Growth and Reproductive Pattern of Intertidal and Subtidal *Sargassum* (Sargassaceae, Phaeophyta) Populations in Bolinao, Pangasinan

Ariel T. Ortiz* and Gavino C. Trono Jr.
Marine Science Institute, College of Science
University of the Philippines, Diliman, Quezon City 1101 Philippines
Email: ariel@msi01.cs.upd.edu.ph

ABSTRACT

First and second year populations of the *Sargassum* in the intertidal and subtidal portions of a seagrass bed were tagged and monitored over a period of 14 months (May 1996-June 1997). Statistical analysis (ANOVA and MANOVA) showed that there was a temporal variation in the thallus length of the *Sargassum* population between the intertidal and the subtidal regions ($p<0.05$). The subtidal population have longer thallus length than the intertidal population. Mean plant heights in the intertidal area (20.5 cm [1st year age group] and 25.0 cm [2nd year age group]) were significantly shorter than those in the subtidal region (26.0 cm [1st year age group] and 31.6 cm [2nd year age group]). *Sargassum* population in the intertidal region reached full maturity a month earlier (November) than those in the subtidal area (December). Peak fertility stage occurred in December for both regions.

Key words: *Sargassum*, growth rate, fertility, reproductive pattern, seasonality

INTRODUCTION

The brown seaweed *Sargassum* is an economically important genus. It is utilized in the industry as animal feed, liquid fertilizer, and raw material for the production of alginate, which has various uses in many industries (McHugh 1987). *Sargassum* is frequently the largest and most dominant seaweed species in terms of standing crop, percent cover, and height in tropical high subtidal and low intertidal zones of the marine environment (Svedelius 1906, Widdowson 1965, Doty 1971, Tsuda 1972, De Wreede 1976, Verheij and Erfteijer 1993). They proliferate in vast areas along coastal waters housing myriad life forms, making them one of the most ecologically important and productive communities. In 1987, fishermen in Central Visayas and Northern Mindanao claimed a decline in fish stocks and other associated marine organisms after tons of *Sargassum* were harvested and exported for seaweed meal (Trono and Lluisma 1990). In the Philippines, 72 *Sargassum* species have been recorded. Of these species, the most common are *S. cristaefolium* C. Agardh, *S. crassifolium* J. Agardh, *S. polycystum* C. Agardh, and *S. oligocystum* Montagne (Silva and others 1987).

Studies have shown that contrasting habitats of wave exposure, variation in depths in the intertidal and subtidal regions, and sites with emergent and submergent substrata, could effect differences in growth of marine

* *Corresponding author*

macroalgal populations (McLachlan et al. 1971, De Silva and Burrows 1973, Russel 1978, Norall et al. 1981, De Ruyter van Steveninck and Breeman 1987). Among these are the various *Sargassum* populations.

This study reports on the seasonality in growth pattern and fertility peaks of *Sargassum* in the intertidal and subtidal areas. Information gathered will serve as baseline information to be used for the formulation of large-scale management scheme for the proper utilization of these resources in the country.

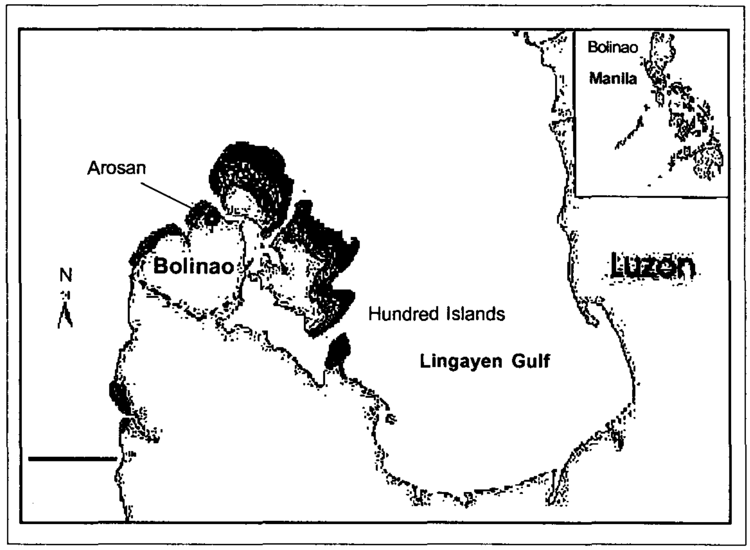

Fig. 1. Location of the study area in Arosan, Bolinao, Pangasinan

MATERIALS AND METHODS

Study site

The study site in sitio Arosan in Bolinao, Pangasinan (16°23'41.2" N lat., 119°53'27.6" E long.) (Fig. 1) is that portion of the reef protected from the SouthWest Monsoon. The area supports vast and well-developed intertidal and subtidal *Sargassum* communities. Three species of *Sargassum* were identified in the area: - *S. crassifolium*, *S. cristaefolium* and *S. polycystum*, all of which were not subjected to heavy exploitation or harvest pressure.

