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A COMPARISON OF THE PHYSIOLOGICAL CONDITION OF THE BLUE MUSSEL, MYTILUS EDULIS, AFTER LABORATORY AND FIELD EXPOSURE TO A DREDGED MATERIAL

William C. Nelson

ABSTRACT

The scope for growth (SFG) of the blue mussel, Mytilus edulis, was measured after exposure to Black Rock Harbor (BRH) dredged material in the laboratory and the field. A laboratory system was used to provide constant exposure levels, ranging from 0 to 10 mg/L, of suspended BRH sediment. Results indicated that concentrations as low as 1.5 mg/L BRH material reduced SFG, clearance rates, and shell growth. In the field, mussels were placed along a transect from the center of the disposal mound to a clean area that was distant from the disposal mound. The estimated maximum BRH exposure in the field (0.8 mg/L) produced no apparent reduction in the SFG of mussels collected 1 m above the bottom at the field sites. The level of BRH material estimated to affect SFG in field-exposed mussels (>0.8 mg/L) was within the range estimated from laboratory experiments (0-1.5 mg/L).

INTRODUCTION

One potential problem with the increased use of estuarine areas for industrial and recreational purposes is that dredging of harbors and channels is often required (Pearce, 1985). The sediments associated with these areas, because of their proximity to commercial and industrial input, may often contain large quantities of toxic contaminants. Disposal of contaminated dredged materials in the marine environment, therefore, represents a problem as to the fate and effects of the hazardous materials contained therein.

A cooperative research project, called the Field Verification Program (FVP), has been established between the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency. The overall goal of the FVP is to evaluate a suite of biological monitoring techniques for assessing the effects of dredged material disposed of in the aquatic environment. One aspect of this project involves the comparison of biological effects measured in laboratory experiments with actual responses measured in the field.

The first objective of the research described in this paper was to evaluate the scope for growth (SFG) index as a measure of the sublethal effect of dredged material on the blue mussel, Mytilus edulis. The mussel was chosen as one of the test species for use in the FVP because it is a sessile, filter-feeding bivalve which has been successfully used in a wide variety of pollution monitoring programs (Goldberg et al., 1978; Phelps & Galloway, 1980). The SFG index was selected as one of the monitoring techniques because it has been effectively used to measure the physiological response of the mussel to pollutants in the laboratory and the field (Widdows et al., 1981; Widdows, 1985). In addition, this physiological index has been correlated with changes in population fitness and may be predictive of ecological consequences (Bayne et al., 1983).

A second objective was to compare the measured SFG response of the mussels exposed to dredged material in the laboratory with those results obtained in the field. The approach was to measure the SFG of mussels placed in the field during and after the actual disposal operation. Mussels were also exposed in the laboratory to a range of dredged material concentrations that bracketed possible field levels. Comparison of the physiological responses between the laboratory and the field, while qualitative, was intended to provide an indication of the comparability between the observed results.

MATERIALS AND METHODS

Laboratory Experiments

Mussels were collected from a clean reference population in lower Narraganett Bay with a scallop dredge from a depth of 10 m. The animals were sorted to obtain a size range of 50 and 55 mm shell length and acclimated in flowing unfiltered seawater from 5° to 15°C at a rate of 1°C per day.

Exposure Methods

Procedures for the collection, handling and storage of the dredged sediment from Black Rock Harbor (BRH), Bridgeport, Connecticut, and a reference sediment (REF) from central Long Island Sound are described by Rogerson et al. (1985).

Mussels were exposed to either BRH or REF sediment in a composite dosing system (Figure 1a). The combined use of a REF and BRH dosing valve for an exposure chamber allowed a mixture of the two sediments to be delivered. While the exposure concentrations of BRH and REF sediment were different between treatments, a total suspended sediment concentration of approximately 10 mg/L was maintained in all five treatments. This level was chosen because it approximated the field suspended particulate levels present in central Long Island Sound (CLIS).

Each exposure chamber (Fig. 1b) was equipped with a transmissometer, an instrument capable of measuring attenuation due to suspended particulates in the chamber, calibrated with the appropriate sediment (Sinnett & Davis, 1983). The dosing valves for each treatment were controlled by a transmissometer-microprocessor feedback loop. As mussels removed suspended particles below the desired concentration, the microprocessor opened the dosing valve to deliver additional suspended sediment every 2 min. The transmissometer circuit was connected to a strip-chart recorder for continous monitoring of the system. This system maintained suspended particulate concentrations within 10% of the desired levels. Each chamber was aerated with three 25-cm air stones to provide oxygen and to ensure even distribution of suspended particulates. A more elaborate explanation of the procedures and exposure system is provided by Nelson et al. (in press).

