Age and Growth of *Ecklonia stolonifera* Okamura in Pusan Bay, Korea

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Age and growth of *Ecklonia stolonifera* Okamura were investigated by random quadrat sampling method at monthly intervals from February 1993 to January 1994 in Pusan Bay, southeastern coast of Korea. The size of various parts of the collected plants was periodically measured individually. An allometric relationship was established according to the total length, blade length, stipe length, stipe diameter and weight of frond. Each age group was divided according to the range of stipe length by the allometric relation.

The population of *E. stolonifera* consisted of five age groups; 1 year (41.5%), 2 years (25.9%), 3 years (21.1%), 4 years (7.8%) and 5 years (3.5%). During a year, biomass of the population increased drastically from May to September, but gradually decreased from October to January. Zoosporangial sori were observed on blades of three or more years old, from October to December. New populations were formed by zoospores, developed on shoots of three or more years old, and also they were vegetatively formed from stoloniferous haptera on two or more year old mother thalli.

Introduction

*Ecklonia stolonifera* Okamura is widely distributed along the eastern and southern coasts of Korea (Kang, 1966). This species usually grows in the subtidal zone, 2–10 m deep, along the coast. The species, which is one of the major primary producers in shallow water (Druelh et al., 1977), plays an important role both ecologically in the coastal ecosystem and economically in the fisheries production. Therefore, considerable knowledge has been accumulated on its distribution, growth and population structures from an ecological point of view.

Recently, several studies on its ecology (Notoya, 1984, 1985, 1986, 1987; Notoya and Aruga, 1980), zoospore germination (Notoya and Asume, 1983) and nuclear divisions (Yabu and Notoya, 1985) were reported. However, little attention has been paid to population dynamics. The study of population dynamics is of great importance, not only for the ecological field but also for fisheries and commercial field in order to provide fundamental data for management and conservation of marine bioresources.

*E. stolonifera* is perennial algae, and its populations are maintained by alternating each age group. Therefore, it is necessary to establish the age structure, growth pattern and maturation period of *E. stolonifera* population.

The present study has been undertaken to determine the age structure of *E. stolonifera* populations, with seasonal fluctuation of growth, and ma-
uration period for twelve months. By analyzing these data, it could be revealed factors controlling recruitment of *E. stolonifera* populations.

**Materials and Methods**

The study site was located off Pusan Bay, southeastern coast of Korea (Fig. 1), where the sublittoral substratum consisted mainly of rocks suitable for kelp communities. *E. stolonifera*, *Sargassum horneri* and *S. ringgoldianum* were the major components of the sublittoral vegetation. *E. stolonifera* usually grew in water deeper than 2~8 m.

The samples were taken at monthly intervals from February 1993 to January 1994. Samples were collected by random quadrat (50×50 cm) at 2~8 m depths through scuba diving. It was assumed that more than 30 individuals were large enough to estimate the parameters in an unbiased manner (Elliott, 1977).

The sizes of various parts of the collected plants were measured for each type of plant and sampling period. An allometric relationship was established between the total length, blade length, stipe length, stipe diameter and weight of frond. Each age group was divided according to the range of stipe length by the allometric relation (Maegawa and Kida, 1984).

The formation of zoosporangial sori on the blade was checked for each population of plants of various sizes.

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**Results**

The *Ecklonia stolonifera* population was composed of fronds of various age groups. According to the range of stipe length by the allometric relation, each age group was divided into 1 to 5 years age groups (Fig. 2). The average stipe length of respective size group clearly corresponded to the stipe length of *E. stolonifera*, the age of which was determined from the stoloniferous rhizoid system (Notoya, 1986).

Numbers of samples and various parameters at different age groups of *E. stolonifera* are shown in Table 1. Distributions of the shoot age of *E. stolonifera* are shown as five age groups; 1 year (41.5%), 2 years (25.9%), 3 years (21.1%), 4 years (7.8%) and 5 years (3.5%). One-year old shoots showed the highest frequency. The average stipe length values from the five age groups were estimated at 2.5, 6.5, 11.3, 14.9 and 16.8 cm, respectively.

Frequency distribution of total length, blade length, stipe length and stipe diameter of *E. stolonifera* populations during the investigation period are shown in Fig. 3. The data indicate that small size classes were recorded over the whole year. Figure 4 showed relationships between total length, blade length, stipe length and stipe diameter in *E. stolonifera* shoots to the age groups. This relationship between age (X) and growth (total length, blade length, stipe length and stipe diameter; Y) was expressed by the formula $Y=16.194X+6.24(r=0.93)$, $Y=13.712X+1.632(r=0.95)$, $Y=4.876X-0.902(r=0.97)$ and $Y=1.652X+0.194(r=0.99)$. Each parameter increased with the age of shoots.

During the investigation period, water temperature and biomass fluctuations are shown in Fig. 5. Water temperature increased until September, 1993, and then decreased greatly in October, 1993. The variations of biomass showed dependency on the water temperature. The thallus number and biomass of the population showed a high peak from May to September, and a low from October to January. The maximum biomass for *E. stolonifera* was recorded in September.

Formation of zoosporangial sori in *E. stolonifera* was observed on blades more than three years old, during from October to December (Fig. 6).