Growth rates

First year age group population

This refers to newly developed *Sargassum* populations from the germling stage (299 days old) which have not yet undergone a "die-back" stage (Ang 1982).

Three permanent plots (A, B, & C) measuring 5x5 m were established strategically in each subtidal and intertidal portions of the *Sargassum* bed. Inside these plots, 20 individuals of the dominant *Sargassum* belonging to this age group were tagged using plastic coated colored wire. The length of the plant (from the holdfast to the tip of the longest shoot) were monitored monthly for 14 months, from May 1996 to June 1997. The increase in lengths were averaged to give the periodic mean thallus lengths.

Second year age group population

This refers to *Sargassum* populations which have already undergone the "die-back" stage and have begun another regeneration cycle (Ang 1982).
In the same 3 permanent plots in both intertidal and subtidal regions, 20 individuals of the dominant species of *Sargassum* belonging to this age group were also tagged, together with the first year age group population. The lengths of the plants were measured and monitored in the same way as the first year age group population.

Multivariate Analysis of Variance (MANOVA) was applied to determine significant differences in the thallus lengths of the populations per habitat over time.

Reproductive periodicity

The reproductive states of the tagged plants were monitored monthly for 14 months. The number of plants that were fertile (presence of fertile structures or receptacles) were counted. The percentage of fertile plantswas determined, thus:

$$\% \text{ Fertility} = \left[\frac{\text{Number of fertile thalli}}{\text{Total number of thalli}}\right] \text{X } 100$$

One-way ANOVA was used to determine (a) the significant differences in the fertility of *Sargassum* populations in the subtidal and intertidal areas and (b) whether the different species in these two habitats would show an identical and synchronous reproductive pattern.

RESULTS

Growth rates

Plants of the same age group in the 3 plots (A, B, & C) exhibited similar growth patterns in both intertidal and subtidal regions (Fig. 2). The means of these growth patterns were computed and presented in Fig. 3. In the intertidal region, both first and second year age groups attained peak thallus length in November, after which they began to die-off by December (Figs. 3a & b). By May, all plants were on their die-off stage. In the subtidal region, however, the plants attained peak thallus length a month later (Figs. 3a & b), after which, gradual die-off ensued until end of February. Regeneration of branches started in March, increasing in length months thereafter. ANOVA and MANOVA tests indicated significant temporal variations in the growth rates of the populations in both intertidal and subtidal regions ($p<0.05$). The tests further showed that the second year age group populations were significantly taller than their intertidal counterpart by about 7 cm ($p<0.05$), particularly in December and June (Fig. 3), during their regeneration stage. Among the first year age group, subtidal plants were significantly taller in certain months of the year (e.g., December) (Fig. 3). The first year age group in the subtidal area measured 23.7-26.0 cm, while the second year age group the varied from 28.9 to 31.6 cm. In the intertidal area, first year age group was 18.2 - 20.5 cm tall while the second year age group measured 22.3-25.9 cm long.

