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ScienceDirect
Estuarine, Coastal and Shelf Science 75 (2007) 308–316
ESTUARINE COASTAL AND SHELF SCIENCE
www.elsevier.com/locate/ecss

Overgrowth patterns of the red algae *Furcellaria lumbricalis* at an exposed Baltic Sea coast: The results of a remote underwater video data analysis

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Received 12 December 2006; accepted 30 April 2007
Available online 6 August 2007

Abstract

The exposed coast on the tide-less south-eastern Baltic Sea is generally unsuitable for large perennial, habitat forming plants, such as eelgrass and bladder wrack. In this area the dominant perennial macrophyte, *Furcellaria lumbricalis*, provides an important substrate for the eggs of commercial fish. This algae is limited to the hard substrates and abundant at depths of 6–10 m. However, the distribution of *F. lumbricalis* is patchy, probably due to the effects of exposure and abrasion from mobile sediments. It has been proposed that the extent of *F. lumbricalis* cover relates to substrate size and stability, sediment abrasion, depth and the direction of predominant stormy winds. A remote underwater video equipment was used to obtain records of distribution of these algae. Video footage was segmented into still images from where physical and biological parameters were obtained. *F. lumbricalis* occurred on cobbles, boulders, and occasionally on pebbles. Cover of algae was greater on boulders surrounded by a stable bottom (boulders) than surrounded by sands and gravels. Cover on cobbles was similar on all bottom types probably due to the movement of this substrate during storms. *F. lumbricalis* occurred close to the seabed on those substrates on stable bottoms where compared with mobile ones. However, elevation of algae from the seabed and cover patterns depended on depth. According to direction of wind exposure, cover on substrates was greater on sheltered surfaces in comparison to exposed ones, where the *F. lumbricalis* was dislodged during storms. The distribution of cover of *F. lumbricalis* may alter according to storm frequency as predicted to take place with changes in climate.

Keywords: phytobenthos; patchiness; sediment stability; abrasion; wind exposure; sublittoral

1. Introduction

The phytobenthos distribution in Baltic Sea is determined by many environmental gradients and their interactions (Wallentinus, 1991; Kautsky, 1995; Kiirikki, 1996; Orav et al., 2004; Eriksson and Bergström, 2005; Eriksson and Johansson, 2005). The role of these environmental factors varies according to the conditions occurring in different localities in the Baltic Sea. For instance the salinity gradient determines the distribution of marine kelps and fresh water plants (phanerogams) which are normally confined to soft sediments (Snoeijs, 1999). Wave exposure and ice scouring generally effect the zonation of brown seaweeds at the northern Baltic Sea regions (Kiirikki, 1996).

The exposed south-eastern (SE) Baltic coast is unfavourable for the most widespread habitat forming species, such as eelgrass (*Zostera marina* L.) and bladder wrack (*Fucus vesiculosus* L.) (Haage, 1975; Baden and Boström, 2001) due to active hydrodynamic conditions. The only dominant perennial macrophyte at the SE Baltic coast is the red algae *Furcellaria lumbricalis* (Huds.) Lamour which is known to be an important commercial species and a spawning substrate for fish (Kireeva, 1960a,b; Trei, 1984; Olenin and Labanauskas, 1994; Korolev and Fetter, 2003; Andrulewicz et al., 2004). This species is

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doi:10.1016/j.ecss.2007.04.038

widely distributed in the northern hemisphere: Atlantic and Indian Oceans, Mediterranean and Baltic Seas (Guiry, 2006).

Earlier studies have shown that at the SE Baltic Sea coast, *Furcellaria lumbricalis* is generally limited by the availability of light and hard substrates (Blinova and Tolstikova, 1972; Labanauskas, 1998). The species occurs from ca. 3 to 16 m, and is abundant in its optimal depth range from ca. 6 to 10 m (Kireeva, 1960b; Olenin et al., 2003). In more sheltered waters of other eastern Baltic regions, *F. lumbricalis* grows at depths up to 1 m (Wallentinus, 1979; Martin, 1999), indicating that the wave effect may be a limiting factor on exposed coasts.

