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Temporal and spatial variation in food availability and meat ratio in a longline mussel farm (*Mytilus edulis*)

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Abstract

The influence of temporal and spatial variation in food availability on mussel meat ratio and biomass was studied in a longline mussel farm (100 m wide and 250 m long, *Mytilus edulis*) during an eight-month period. Current velocity and phytoplankton concentration were measured and mean mussel biomass, density, wet weight and meat ratio were determined. The longline farm aligned the current direction lengthwise through the farm and reduced the current speed and flow to approximately one half to one third of reference station. The mean fluorescence depletion in the centre of the farm was 11% and the phytoplankton concentration (cells L^{-1}) was 20 to 91% less in the centre of the farm compared to the reference station. The mean meat ratio increased 1.8 times through the spring phytoplankton bloom. The mean meat ratio (%) and biomass (kg) were spatially variable through the farm with low values in the centre and increasing values towards the edges of the farm. This variation in meat ratio and biomass was observed at all natural phytoplankton concentrations and attributed to spatial variation in food availability through the farm.

Keywords: Bivalve aquaculture; Current velocity; Food availability; Meat content; Mussel; *Mytilus edulis*; Seston depletion

1. Introduction

The development of the mussel (*Mytilus edulis*) farming industry in Norway is based on the technology and methods of suspended longline culture and large sheltered coastal areas are potentially suitable for farming. However, the anticipated expansion and export volumes have not been realized, in part because of low meat ratio, probably related to overcrowded stocks and lack of husbandry knowledge.

The growth of suspension-feeding bivalves is largely controlled by food availability (Winter, 1978; Bayne and Newell, 1983; Soniat and Ray, 1985; Berg and Newell, 1986), which in turn is affected by seston concentration, composition and transport rate (Incze and Lutz, 1980; Frechette et al., 1989; Blanco et al., 1996). Food availability is often coupled to phytoplankton dynamics (Rosenberg and Loo 1983; Smaal and van Stralen, 1991) and large volumes of mussels are typically farmed in areas with a high concentration of phytoplankton. Examples of high chlorophyll *a* (Chl *a*) concentrations are 4–12 mg m^{-3} in Ria de Arousa (Figueiras et al., 2002), 8 mg m^{-3} in Benguela Bay (Pitcher and Calder, 1998), 7.5 mg m^{-3} in Oosterschelde, 4–22 mg m^{-3} in Marennes–Oléron Bay (Dame and Prins, 1998) and 6.9 mg m^{-3} in Chesapeake Bay (Dame and Prins, 1998). Several of these farming sites are shallow bays with high tidal amplitude leading to resuspension of organic material and an additional increase in food availability.

In comparison, farming sites along the western coast of Norway are considerably deeper and resuspension of organic material available to mussels in suspension culture is likely to be insignificant since phytoplankton constitutes the major component of the seston in western Norwegian fjords (Erga, 1989a,b; Erga et al., 2005). The biomass of phytoplankton along the Norwegian coast follows a seasonal pattern with a period of algal blooms in late winter/early spring, late spring/