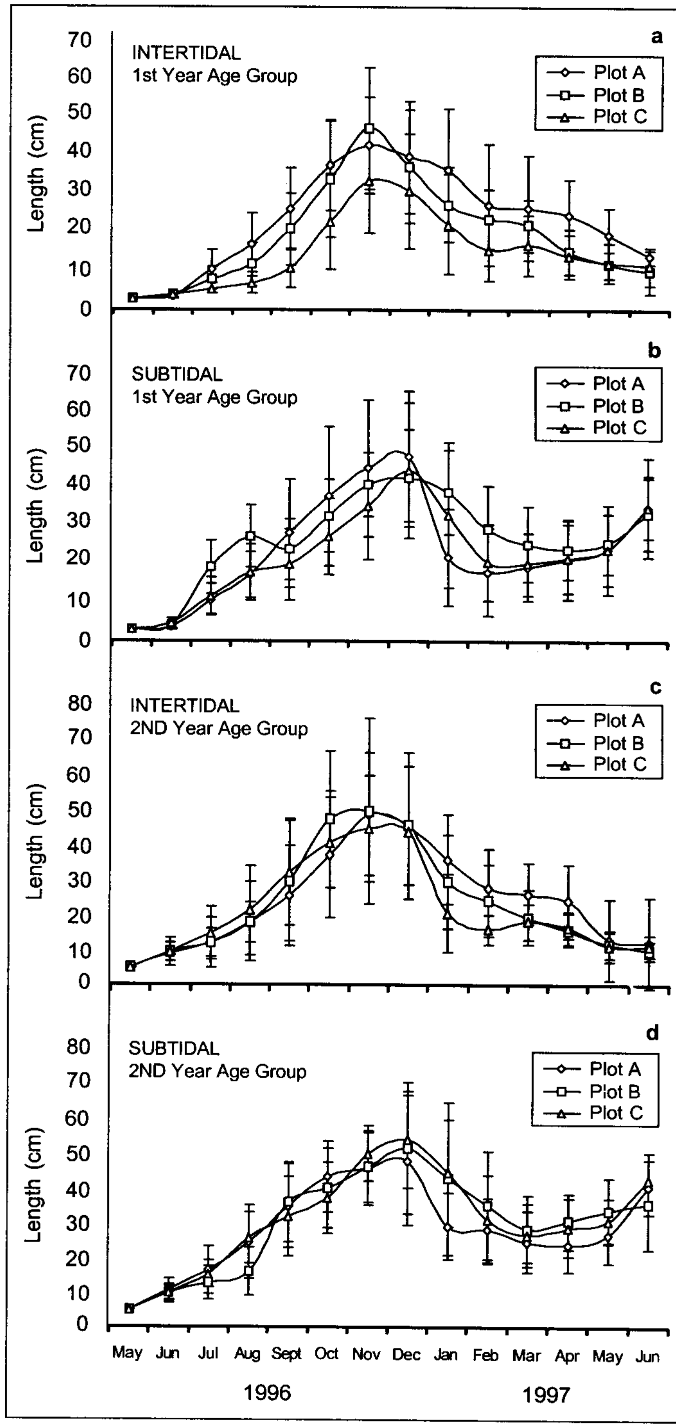

Fig. 2. Monthly variations in the mean thallus lengths of the 1st and 2nd year age group *Sargassum* population in the 3 plots in the intertidal (A & C) and subtidal (B & D) regions

Reproductive periodicity

Peak fertility of *Sargassum* in the intertidal and subtidal zones occurred and coincided with the months when the plants reached full maturity (Fig. 4). In both regions, the plants were fertile in September to about April,

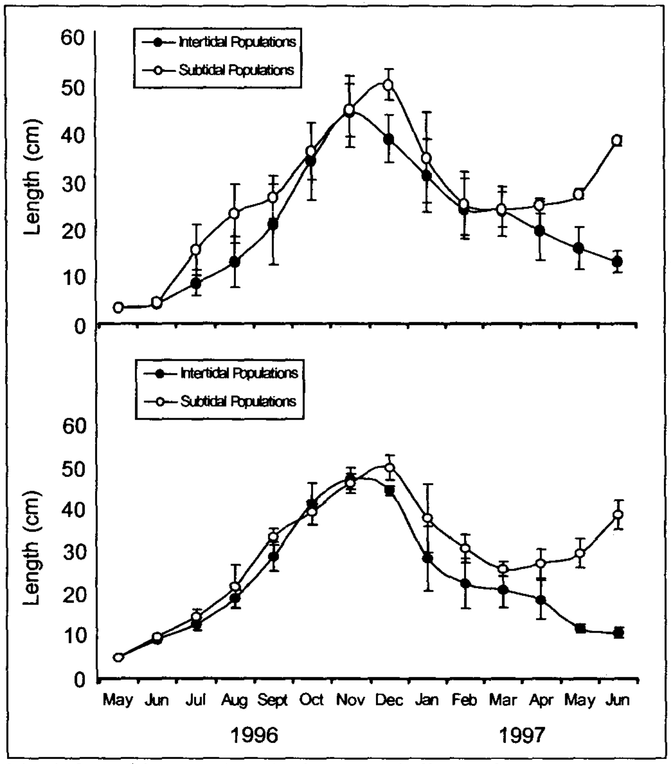

Fig. 3. Monthly variations in the mean thallus of the *Sargassum* populations 1st year (a) and 2nd year (b) age group in the intertidal and subtidal regions

reaching peak fertility in December, when plants were tallest.

DISCUSSION

Both the intertidal and the subtidal areas in the northwestern part of Bolinao, particularly Arosan, supported vast *Sargassum* beds. This could probably be due to the rocky coralline substrate reported to be favorable for *Sargassum* growth (Tsuda 1972).

