggs liberated per plant or conceptacle was counted as described below. Observations were continued until the conceptacles were empty, which took upto 20 days. Empty conceptacles were recognized by the exudation of mucilage or by turning brown.

To count the total number of eggs released from the plant, 1 ml aliquots of sea water with released eggs were taken and the number of eggs in ten different random fields from each of 5-10 samples were counted under a Wild inverted microscope at 40x magnification. This figure was converted to the total number of eggs liberated per conceptacle or per plant.

The plants used were of the same morphology and each with the same number of bladders. However, the number of conceptacles present on the same size of bladder (i.e., per unit surface area) varied. To count the number of conceptacles per plant, a piece of bladder surface was cut or a segment was observed directly under the microscope at 40x magnification. The number of conceptacles in one field of view was counted and this figure was converted to the number of conceptacle present in the whole area covered by a bladder and then multiplied by the number of bladders present in a plant. The surface area of a bladder was calculated using the formula for the curved area of a right cylinder. The number of conceptacles per plant was taken to be the mean of 25 of 5 different plants. The ends of the segments were not included as few, if any, conceptacles were observed on them. The lower most and the upper one or two bladders were also excluded as the former was non-fertile and the conceptacles on the latter were immature. However, when mean values of 50-100 counts from 5-10 subjects were plotted in both ways, i.e., on a per plant and per conceptacle basis, there were no apparent differences in the pattern of egg liberation. Therefore, the number of eggs produced per plant is not shown.

Results

Seasonal Egg Liberation: The results presented in Fig.1 confirmed that eggs can be liberated throughout the year, though the number varied considerably and is seasonally dependent. There was nearly always a high liberation on the first day of the experiment which could be induced by the transference of the plants from the shore to the laboratory. Release was significantly lower on the second day of the experi-

