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# Seasonality pattern of biomass accumulation in a drifting *Furcellaria lumbricalis* community in the waters of the West Estonian Archipelago, Baltic Sea

Georg Martin*, Tiina Paalme & Kaire Torn
*Estonian Marine Institute, University of Tartu, Mäealuse 10 a, 12618 Tallinn, Estonia*

*Author for correspondence: e-mail georg.martin@ut.ee

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**Abstract**

A free-floating, loose form of *Furcellaria lumbricalis* (Huds.) Lamour is rare in the Baltic Sea area. Kassari Bay, situated in the West Estonian Archipelago Sea area contains the largest known community of this kind. Here the free-floating mixed *Furcellaria lumbricalis-Coccotylus truncatus* (Paela) M. J. Wynne et J. N. Heine community inhabits sandy bottom, covering up to 120 km$^2$. Commercial exploitation of the community started in 1966 and has led to regular monitoring surveys for the quantification of the commercial resource. The aim of the present study was to determine the potential growth rates of the two community-forming species as well as to test different environmental factors affecting their growth. Results showed that the highest growth rates were measured in shallower depths (4 m) for both species. The seasonal growth pattern was also very similar for both species, showing the highest growth rates during the beginning of summer. Incubation of both species in another sea area with apparently similar basic environmental conditions (the northern part of the Gulf of Riga, Kõiguste Bay) resulted in significantly lower growth rates during the whole incubation period.

## Introduction

In the Baltic Sea, at least two ecologically distinct forms of the red algal species *Furcellaria lumbricalis* are found. The attached form of this species is very common on the hard bottoms of the lower part of the phytobenthic zone of the Baltic Sea (Nielsen et al., 1995). Loose-lying *F. lumbricalis* is, on the contrary, very unique. Only three localities have been described as having large communities of this form in the Baltic Sea. One of these (Puck Bay) has already lost the population due to eutrophication and pollution problems (Martin et al., 1996; Kruk-Dowgiallo & Ciszewski, 1994). Austin (1959) described a similar agglomeration of loose *Furcellaria* in the central Kattegat area. The sea area of the West Estonian Archipelago hosts the largest known community of this kind, where a mixed community of loose-lying *Furcellaria lumbricalis* and *Coccotylus truncatus* covers up to 120 km$^2$ of sea bottom with more than 140 000 tons of wet biomass in Kassari Bay. The community was described for the first time by Kireeva (1961, 1964). The mean biomass of this community varied between 500 and 1000 g of wet weight m$^{-2}$ and occasionally reached a maximum of 2.1 kg wet weight m$^{-2}$ (Trei, 1975, 1976; Martin et al., 1996). The community was found on sandy substrates at depths between 5 and 9 m, where it formed a 0.15 to 0.3 m thick carpet on the seafloor. The proportion of the two dominant species differed slightly depending on locality but usually 60–70% of the biomass was *F. lumbricalis,* while *C. truncatus* accounted for 30–35%, on average. The proportion of other species was usually low, less than 5% (Trei, 1975, 1976; Martin et al., 1996).

The loose red algal community has been used as raw material for agar production since 1966 and annual yields have been estimated to be near 1000 t wet weight. The status of the community has been

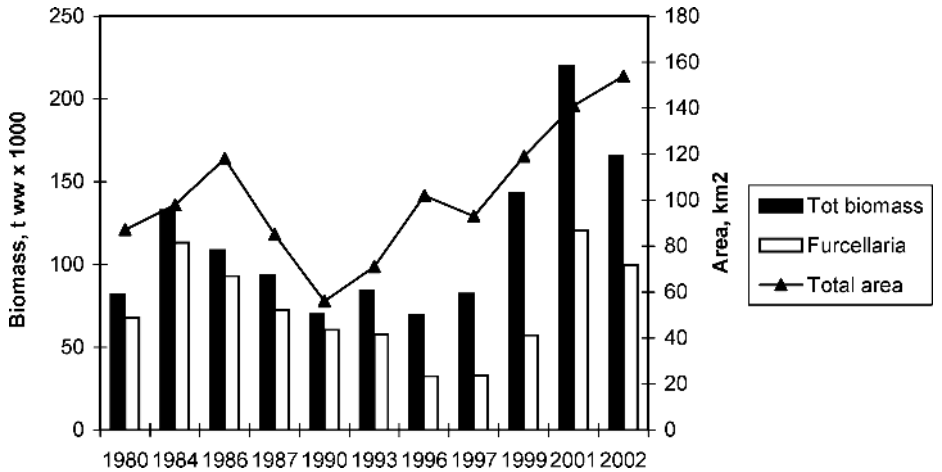


*Figure 1.* Dynamics of different characteristics of loose red algae community in Kassari Bay according to the results of commercial resource monitoring studies. Parameters shown are total biomass of the community, biomass of the species *Furcellaria lumbricalis* in the community and total area of the community.

monitored regularly and a decline in the loose *Furcellaria lumbricalis – Coccotylus truncatus* community was recorded in the Kassari Bay of the Väinameri area during 1996–97. Since then, both the total area of the community and total biomass have been steadily increasing (Figure 1). The decline in the loose red algal community was due to the extensive overgrowing of filamentous brown algae, which fixed the algal carpet and caused oxygen deficiency in the near-bottom layer (Martin & Kukk, 1997a,b, 1998, 1999).

The aim of this study was (1) to experimentally compare the growth rates of loose-lying form of *F. lumbricalis* with the accompanying species *C. truncatus,* (2) to compare the growth rates of these species in different ecological conditions (two different experimental sites, three different incubation depths) and (3) to follow seasonal changes in production.

## Material and methods

### *Study area*

Väinameri (inner sea of West-Estonian Archipelago) is formed by a system of straits connecting the waters of the Gulf of Riga to the Baltic Proper and the entrance to the Gulf of Finland (Figure 2). The total surface area of the system is 2243 km$^2$ (Suursaar et al., 1998). The mean depth of the whole system is less than 10 m. Kassari Bay, in the western part of the area, is connected to the Baltic Proper through the narrow Soela Strait and separated from the eastern part by a grid of islets. Hydrologically, this area behaves differently from the other parts of the Väinameri as it is more influenced by the saline waters of the Baltic Proper (Suursaar et al., 1998). The impact of the riverine inflow on the system is very small; the amount of fresh water entering the system reaches only 1 km$^3$ yr (Astok et al., 1999). The sea-floor is mainly of soft sediments, including fine mud and sand fractions. Harder substrata such as gravel or boulders can be found only in the most shallow and wave exposed areas. Due to the shallowness and the substrate being dominated by fine sediment fractions on the bottom, the water transparency is often very poor. After storms the Secchi depth may decrease to 0.5 m, while in the case of prolonged calm weather conditions the photic zone reaches the bottom in about 90% of this area.

The Gulf of Riga has a surface area of 16 330 km$^2$ with a water volume of 424 km$^3$, which makes up 3.9% of the total area of the Baltic Sea and 2.1% of its volume (Berzinsh, 1995). The volume of the annual freshwater input to the system is estimated to about 31 km$^3$ (Yurkovskis et al., 1993). An important feature of the basin is the lack of permanent stratification which enables intensive water exchange processes between the deep and surface layers. The nutrient regime of the Gulf of Riga basin differs greatly from that of the other parts of the Baltic, having several time higher nutrient concentrations compared to adjacent basins (Astok et al., 1999, Yurkovskis et al., 1993).