In addition to the suspended sediment, a unicellular alga, T-Iso, a strain of Isochrysis galbana, was pumped into each exposure chamber in order to maintain a suspended concentration of food at 0.5 mg/L. All experiments were conducted at 15°C. Filtered seawater flowed through each experimental chamber at a rate of 0.4 L/min. Each chamber was cleaned every other day.

An initial experiment, consisting of three exposure levels: 0, 50, and 100% BRH, was stopped after 14 d because adverse SFG effects were observed in the mussels from the BRH exposures. A second experiment, with exposure levels

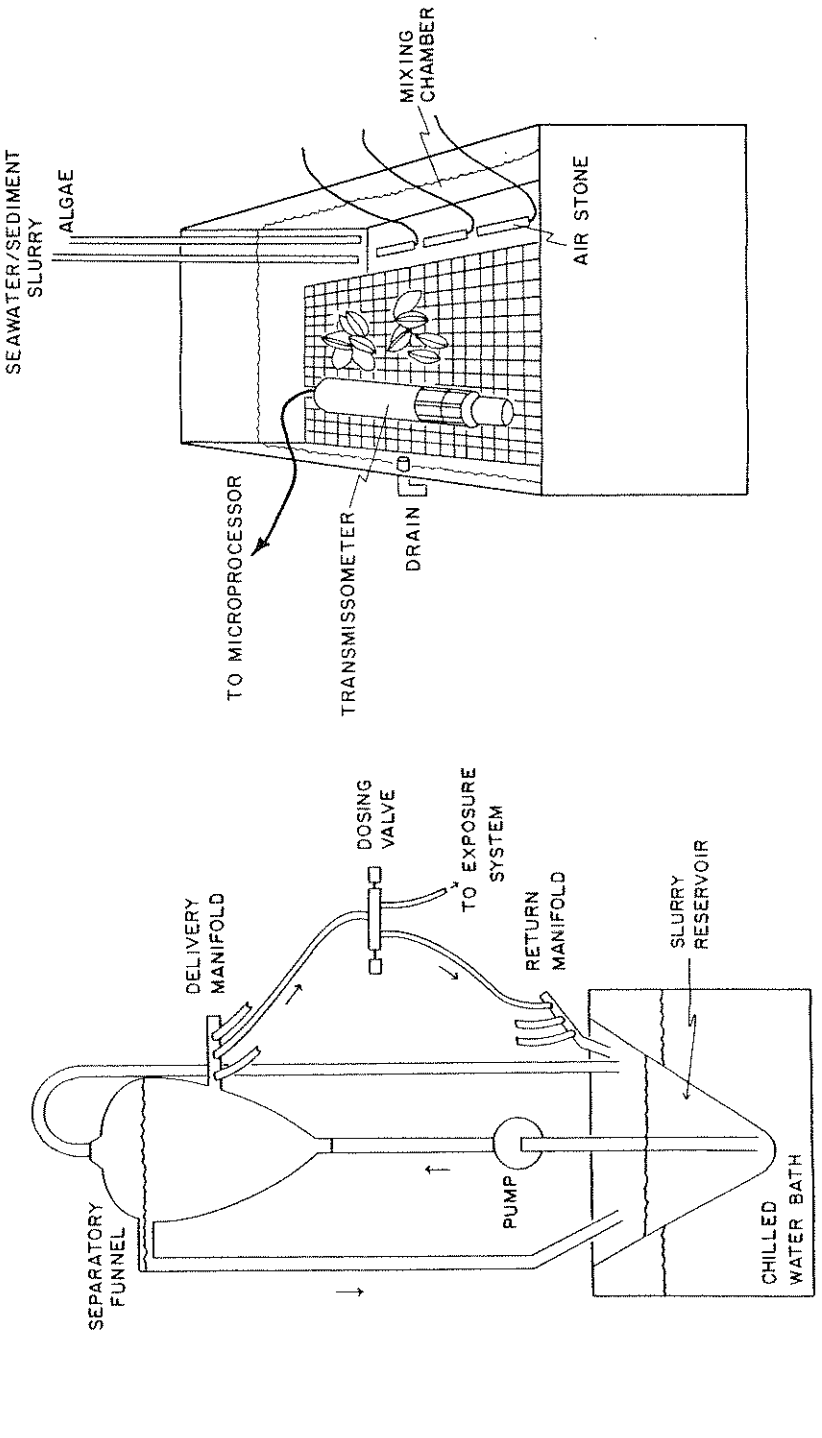

Fig. 1. Schematic diagram of the composite dosing system (1a) and mussel exposure chambers (1b) used in the laboratory experiments.