The distribution of *Furcellaria lumbricalis* is patchy even within its optimal depth range varying in abundance from single specimen to very dense beds (Olenin and Labanauskas, 1994; Olenin et al., 2003). Size and stability of substrates as well as the surrounding bottom (on which these substrates are situated) are also very diverse within this depth zone. Therefore, it has been suggested that the distribution patterns of *F. lumbricalis* relate to substrate size, exposure to stormy winds and abrasion by mobile sediments. Since direct observations at the exposed coast are seldom possible, a remote underwater video survey was undertaken. This method allowed mapping of small-scale distribution of algae which may reflect the consequences of abrasion and storm effects. The following working hypotheses were formulated:

- the cover of *F. lumbricalis* should be greater on large and stable substrates (e.g. boulders) which help the algae to avoid scouring and detachment;
- the cover of the algae should be greater on substrates surrounded by stable sediments (e.g. boulders) than on substrates surrounded by mobile sediments (e.g. sands and gravels);
- the position of *F. lumbricalis* holdfast on the substrate should be higher above the seabed surrounded by mobile sediments than by stable sediments, due to abrasion effect;
- the substrate mobility and effect of sediment abrasion upon the cover of algae should be greater at lower depths than at deeper sites; and
- the cover of *F. lumbricalis* should be denser on sheltered surfaces of substrates (in case of this study site: E, NE and SE) compared to exposed ones (W, NW and SW).

2. Methods

2.1. Study area

The underwater study area was on the south-eastern part of the Baltic Sea coast, Lithuania, where abundant *Furcellaria lumbricalis* beds occur (Fig. 1) (Blinova and Tolstikova, 1972;

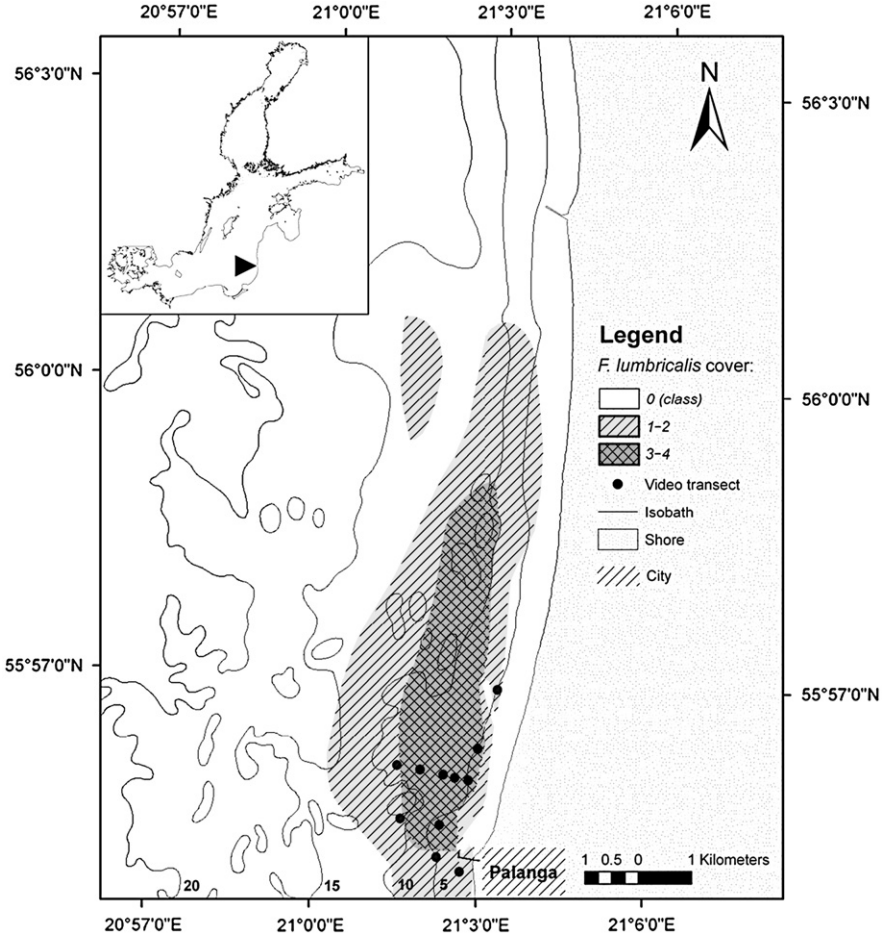

Fig. 1. Study site and location of video transects within the *Furcellaria lumbricalis* bed at the Lithuanian coast, SE Baltic Sea.