FOOD CONDITIONS AND GROWTH OF BIVALVE SPECIES IN THE WESTERN WADDEN SEA

Joana F.M.F. Cardoso*

Bivalves are a main component of the bottom fauna in many estuarine areas. They often occur in high abundance and form an important food source for shore birds, fishes and crustaceans. Environmental conditions such as water temperature, salinity and food availability influence growth in bivalves, and determine their distribution and abundance. The role of food as a forcing function determining population dynamics of bivalve populations is still unknown. In this project growth of five bivalve species was analysed with a dynamic energy budget model. Model results were compared with observed growth in the field and food conditions for the various species were reconstructed. The results suggest that growth of bivalves in the western Wadden Sea is not maximal due to suboptimal food conditions.

In the shallow Wadden Sea bivalve species are an important component of the bottom fauna, both in intertidal and subtidal areas. In these areas, bivalves experience strong seasonal and annual variations in environmental conditions such as temperature and food availability. Food availability is considered the most important factor influencing growth of bivalves. In this study, differences in growth between bivalve species (interspecific) and within different habitats of a species (intraspecific) in the western Wadden Sea were analysed. The aim was to reconstruct the food level in the field for the different species by analysing growth at the current water temperatures. In this way insight could be obtained also into the existence of food competition among bivalve species in the western Wadden Sea.

The study included five of the most common species: the Baltic tellin *Macoma balthica*, the edible cockle *Cerastoderma edule*, the blue mussel *Mytilus edulis*, the soft-shell clam *Mya arenaria* and the Pacific oyster *Crassostrea gigas*. These species were sampled in intertidal and subtidal areas in the Wadden Sea and along the North Sea coast. A well known dynamic energy budget (DEB) model was applied to analyse the allocation of energy to growth in relation to habitat conditions (temperature and food). Two types of DEB simulations were done: [1] annual growth in shell length of the various species was predicted under current temperature conditions and a range of food levels, between 0 (starvation) and 1 (ad libitum), and [2] seasonal variation in food level was reconstructed for each species and habitat by simulating growth along the year and comparing it with the observed growth in the field, under current temperature conditions.

Comparison between model simulations and growth measured in the field showed that for most species and habitats growth in the field was lower than maximal since, for most individuals, simulated growth curves only matched observed growth curves when food level was lower than 1 (Fig. 1).

Digging for soft-shell clams *Mya arenaria* in an intertidal area.

