

Winter temperature and reproductive success in shell-fish in the Dutch Wadden Sea

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Abstract

Effects of mild and cold winters on the reproductive success of some species of bivalves were studied under experimental conditions. Egg production in the Balthic clam *Macoma balthica* and the cockle *Cerastoderma edule* was smaller after high than after low winter temperatures. Egg production in *M. balthica* was positively correlated with their body weight and they lost a higher proportion of their weight during mild than during cold winters. The eggs of the cockle were smaller after a mild than after a cold winter, giving rise to smaller D-larvae. The lower quantity and quality of eggs after mild as opposed to cold winters can explain why reproductive success in bivalves is generally higher after cold than after mild winters.

1. INTRODUCTION

Ever since 1970, numbers and biomass of bottom animals are recorded annually on the Balgzand, a tidal-flat area in the westernmost part of the Dutch Wadden Sea. Strong year-to-year fluctuations in biomass were observed in most bivalve species, resulting in a low stock size in some years, which then creates a conflict between fishery and nature conservancy. Fluctuations were synchronised for several species and failure of recruitment occurred in particular after mild winter in the cockle, the mussel, the Balthic clam and the gaper clam. In these species reproduction is usually highly successful after cold winters [1]. Two factors can be responsible for these fluctuations:

1. Due to an early appearance of predators (shrimps, shore crabs) after mild winters on the tidal flats, the predation pressure on juvenile bivalves will be higher after mild winters than after cold winters [2,3].
2. At high winter temperatures metabolic processes in bivalves proceed at a relatively high rate. As a consequence, weight loss is high during mild winters and energy available for gametogenesis is lower after mild than after cold winters.

Higher weight losses during mild winters have been found in mussels and other species of bivalves [4,5]. Low adult weights may affect viability of their offspring by the reduction of size of eggs and larvae [6]. Egg size appears to be important for the survival of bivalve larvae [7]. Our aim is to find out whether such processes can be observed also in Wadden Sea bivalves. By simulation of mild and cold winters, the influence of winter temperature on quantity and quality of eggs is being studied in bivalves such as the Balthic clam, the cockle and the mussel.

2. MATERIAL AND METHODS

To study effects of winter temperature on bivalves, we kept groups of mussels, cockles and Baltic clams at different levels of water temperature during the winter months until spawning. One group followed the water temperature in the field, the other was kept at a 2.5°C lower level. At each of the two temperature treatments, an intertidal (intermittently immersed) and a subtidal (permanently immersed) group was run. Longer immersion times result in longer daily feeding periods and less weight loss. We used the animals of the four different groups for the determination of body weights prior to spawning, egg production, egg size and size of the larvae.

3. RESULTS

The results of measurements of condition index and egg production are shown in Table 1. Egg size and shell length of D-larvae are shown in Table 2. Combined results of body weights and egg production from the years 1993 and 1994 are shown in Figure 1

Table 1

Weight (standardised for animals of exactly 10 mm shell length) and egg production (means \pm SE) after four treatments. Experiments of 1994.

	Baltic clam		cockle	
	weight	egg no. (*10 ⁴)	weight	egg no. (*10 ⁵)
warm tidal	8.1 \pm 0.4	1.9 \pm 0.4	7.8 \pm 0.7	0.7 \pm 0.1
cold tidal	9.5 \pm 0.3	3.0 \pm 0.5	8.7 \pm 0.1	2.2 \pm 0.8
warm subtidal	9.8 \pm 0.4	2.0 \pm 0.6	10.0 \pm 0.3	0.1
cold subtidal	13.8 \pm 1.3	6.4 \pm 0.8	11.4 \pm 0.2	2.0 \pm 0.3

Table 2

Egg size of the Baltic clam and egg size and larval shell length of the cockle after four treatments. Experiments of 1994.

	Baltic clam	cockle	
	egg size (μ m)	egg size (μ m)	D-larvae shell length (μ m)
warm tidal	104.1 \pm 0.2	76.7 \pm 0.8	106.0 \pm 0.7
cold tidal	106.9 \pm 1.3	78.2 \pm 0.4	122.4 \pm 0.7
warm subtidal	106.5 \pm 0.7	75.3 \pm 0.1	
cold subtidal	104.6 \pm 1.4	79.3 \pm 0.3	123.0 \pm 3.3

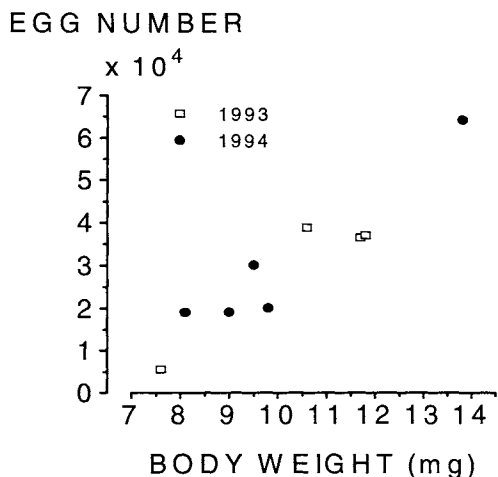


Figure 1

Egg production in the Baltic clam as a function of body weight (at standard shell length) just before spawning. Data from experiments in two winters combined.

Body weights varied in the expected way, the higher temperatures and shorter feeding time resulted in lower body weights. Egg production was in both species higher at the lower than at the higher winter temperatures (Table 1).

Egg size of the Baltic clam was not influenced by winter temperature. In the cockle the eggs of the groups kept at higher winter temperatures were somewhat smaller. The shell lengths of the D-larvae were much smaller after mild than after cold winters (Table 2).

The plot of egg numbers against body weights (Figure 1) showed a similar correlation as reported by others [4,5]. High body weights resulted from either good feeding conditions or low winter temperatures (compare Table 1).

4. CONCLUSIONS

Apart from diminishing predation pressure, cold winters are beneficial to reproductive success in bivalves by the production of higher numbers of larger eggs, giving rise to more and bigger larvae (which are expected to be more viable than small ones).

5. REFERENCES

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