Maryland Sea Grant

RESEARCH NOTES

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SESTON AS A FOOD RESOURCE IN OYSTER GROWTH

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EDITORS PREFACE

Why will oysters in one region of the Chesapeake Bay grow larger than those in another? Why will spat set more abundantly in yet another? Though no definitive answers can be given as yet to such questions, numerous factors influence growth, reproduction, the hardiness of larvae and the development of newly metamorphosed spat. Among the most critical factors is an environmental regime that produces an abundance of nutritious and suitable food.

From one location to another, daily and seasonally, estuarine waters are in continual flux. Salinities, for example, vary in response largely to precipitation. Water quality is affected by the flushing of chemical compounds and metals into tributaries, the runoff of sediments from shorelines, and the tons of inorganic nutrients that enter the Bay from farmland and waste treatment plants as well as natural terrigenous inputs. Fluctuations in nutrients condition the size, the species and the numbers of plankton, major food sources of free-swimming oyster larvae and adults.

Maryland Sea Grant research has been focusing on just how seasonal changes in nutrition affect growth and fecundity of the American oyster Crassostrea virginica. For several seasons Roger Newell and colleagues have been working in adjacent subestuaries of the Choptank River which consistently show differences in oyster growth: adult oysters in the Tred Avon grow significantly larger than those in Broad Creek, though spat set in Broad Creek is generally greater. Why?

Hypothesizing that both bodies of water provide different food regimes, Newell and Joseph Berg set out to determine those differences in terms of seston as a clue to explaining the larger oysters in the Tred Avon. Seston is the organic and inorganic suspended matter that oysters feed on.

Over some 15 months of intensive sampling, they analyzed the quantity of seston in each body of water and the quality of that seston. To their surprise, they found few differences in the quality of seston -- namely the particulate organic carbon (POC), particulate organic nitrogen (PON) and energy content -- though they did find considerable difference in the quantity: the Tred Avon River had more than twice the amount of seston than Broad Creek during the spring and summer months, when oysters are feeding at their heaviest. Thus, adult oysters in the Tred Avon

have more food available to them than those in Broad Creek. And it is the greater amount of food, they suggest, that greatly influences the larger growth of adult oysters.

-- The Editors

INTRODUCTION

Many bivalve species obtain their food by filtering particulate matter from the water column (Jørgensen 1966). This particulate matter, called seston, includes all organic and inorganic suspended matter retained on a filter with pore size of one micron (Holm-Hansen 1972; Parsons et al. 1977). The quantity of seston and its quality as a food resource varies over time on a scale from seconds to years, and spatially over distances less than one meter to tens of kilometers. These variations are the response to physical and biological factors, among them, river discharge, runoff from rainfall, wind-wave and tidal resuspension, storm events, changes in insolation and meteorological events, shore erosion, basin shapes and biological production. Thus, the amount of seston is not constant with respect to time and space, nor is its potential nutritive value to bivalves such as the American oyster Crassostrea virginica.

While a number of studies have recognized that bivalve populations exhibit different rates of growth and fecundity as a result of differences in the quantity and quality of food (Bayne and Widdows 1978; Newell and Bayne 1980; Newell et al. 1982), only Widdows et al. (1979) have tried to characterize the temporal and spatial variations in food quality available to natural populations of suspension feeding bivalves.

The two sampling sites in the Choptank River in Maryland were selected because of the pattern of differences in growth. Though oyster recruitment in Broad Creek is greater than Tred Avon, shell size is significantly greater in the Tred Avon River. These two basins are similar in surface area, temperature and salinity. Broad Creek, however, is wide and shallow (3 to 5 m) with little development along its banks, while the Tred Avon is narrower and deeper (4 to 7 m) and supports a higher density of housing along its banks.

METHODS

Water samples were collected over a 10-hour period, approximately once a month, for a period of 15 months. The two systems were sampled on consecutive days to try and minimize differences not due strictly to aperiodic events such as storms. Water was pumped from 25 cm above the bottom for approximately 5 min. each hour for 10 h. Samples were vacuum filtered onto prewashed and weighed Whatman GF/C filters and then prepared for laboratory analysis.

The quantity of seston was based on the amount of particulate organic carbon (POC), particulate organic nitrogen (PON), energy content (Joules), chlorophyll a, particulate organic matter (POM) and particulate inorganic matter (PIN) per liter of water filtered. The nutritional quality of seston was based on the amount of POC, PON and energy (Joules) per mg of seston and the percentage of the total that was organic.

DISCUSSION

Seasonal Variations in Seston Concentrations

Over the period of the study, seston concentrations were consistently greater in the Tred Avon (5 to 30 mg/L) than in Broad Creek (4 to 10 mg/L), although in both systems there were higher concentrations in summer and a steep decline between September and October (Figure 1). This pattern can be attributed to both seasonal cycles of riverine discharge (Schubel and Biggs

1969) and runoff (Biggs 1970) as well as the seasonal increase and decrease in biological activity, for example, bioturbation (Ward 1981).