Although the peak growth and die-off of *Sargassum* in the intertidal and subtidal regions in Arosan did not occur simultaneously (i.e., the intertidal population reached peak growth in November, a month earlier than the subtidal population which reached it in December), peak growth periods of both populations in the two regions coincided with those reported for similar *Sargassum* species in Dewey Pt., also in Bolinao (Trono and Lluisma 1990, Trono and Tolentino 1992, 1993) as well as, for *Sargassum oligocystum, S. obtusifolium* J. Ag. and *S. polyphyllum* J. Ag. in Hawaii (Ohno 1978). The maximum growth of *Sargassum* in Hawaii was from November to January (Ohno 1978) while the highest standing crop was harvested for similar species in Dewey, Bolinao, during that period (Trono and Luisma 1990, Trono and Tolentino 1992). In this study, the observed highest growth rates during the cold months, from September through January, were similar to that of temperate *Sargassum* species which also reached full maturity in wintertime (Nuñez and Valdez 1997). In Bahia, Mexico, periods of growth and development of *Sargassum* slightly vary in the intertidal and subtidal areas, indicating that its development is geographically and temporally different even for the same or different species (Nuñez and Valdez, 1996).

The apparent shortness of the *Sargassum* populations in the intertidal region as a consequence of slower growth rate compared to the subtidal

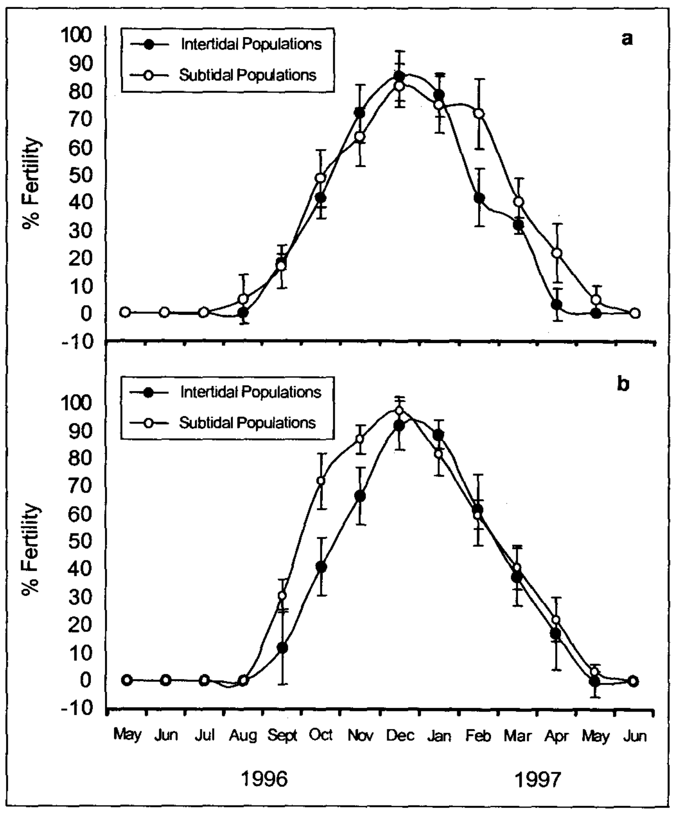

Fig. 4. Monthly variations in the fertility of the 1st year (A) and 2nd (B) age group *Sargassum* populations in the intertidal and subtidal regions

population could be due to the exposure of the growing thalli to desiccation during low tides, which consequently depressed their growth potential. This effect was even more evident during summer months (April-June) when intertidal area was exposed to higher light intensity and temperature characteristic of the period. In the subtidal region, where the plants were fully submerged all throughout their lifespan, their maximum growth potential was attained. This observation corroborates that of Largo et al. (1994) on those species of *Sargassum* found in Liloan, Cebu and that of Allender (1977) on *Padina japonica* (Yamada) where the species grow best when continuously submerged. Their growth rates decrease with increasing emersion up to a clear upper zone boundary.

In both intertidal and subtidal regions, *Sargassum spp.* became fertile only after attaining their maximum height or length. Their fertility followed closely their peak in growth. Development of receptacles (special branches containing the reproductive structures) occurred during the colder part of the year, attaining peak fertility in December. A similar observation on *Sargassum* growth was reported by Trono and Tolentino (1993) who found that peak in standing crop was followed by a peak in fertility, culminating in senescene or die-back by the end of December to February. In Guam, *S. polycystum* also attained its maximum growth and ferility in December (Tsuda 1972). The lower temperature in November and December (Glenn and others 1990) could have induced or triggered fertility of the populations in both intertidal and subtidal regions.

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