Food Selection by Eiders – Why Quality Matters

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Introduction

Eider ducks are bivalve specialists. They feed on a variety of bivalve species, ranging in size from a few millimeters up to several centimeters. They are captured by head dipping or diving up to depths of over 30 meters. Eiders are able to feed on buried bivalves such as cockles or baltic tellins, which may be dug out of the sediment with the bill, even when the birds are diving. The shallow waters of the Wadden Sea with their productive benthic communities dominated by bivalves therefore seems to be an ideal habitat for eiders. In the Wadden Sea, the main food of eiders are mussels and cockles, two widely distributed species, which contribute a high share to the total macrozoobenthic biomass. Eiders are the most important avian predators in the Wadden Sea, however, their consumption is low in relation to the annual production of mussels and cockles. On average, only 10% is taken by eiders each year. It therefore appears that the Wadden Sea is a suitable habitat, with a rich food supply for eiders. Food limitation or competition with other species or fisheries seems to be unlikely, so how can eiders suffer from food shortage?

A special habit of eider ducks is to swallow mussels and cockles whole and crush the shells in their stomach, where they are then ground into small fragments. Eiders have a large and very strong stomach, which enables the birds to exploit a wide size range of molluscs. However, it is obvious, that such a feeding habit is expends much energy. The ducks have to crush the shells, then heat the mussel flesh and the water locked between the valves to body temperature and finally, excrete the salt from the mussel flesh and water. As part of the ecosystem research project, I studied food selection and the costs and benefits for eiders feeding on mussels (Nehls 1995). The results show that mussel quality is of high importance when eiders decide where and what to feed on and they indicate, that only a part of the mollusc stock within the Wadden Sea may be suitable for eiders.

Food Selection

Eiders prefer certain sizes of mussels and cockles. Size selection in eiders feeding on mussels was studied over four years in Königshafen, Sylt. Eiders much preferred certain size classes out of a wide range of mussel sizes found on the mussel beds (Fig. 1).

Mussel sizes consumed by eiders changed in the course of the year. In winter, eiders took a wide size range of mussels, with median sizes between 40 and 50 mm. Mussels larger than 60 mm were rarely taken. In late spring, a sharp drop occurred in the size of mussels consumed. In May, the smallest mussels were taken and eiders focussed on a rather narrow range of mussel sizes. In the course of the summer, eiders took increasingly larger mussels and a wider size range was selected. The seasonal pattern in size selection was consistent throughout the period of the study. Although eiders are able to consume mussels up to 80 mm in size, 80% of the mussels consumed in Königshafen were between 30 and

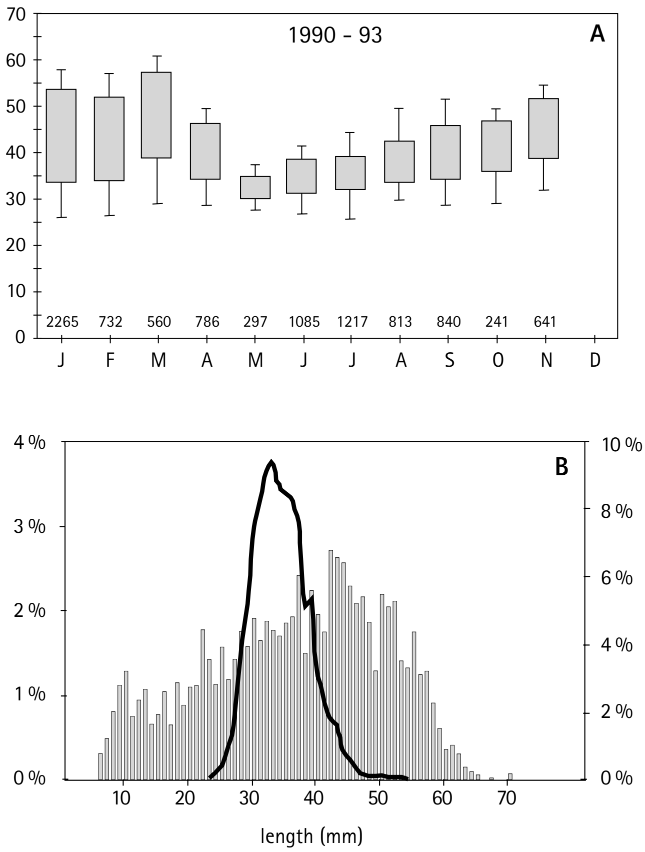
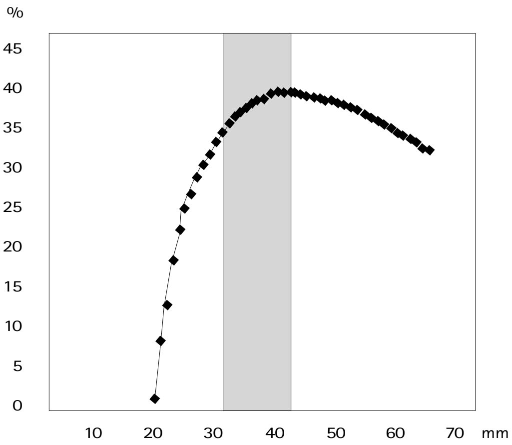


Figure 1: Size selection in mussel feeding eiders. A: Seasonal variation in mussel sizes taken by eiders in Königshafen / Sylt 1990–1993. B: Frequency distribution of mussels on a bed in Königshafen (bars, left Y-axe) and sizes taken by eiders on this bed (black line, right y-axe) (Nehls 1995).