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of 0, 10, and 30% BRH, ran for a period of 28 d, with SFG and shell growth measured on Days 14 and 28. Additional mussels were sampled from the exposure system for histopathological and chemical analysis. The results of these analyses will be reported in subsequent publications.

Field Experiments

Mussels were collected from the Narragansett Bay reference station, returned to the laboratory and sorted as described above, several days prior to deployment in the field. One-hundred individuals were placed into each of many polyethylene baskets and maintained in ambient, flowing raw seawater (usually 1 or 2 d) until deployed at the field stations.

Each field station consisted of a surface buoy moored to a large concrete block on the bottom and several smaller satellite stations placed about 8 m from the central block. Each satellite consisted of a subsurface buoy, connected to a small cement block, from which mussels were placed 1 m above the bottom.

Four stations were established at the central Long Island Sound (CLIS) dumpsite: CNTR, at the center of the disposal mound; 400E, 400 m east of the center at the fringe of the mound; 1000E, 1000 m east of the center and away from the disposal mound; and REFS, approximately 3 km south of the CNTR station and out of the influence of the disposal area because of the east-west circulation in the Sound.

Mussels were deployed at each of the four stations for one month prior to any disposal to collect pre-dump data. During the disposal operation, caged mussels were placed at the 400E, 1000E, and REFS stations. Upon completion of the disposal operation, mussels were deployed and retrieved at each of the four stations at monthly intervals for three months, then on a quarterly basis for the next year.

After collection from the field stations, mussels were returned to ERLN and placed in flowing raw seawater overnight; SFG measurements were begun the following morning.

Field Exposure Conditions

An exact description of the BRH exposure conditions in the field was impossible due to limited data. One estimate of BRH exposure conditions in CLIS was calculated using laboratory-generated relationships between PCB tissue residues and BRH exposures. Day 28 PCB mussel tissue residues

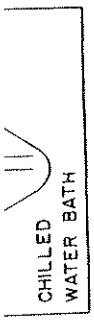

Fig. 1. Schematic diagram of the composite dosing system (1a) and mussel exposure chambers (1b) used in the laboratory experiments.

from the 0, 10, and 30% BRH treatments were regressed against measured BRH exposure concentrations (0, 1.5, and 3.3 mg/L) from the same exposures. The PCB tissue residues of field-exposed mussels were substituted into the resultant equation to estimate the field BRH exposure concentrations necessary to produce the observed tissue residues.

Scope for Growth Procedures

The SFG index is based on the balanced energy equation of Winberg (1960):

$$C - F = Ab = R + U + P$$

where C is the energy consumed, F is the energy lost as feces, Ab is the energy absorbed by the animal, P is the energy incorporated into production, and R and U represent the energy lost through respiration and excretion, respectively.

A simple derivation of this equation allows for the calculation of production:

$$P = Ab - (R + U)$$

Because P is not measured directly, but rather is obtained through subtraction, it is termed SFG. Scope for growth is a measure of the energy available for somatic growth and reproduction in an organism.

The approach taken in this project was to measure the SFG of mussels under standardized conditions to determine relative differences after laboratory and field exposures. Differences in relative SFG values were interpreted as being caused by the respective exposures of the mussels because, under standardized conditions, mussels of similar physiological condition should exhibit similar SFG responses. This approach was used because the goal of this study was to compare the laboratory and field SFG results. Measurement of SFG under separate laboratory and field conditions would not allow this comparison.

Calculation of the SFG index for M. edulis required the measurement of four parameters: clearance rate, respiration rate, food absorption efficiency, and ammonia excretion rate. The procedures used to measure the SFG of the mussels were the same for both the laboratory and field-collected animals and are described in detail by Nelson et al.

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(1985). Scope for growth measurements were completed on 10 mussels from each laboratory exposure treatment or field station. All SFG measurements for a given treatment in the laboratory experiments were completed within 24 h after termination of the experiment, at a temperature of 15°C. Measurement of SFG on mussels from the CLIS field stations were completed within 24-48 h of their return to the laboratory, at the ambient temperature in CLIS at the time of collection.