*Corresponding author: cardoso@nioz.nl

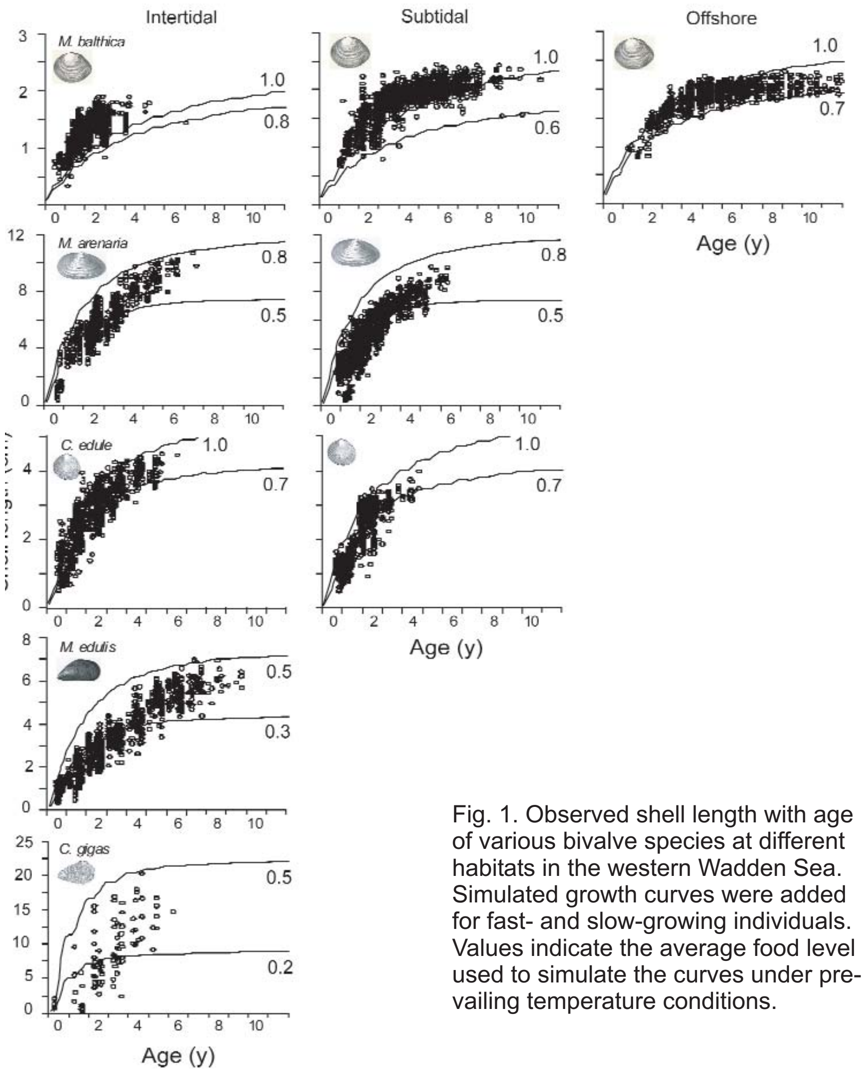

Fig. 1. Observed shell length with age of various bivalve species at different habitats in the western Wadden Sea. Simulated growth curves were added for fast- and slow-growing individuals. Values indicate the average food level used to simulate the curves under prevailing temperature conditions.

Sampling with the box-corer by boat in a subtidal area.

Intraspecific differences in growth rates of bivalves growing up in different habitats appeared to be not very large. However, variability among individuals within sites was rather strong. This could be due to bias in age determination or/and to variability in food conditions caused by the high density of some species. In *M. balthica*, observed growth at the intertidal and subtidal was faster than maximum simulated growth at optimal food conditions. Individual or within site variability in DEB model parameter values could be responsible for this. The most successful species were *M. balthica* and *C. edule* with an annual simulated food level between 0.7 and 1.0; followed by *M. arenaria* (0.5-0.8), *M. edulis* (0.3-0.5) and *C. gigas* (0.2-0.5). For analysis of the seasonal variation in food conditions, the seasonal pattern in food level was reconstructed separately for each age class. The reconstructed mean food level for two species is presented in Fig. 2.

Fastest growth was found between spring and summer, corresponding to the bivalves' main growing season. As a result, the highest reconstructed food level was found in this period. In the Wadden Sea, the growing season starts at the beginning of the phytoplankton spring bloom. During this period of abundant food in the water column, bivalves can feed maximally. After the spring bloom, phytoplankton growth declines and the amount of food for bivalves in the water decreases. As a result, the simulated food level for the various species decreases during summer and/or autumn, suggesting that strong food competition between species must have occurred during these periods. Overall, growth of the different species is not maximal at the current water temperatures, probably due to suboptimal food conditions. Whether these are the consequence of food limitation only or also of reduced filtration efficiency due to the high sediment load in the water is still uncertain.

This research was supported by the project ‘Praxis XXI’ from the Portuguese Science Foundation and by the project Van Gogh from the Netherlands Organization for Scientific Research (NWO).

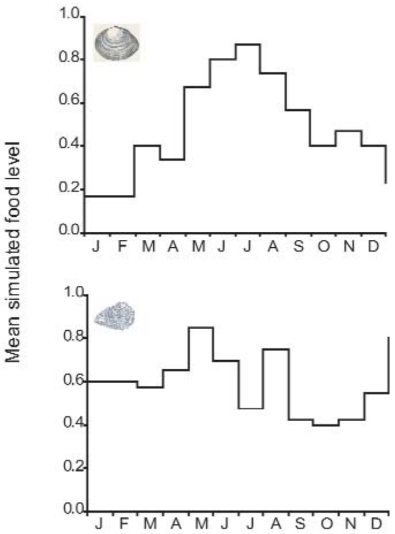

Fig. 2. Simulated seasonal food level for two bivalve species

The Mok bay at Texel (intertidal area where oysters *Crassostrea gigas* were sampled).