Productivity of the *Ecklonia cava* Community in a Bay of Izu Peninsula on the Pacific Coast of Japan

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Net production of the *Ecklonia cava* community was monitored on a monthly basis for a year, and annual net production was estimated. Growth rate of blades reached a maximum of about 13 g dry wt • m⁻² • day⁻¹ in spring and a minimum of about 2 g dry wt • m⁻² • day⁻¹ in late summer. Annual production of blades was calculated to be 2.84 kg dry wt • m⁻² • year⁻¹. If the growth of stipes is taken into account, annual net production is estimated to be about 2.9 kg dry wt • m⁻² • year⁻¹. Standing crop was monitored monthly for two and a half years, and a close negative correlation was found between seasonal change in standing crop and net production. Standing crop reached a maximum of about 3 kg dry wt • m⁻² in summer and a minimum of about 1 kg dry wt • m⁻² in winter. Low productivity in summer at a period of maximum biomass may be explained by the dense canopy and the large area of reproductive portion occupying a blade, which diminish net assimilation.

Key words: *Ecklonia cava* — Leaf area index — Leaf-marking method — Net production — Submarine forest.

Communities dominated by the perennial brown alga *Ecklonia cava*, with stipes as long as 1.5 m or more, are the most typical submarine forests in central Japan. As a consequence the attention of underwater ecologists has been focussed on them. Most of their studies are on structural aspects of the community (Iwahashi, 1968a, b, 1971, 1979; Hayashida, 1977, 1983, 1984, 1986; Kida and Maegawa, 1982, 1983, 1985; Ohno and Ishikawa, 1982; Kasahara and Ohno, 1983; Ohno et al., 1983; Maegawa and Kida, 1984), and a few studies are on structural aspects such as productivity (Yokohama, 1977b; Maegawa et al., in press; Sakanishi et al., in preparation).

Attempts to estimate production in the *Ecklonia* forest have been made by measuring photosynthesis and respiration of the plants *in situ*, as well as by measuring growth rate of their blades (Yokohama, 1977b). The latter method produced useful estimation of net production of the forest over a long term.

An adult plant of *Ecklonia cava* has a pinnate blade consisting of a primary blade...
and 10–30 pairs of bladelets. In studies on *E. radiata* (Mann and Kirkman, 1981; Kirkman, 1984) these bladelets are referred to as secondary blades. Growth of the new bladelets and associated tissue of the primary blade is initiated by an intercalary meristem at the junction of stipe and blade. With the successive formation of new bladelets and the tissue of primary blade the earlier formed bladelets progress towards the upper end of the plant. At the same time the bladelets increase in size until a point where this is over balanced by the effects of grazing, autolysis and wave action.

Yoshida (1970) used a leaf-marking method to investigate seasonal change in the rate of production and dropping off of bladelets in *Eisenia bicyclis*, an alga with a morphology similar to that of *Ecklonia* species. Yokohama (1977b) modified this method and used it to estimate net production of *Ecklonia cava*.

In the present study, this biomass method has been improved and used to estimate annual net production, as well as seasonal change in productivity, of the *Ecklonia* forest in a bay on the Pacific coast of Japan.

A portion of the results of the present study was published in Japanese (Tanaka et al., 1983, 1984).

**Materials and Methods**

On the Pacific coast of central Japan, the submarine forest is formed by *Ecklonia cava* and its related species *Eisenia bicyclis*. *Eisenia* occupies the range from the low-water mark to a depth of 3–7 m, and *Ecklonia* occurs in deeper waters, to a depth of 20–30 m (Yokohama, 1977a; Iwahashi, 1979; Kida and Maegawa, 1982, 1983; Hayashida, 1983).

The Shimoda Marine Research Center is situated at the head of Nabeta Bay, near the tip of the Izu Peninsula on the Pacific coast of central Japan (Fig. 1). Dense populations of *Ecklonia cava* and *Eisenia bicyclis* are found at a site 0.4 km distant from the head of the Bay. At that site the boundary between the zones of *Ecklonia*...