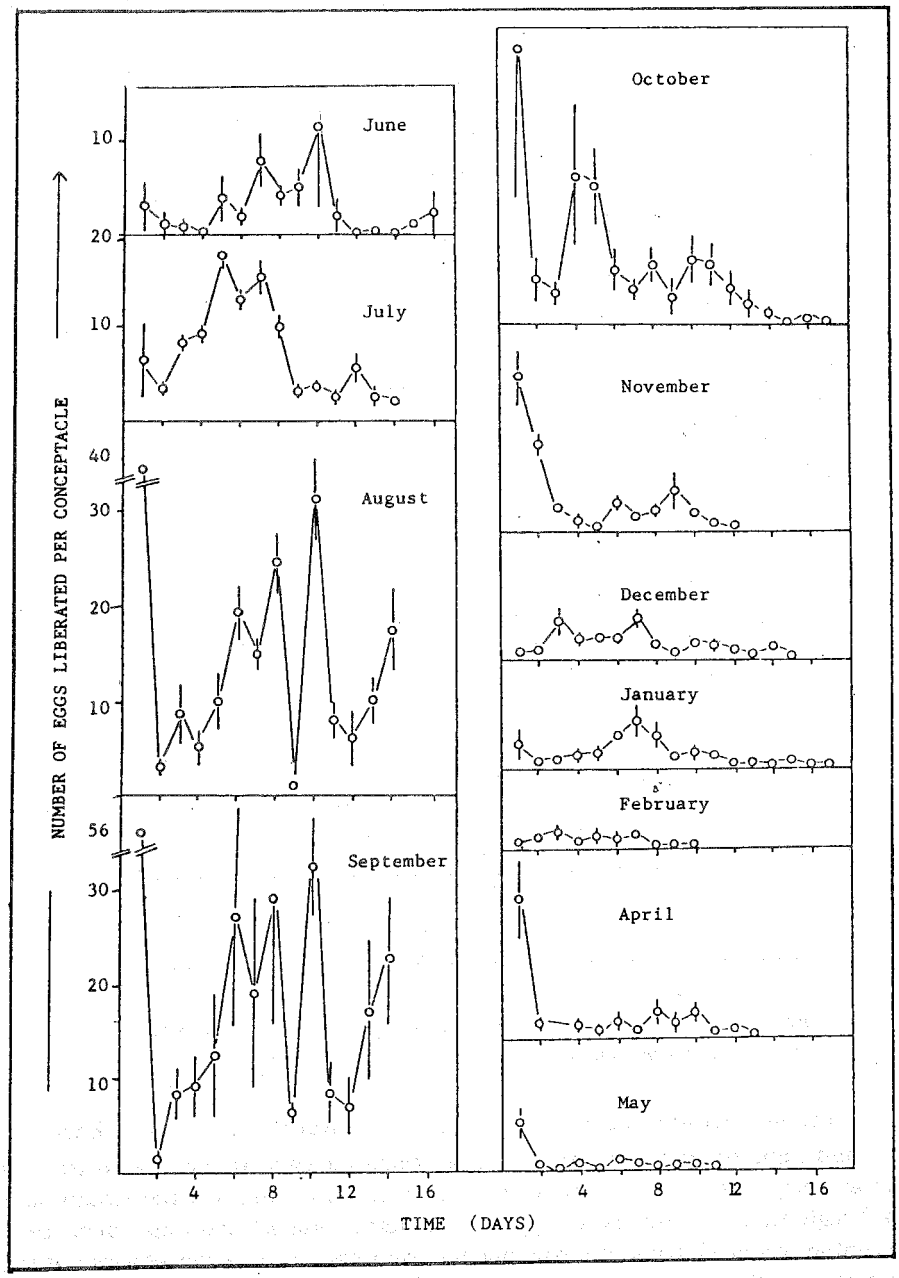

Fig.1. Seasonal variation of daily egg release per conceptacle. (No observation in March).

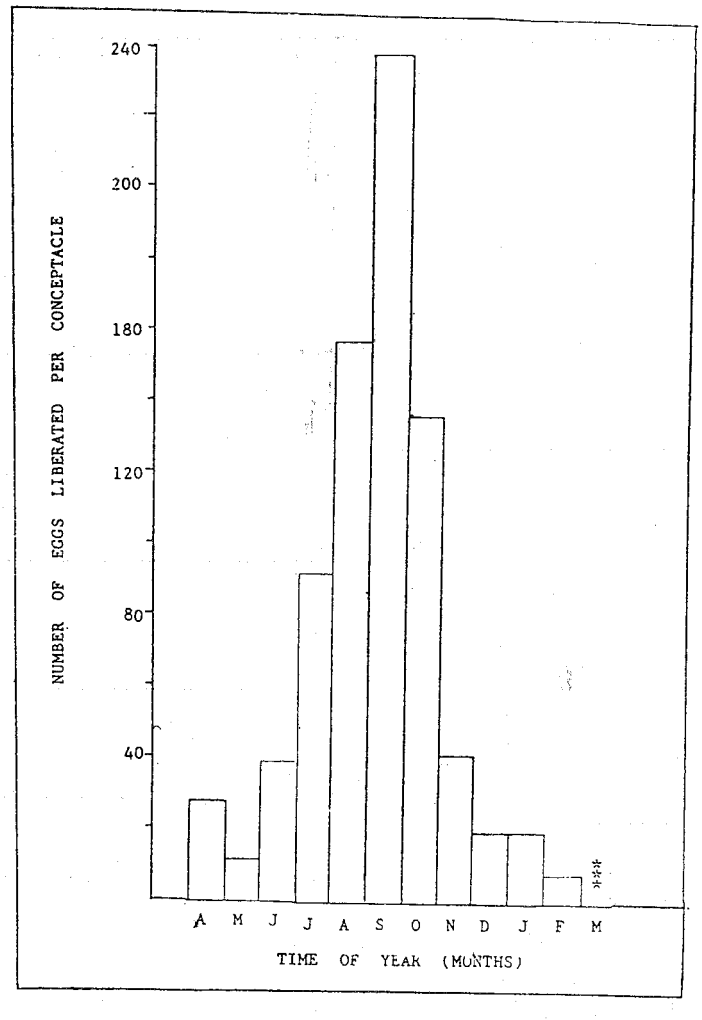

Fig.2. Seasonal variation in total egg production over a 10 day period.
*** = No observation in March.

ment. A second liberating peak occurred after an interval of 2-6 days. Except in August and September the number of eggs released were reduced with time. In August and September there were a series of liberation peaks and the release level was still high after 14 days. This suggests that during August and September, there was a continuous production of fertile oogonia with eggs in the conceptacles but that in the other months they were produced more slowly.