Figure 2: Energy utilization of eiders in relation to mussel size. The graph gives the proportion of energy gained versus energy spent in foraging for eiders feeding on mussels by diving. The shaded area indicates the mussel sizes taken by eiders at this time (June 1990) (Nehls 1995.)



52 mm. Size selection was not influenced by the eiders' feeding technique. Eiders, which fed at low tide by head dipping, and eiders feeding at high tide by diving on the mussel bed consumed the same size ranges.

Cockles are much smaller than mussels and do not grow out of the size range consumed by eiders. Cockles are mainly taken by head dipping when the tide is low. Size selection has been studied less intensively, but occasional observations show, that all sizes of cockles are taken by eiders, with a preference for the larger ones (Nehls 1991).

Processing the Food – Hard Work on Hard Shells

An eider, which has completed a feeding session and consumed 10 to 20 mussels, will start preening and resting for 20 to 30 minutes and even sleep for a short while before it resumes feeding. Experiments with captive eiders showed, however, that the birds – although sometimes motionless – are working hard during this time. Their metabolic rate, which was measured in a respiratory chamber, may double in response to a single meal of a dozen mussels and remain elevated for two to five hours. The reason for this is the internal processing of the food. It has long been known that digestion is an energy consuming process and the same is true for shell crushing, warming the food to body temperature and the excretion of the salt from the isoosmotic bivalves. Shell crushing is an especially demanding task. The energy costs for shell crushing increase exponentially to mussel's length, reflecting that shells get much thicker as mussels grow larger. Almost 20% of the assimilated energy of a mussel is spent crushing the shells. The digestion of the mussel flesh requires energy of the same magnitude as shell crushing. The heating of the mussels to body temperate and the excretion of the salt expend less energy, but these costs also contribute to the budget. Diving and the processing of the mussel clumps until a mussel can be swallowed further increases the energy costs of foraging. Eiders select mussels, which offer the highest energy efficiency, but even in the most suitable mussel sizes, 50 to 60% of the assimilated energy is spent during foraging and digestion (Fig. 2). This means that foraging efficiency in mussel feeding eiders is very low. The ratio of energy assimilated versus energy spent is about 2:1, which is much lower than in most other species. Foraging and digestion are the most important energy consuming activities for eiders, comprising of about half of their daily energy budget. Variations in flesh content and shell weight will considerably influence the energy gain. Thick-shelled mussels with low flesh content will not allow an energy gain, in fact, eiders feeding on poor mussels may starve despite having a full stomach. This highlights the fact, that food quality is of paramount importance to eiders when they are deciding where and what to feed on.

Consequences

In Königshafen, eiders carefully selected the mussel sizes, which provided the highest energy efficiency. What about differences in the mussel quality between sites? The growth conditions of filter feeding bivalves in tidal waters vary in relation to environmental parameters, such as water turbidity, composition and amount of phytoplankton, emersion period and current velocity. Two main gradients have been identified for mussels: 1. Growth conditions on the tidal flats improve with decreasing emersion time. Culture plots are consequently situated in the subtidal zone. 2. Growth conditions are better close to the inlet to the North Sea and decrease towards the mainland, probably as a consequence of increasing turbidity and decreasing algae content (Ruth 1994). On good sites, mussels do not only grow faster, but they also have higher flesh contents and lower shell weights. The ratio between shell weight and flesh content varies by more than factor 2. On productive beds, mussels contain 0,5 g flesh per 1 g shell, on poor beds it is only 0,2 g flesh per 1 g shell (Nehls unpubl.). From an eiders point of view, differences in the quality of mussels between beds must therefore be large. They have to decide whether to feed on beds where mussels are lean and thick shelled or fat and thin shelled. The large differences in the quality of mussels and probably also for cockles from different locations within the Wadden Sea will considerably restrict the amount of mussels and cockles, which may serve as a food resource for eiders. In many locations, flesh content will be too low and shells too thick to allow a sufficient energy gain. Other mussel beds are almost ignored by eiders, although the exploitation on some mussel beds is as high as the annual production.

Can these findings help us to understand the mass mortality of eiders? First, it has to be stated, that only a fraction of the bivalve stocks in the Wadden Sea can be exploited by eiders and that food limitation might be common, even though eiders take only 10% on average of the bivalve stock. This will increase the risk of competition with fisheries, if these were interested in the same mussels and cockles as the eiders. As fisheries will be interested in dense stocks of high quality, competition with mollusc eating birds such as eiders is very likely to occur. Second, natural fluctuations may affect the mollusc stock in quantity and in quality. It has been noted, that the conditions of bivalves in the Wadden Sea is low in mild winters (Zwarts 1991), probably as a result of a higher metabolic rate of the bivalves at mild temperatures. This may severely reduce the proportion of mussels and cockles, which can be profitably exploited by eiders. As the winter 1999/2000 was very mild, it can be assumed, that prey quality was rather poor. In combination with a low mollusc stock and a high fishing intensity this has probably led to a very poor feeding situation in the Dutch Wadden Sea.

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