Estimates of Food Quality and Quantity

Food quality was found to be negatively related to seston concentration. One explanation is that, with greater abundances of seston, inorganic material (PIM) increases at a greater rate than does the organic material (POM). Though this seeming dilution of food quality has been viewed as deleterious to suspension feeders (Kirby-Smith 1976; Widdows et al. 1979), recent Sea Grant-sponsored studies on oysters by Newell and Jordan (1983) and on other bivalves (Kiørboe and Møhlenberg 1981) indicate that bivalves can preferentially ingest organic particles and reject inorganic particles as pseudofeces. Therefore, the decrease in estimates of food quality as a result of the disproportionate increase of inorganic material with concentration is not as deleterious to suspension feeders as previously supposed.

The higher concentrations of seston in the Tred Avon River mean that during the summer period of peak metabolic requirements for the oyster, these oysters had about twice the amount of food material per unit volume of water available to them than those in Broad Creek. And it is this differential food availability that may explain the larger adult oysters in the Tred Avon.

Seasonal Patterns in Estimates of Seston Food Quantity and Quality

Seston concentration and estimates of seston food quantity were lower in the Tred Avon during spring and early summer 1983 than in the corresponding season of 1982; these differences can be attributed to precipitation which totaled 11 cm in 1982 and 48 cm in 1983. On the other hand, seston concentration and food quantity were similar in Broad Creed during these two years. The reason may have to do with inherent differences between the two basins.

The Tred Avon system drains a larger land area (97 km) than does Broad Creek (41 km). This factor could have resulted in a greater flushing rate for the Tred Avon system than Broad Creek and a delay in the increase of natural production of suspended organic particulates, as reflected by the low chlorophyll a-to-carbon ratio during spring 1982 (approximately 100), though it increased dramatically during spring 1983 (approximately 1000). This ratio has been used to estimate relative detrital content of the seston (Zeitzschel 1970), and values of 100 or less are considered to indicate that the carbon is primarily from living phytoplankton. The increase in rainfall and resulting increase in riverine discharge may have influenced the estimates of seston food quality by replacing autochthonous particulates with detrital particles that were transported into the system from land run-off and from upriver.

SUMMARY

During the summer, when oysters are most active, concentrations of seston in the Tred Avon were approximately double those in Broad Creek. During the winter, when oyster metabolism is depressed by low water temperatures, concentrations of seston were similarly low in both the Tred Avon and Broad Creek.

Though estimates of seston food quality are lowest during the summer because of the "dilution" of organic materials with inorganics, oysters and other bivalves can still select the organic materials and reject inorganic mataerials. Thus the small decrease in estimates of seston food quality are probably not a biologically important change in the food resource of the oyster. Since the quality of seston in both systems is similar, the important difference is in the quantity of food available to the oysters. The Tred Avon River has a greater quantity of seston than Broad Creek, which suggests that the larger adult size of the Tred Avon oysters, or the smaller size of oysters in Broad Creek, is the result of the amount of "food material" available to them.

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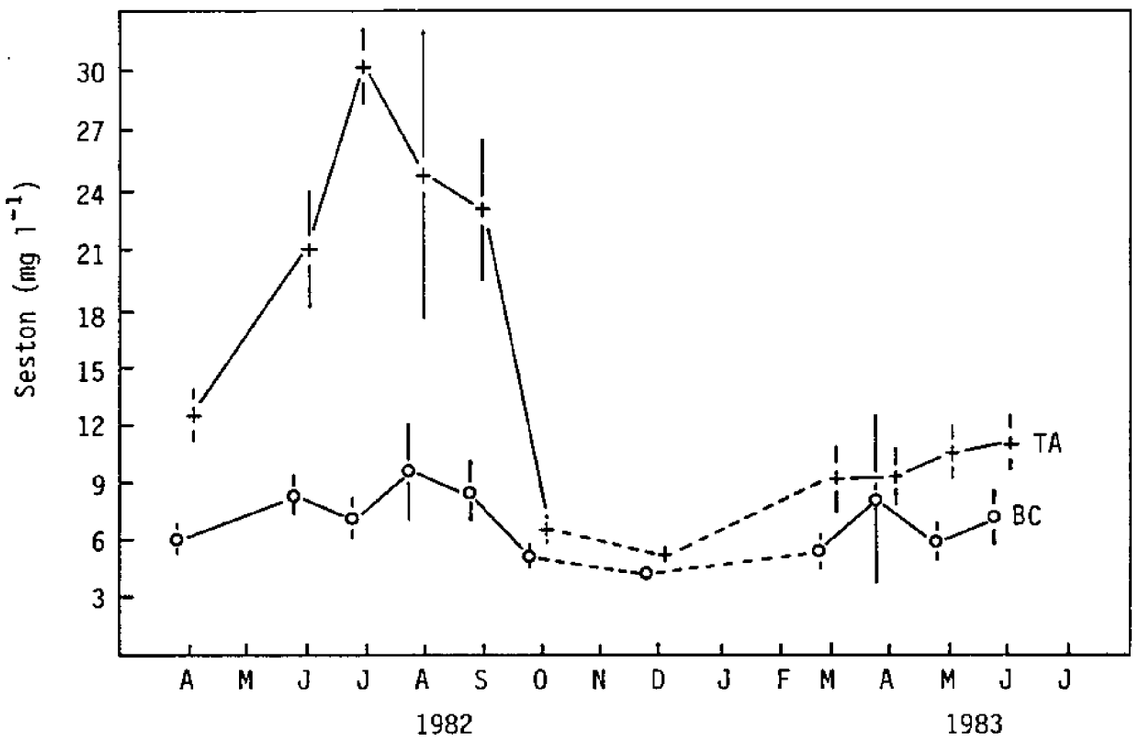