Total eggs liberation in the first ten days of each month, plotted separately (Fig.2) showed that the egg release was low from December to February but then gradually started to increase from April with maximum liberation in September

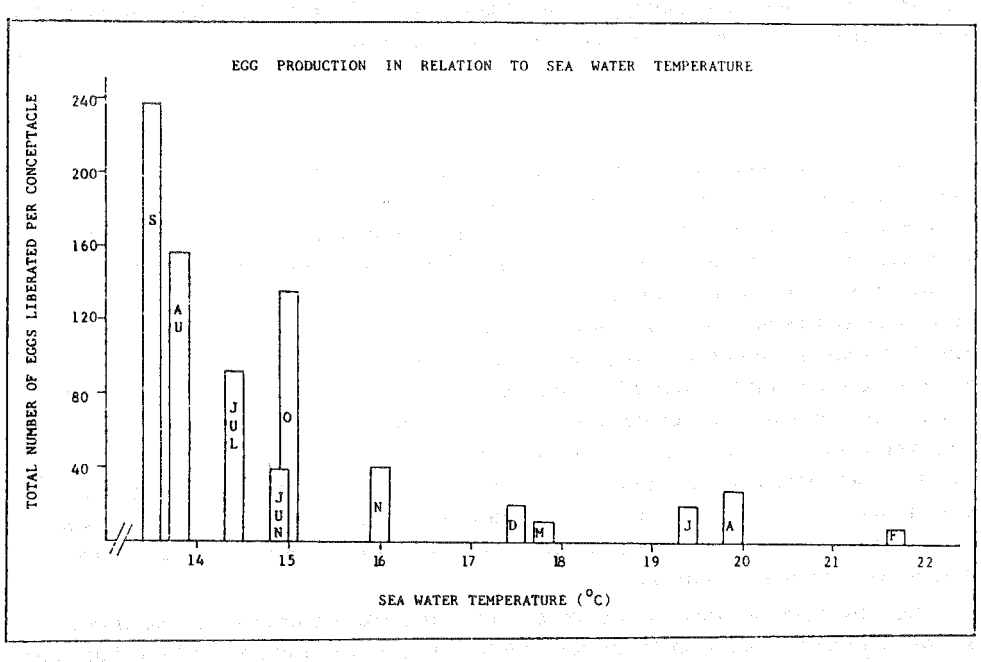

Fig.3. Egg production in relation to sea water temperature. The data from Fig.2. plotted agaisnt the mean monthly sea water temperature.

J. January; F, February; M, March; A, April; M, May; Jun, June; Jul. July; Au, August; S, September; O, October; N, November; D, December.

(except in April). However, a good liberation of eggs was obtained from July to October relating to the winter and early spring season and low liberation of eggs coincided with the late spring to the summer and autumn season. This suggested a relationship with sea water temperature. The data was therefore, plotted against the mean sea water temperature for each month (Fig.3). The liberation of eggs decreased with increasing temperature. The highest egg liberation coincided with winter (13.5^{o}C) the lowest with summer (22^{o}C) sea water temperature. As the water cooled down in June (15^{o}C) the number of eggs liberated increased till the highest in September then decreased with increasing sea water temperature to the lowest in February.

Sea water temperature higher than 16^{o}C was not favourable for the egg release relating to the late spring, summer and autumn season (Fig. 3,D,J,F,A,M). The low temperature (13.5^{o}C-16^{o}C) favoured egg release in the field (Fig.3, Jun, Jul, Au, S,O,N) which coincided with the late autumn, winter and early springs.

***Egg-Production Potential*:** During the winter season (July, August and September), the average number of eggs released per day was about 10 eggs per conceptacle and 2.0x10^{4} per plant, but in spring (October, November and December) production was low about 8 eggs per conceptacle and 8x10^{3} per plant. In summer (January, February) production was quite low, 1.0 eggs per conceptacle and 3.0x10^{3} per plant but in

autumn (April, May and June) egg production was a little higher than summer, 2.0 eggs per conceptacle and $5.0x10^3$ eggs were produced from whole plant.

Discussion

The field observations of both seasonal egg liberation and egg potential output suggest that *Hormosira* will not occur much further north than New Zealand because the water will be too warm for satisfactory egg production. Although egg production can occur at higher temperature, the viability of the egg is low and abnormal embryos often results in fertilization experiments. In June, for instance, a release of gametes was achieved in the laboratory but fertilization or germination was not obtained probably indicating immature eggs. Between February and May fewer gametes were liberated but abnormal embryos often results in fertilization experiments. It seems that during this period, non-viable or unhealthy gametes were found at the time when the conceptacles were almost empty and releasing only a few and over mature eggs. Moss & Sheader (1973) similarly obtained a lower percentage of germination at the beginning and at the end of the fruiting period in *Halidrys siliquosa* (Fucales). The highest percentage of fertilization was recorded from July-October relating with the winter and early spring season.