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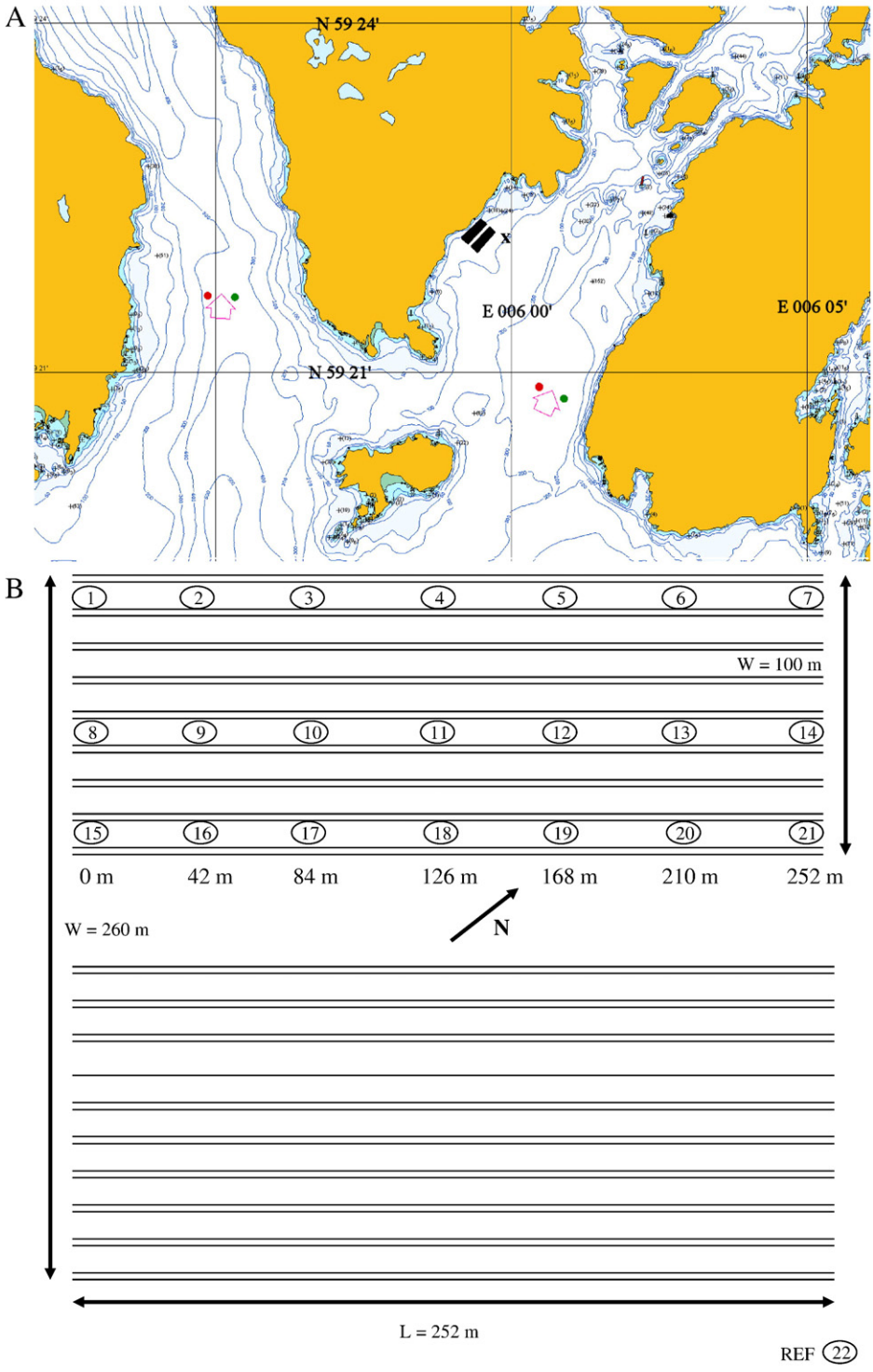

Fig. 1. (A) Site map of the farm area and the investigated mussel farm in the Sandsfjord. Surface area of the inner and outer farm blocks indicated in black and fjord reference site indicated by X. (B) Mussel sampling station overview. Mussel samples were only taken from the inner block of the farm as the outer block was harvested. Sampling stations 1 to 7 on longline 1 are towards the shore, sampling stations 8–14 on longline 5 are referred to as the mid section and sampling stations 15–21 on longline 9 are towards the outer farm block. The arrow between the blocks indicates north. W is width of block and farm and L is length of farm. Station 22 is the reference station.

early summer and occasional autumn blooms. On regional or local scales blooms may occur from wind generated upwelling of nutrient-rich deep water. For extended periods the concentration of Chl *a* along the Norwegian coast is less than 1–2 mg m^{-3} (Erga, 1989a,b; Frette et al., 2004), due to nutrient limitation (Paasche and Erga, 1988; Erga et al., 2005). Hence, Norwegian fjords and coastal waters are considered low seston environments compared to sites where most studies on mussel feeding on natural seston have been carried out (Grant et al., 1997; Smaal et al., 1997; Pitcher and Calder, 1998; Dame and