Figure 1. Mean seston concentration (mg/l; 95% confidence interval) for the Tred Avon (+) and Broad Creek (o) from April 1982 to June 1983.

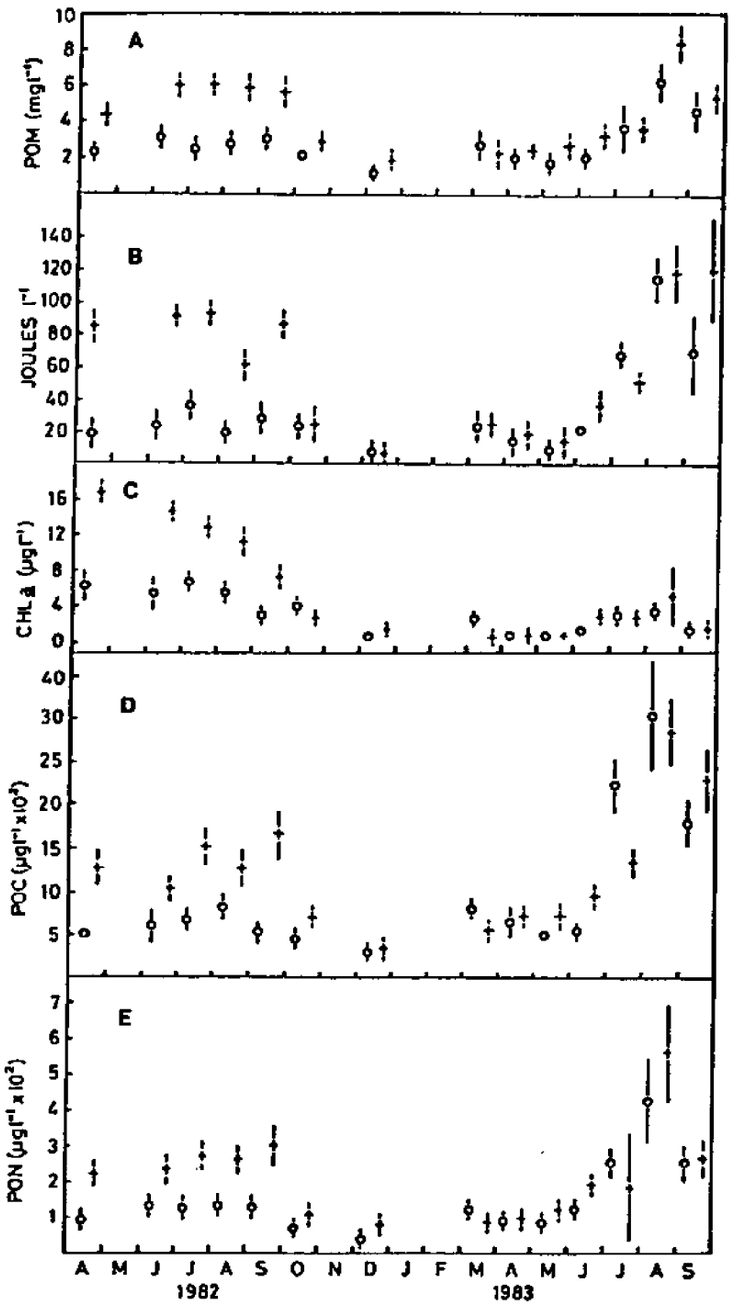

Figure 2. Estimates of seston food quality (95% confidence interval for the Tred Avon (+) and Broad Creek (o), from April 1982 to June 1983. (A) % organic, (B) Joules/mg of seston, (C) and (D) mg POC and PON/mg of seston.

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