The above results showed a clear correlation between liberation and temperature as has been concluded by Boney (1965, 1966) and Feldmann (1951) that eggs release is related to the sea water temperature and spore shedding in sea water has reached optimum temperature for each species (Suto, 1950). Gauer *et al.*, (1982) and Pothen *et al.*, (1983) reported that the temperature and process of insolation play a leading role in seasonal growth and reproduction of the algae.

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References

Abe, M. 1970. A method of inducing egg liberation in *Fucus evanescens*. *Bot. Mag.* (Tokyo), 83; 254-255.

Begum, M. and F.J. Taylor. 1979. The development of the embryo of *Hormosira banksii* in laboratory culture. Australian and New Zealand Association for the Advancement of Science, Congress 49, Auckland. Abstracts 1: 377.

Boney, A.D. 1965. Aspects of the biology of the seaweed of economic importance. In: *Advances in marine biology*, (Ed.) F.S. Russel, Acad. Press, London, 3: 105-253.

Boney, A.D. 1966. *A biology of marine algae*. Hutchinson Educational Ltd. London, 216 pp.

Brawley, S.H., R. Wetherbee and R.S. Quatrano. 1976a. Fine structural studies of the gametes and embryos of *Fucus vesiculosus* L. (Phaeophyta). I. Fertilization and pronuclear fusion. *J. Cell Sci.*, 20: 233-254.

Brawley, S.H., R. Wetherbee and R.S. Quartrano. 1976b. Fine structural studies of the gametes and embryos of *Fucus vesiculosus* L. (Phaeophyta). II. The Cytoplasm of the egg and young zygote. *Jour. Cell Sci.*, 20: 255-271.

Callow, M.E., L.V. Evans, G.P. Bolwell and J.A. Callow. 1978. Fertilization in brown algae. I. SEM and other observations on *Fucus serratus*. *Jour. Cell Sci.*, 32: 45-54.

Clarke, S.M. and H.B.S. Womersely. 1981. Cross-fertilization and hybrid development of forms of the brown alga *Hormosira banksii* (Turner) Decaisne. *Aust. Jour. Bot.*, 29: 497-505.

Feldmann, J. 1951. Ecology of marine algae. In: *Manual of Phycology* (Ed.) G.M. Smith, Chronica Botanica Co., Waltham, Mass., 313-334

Forbes, M.A. and N.D. Hallam. 1978. Gamete structure and fertilization in the brown alga *Hormosira banksii* (Turner) Decaisne. *Brit. Phycol. Jour.*, 13: 299-310.

Forbes, M.A. and N.D. Hallam. 1979. Embryogenesis and substratum adhesion in the brown alga *Hormosira banksii* (Turner) Descaisne. *Brit. Phycol. Jour.*, 14: 69-81.

Gaur, K., T. Ramakrishna, D.P Sabbaraju and M.S. Murthey. 1982. Ecological studies on *Ulva lactuca* from veraval, India. *Hydrobiol.*, 89: 89-94.

Inoh, S. 1930. Embryological studies on *Sargassum*. *Sci. Rep., Tohoku*, Imp. Univ. 5: 421-438.

Levring, T. 1949. Fertilization experiments with *Hormosira banksii* (Turner) Decaisne. *Phys. Plant.*, 2: 45-55.

Levring, T. 1952. Remarks on the submicroscopical structure of eggs and spermatozoids of *Fucus* and related genera. *Phys. Plant.*, 5: 528-539.

Moss, B.L. and A. Shaeder. 1973. The effect of light and temperature upon the germination and growth of *Halidry siliquosa* (L.) Lyng. (Phaeophyceae, Fucales). *Phycologia*, 12: 64-68.

Osborn, J.E.M. 1948. The structure and life-history of *Hormosira banksii* (Turner) Decaisne. *Trans. Royal Soc. New Zealand*, 77: 47-71.

Pollock, E.G. 1970. Fertilization in *Fucus*. *Planta*, 92: 85-99.

Pothen, S., D.P. Subbaraju, T. Ramakrishna and M.S. Murthy. 1983. Effect of salinity, pH and temperature on the spores and sporelings of *Dictyopteris australis*, an alginophyte. *Hydrobiol.*, 102: 51-54.

Suto, S. 1950. Shedding, floating and fixing of the spores of *Gelidium*. *Bull. Jap. Soc. Fish.*, 15: 671-673.

Tahara, M. 1909. On the periodical liberation of the oospheres in *Sargassum*. *Bot. Mag. Tokyo.*, 23: 151-153.

Tahara, M. 1913. Oogonium liberation and the embryogeny of some fucaceae algae. *J. Coll. Sci. Tokyo.*, 32: 1-13.

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