Actual Growth

In addition to SFG, a measure of energy available for potential growth and reproduction, changes in actual shell growth were measured on the same mussels. Ten mussels from each treatment were numbered and measured for greatest shell length on Days 0, 14, and 28. Actual growth was not measured for the field-exposed mussels.

Statistical Analysis

The objectives of this study were to examine qualitative relationships between the laboratory and the field. Therefore, the experimental design did not employ replicated exposure treatments in the laboratory (exposure chambers) and the field (mussel baskets). Standard errors presented in the tables and figures were calculated from 10 individual samples within a treatment or basket. These values are included to indicate variability within a treatment, not between 10 statistical replicates.

In the laboratory experiments, regression analysis was used to determine the relationship between SFG and BRH exposure concentration (Snedecor & Cochran, 1967). The limited exposure data from CLIS precluded measuring similar relationships for the field mussels. Consequently, only qualitative relationships between SFG and exposure in the field, and between laboratory and field results, could be made.

RESULTS

Exposure System

The strip-chart record indicated that the dosing system maintained a suspended particulate level of 10 mg/L approximately 90% of the time. Examples of times when the 10 mg/L

was not maintained include cleaning of the exposure tanks, changing of the slurry reservoirs, and clogging of the sediment delivery lines.

The actual concentrations of BRH and REF material dosed into each treatment are listed in Table 1. The design of the system ensured that the actual BRH concentration was the same as the nominal concentration in the 0, 50, and 100% BRH treatments. The 10% BRH and 30% BRH treatments required manual adjustment of each valve in order to provide the desired concentration. The actual amount of BRH delivered to the 10% BRH treatment was 15%, while the actual amount delivered to the 30% BRH treatment was 33%.

Table 1. Nominal and mean (standard error) actual concentrations of BRH suspended sediment delivered to the laboratory exposure treatments.

Nominal Percent BRH	Actual Percent BRH	95% Conf. Int.
100%	100(0.0)	
50%	50(0.0)	
30%	33(0.8)	31.2 - 34.5
10%	15(1.4)	12.2 - 17.6
0%	0(0.0)	

Scope for Growth Measurements

Laboratory experiments. The values for each of the measured physiological parameters were standardized to the mean dry weight of all the mussels for a particular experiment. The mean weight for the mussels from the first experiment was 0.48 g; for the second experiment, 0.74 g.

The clearance rate data indicated that mussels from the 50% and 100% BRH chambers exhibited lower clearance rates than the 0% BRH animals in the first experiment (Table 2). On Day 14 in the second experiment, clearance rates of mussels from the 30% chambers were reduced compared to the 10% BRH mussels, which were in turn lower than the 0% mussels. By Day 28, however, mussels from the 30% and 10% BRH chambers exhibited clearance rates that were similar to each other but much lower than the 0% BRH mussels.

Inspection of the absorption efficiency, respiration rate, and ammonia excretion rate data indicated no differences among chambers at any of the sampling times.

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Table 2. Mean (standard error) clearance rates of mussels (N = 10) sampled from the two laboratory experiments after exposure to various concentrations of BRH and REF suspended sediment.

Treatment	Clearance Rate (L/h)
Experiment One	
0% BRH	4.69(0.25)
50% BRH	0.54(0.20)
100% BRH	0.17(0.07)
Experiment Two Day 14	
0% BRH	4.47(0.18)
10% BRH	2.48(0.56)
30% BRH	0.81(0.30)
Day 28	
0% BRH	3.51(0.43)
10% BRH	1.80(0.41)
30% BRH	1.07(0.24)

Table 3. Mean (standard error) scope for growth values of mussels (N = 10) from the two laboratory experiments after exposure to various concentrations of BRH and REF suspended sediment.

Treatment	Scope for Growth
Experiment One	
0% BRH	10.62(1.10)
50% BRH	-4.26(1.54)
100% BRH	-7.14(1.30)
Experiment Two Day 14	
0% BRH	14.17(0.59)
10% BRH	5.03(2.00)
30% BRH	-2.82(1.81)
Day 28	
0% BRH	7.16(1.86)
10% BRH	0.14(1.30)
30% BRH	-1.79(1.39)

The Day 14 SFG values in the first experiment (Table 3) were reduced in the 50% and 100% BRH chambers. In the second experiment, SFG values on Day 14 followed the same pattern as clearance rates. Mussels from the 10% BRH chambers exhibited lower SFG values than the 0% BRH mussels; however, these values were higher than those for mussels from the 30% BRH chambers. By Day 28, the SFG of mussels from both the 30% and 10% chambers were reduced compared to the 0% BRH mussels but were not different from each other.

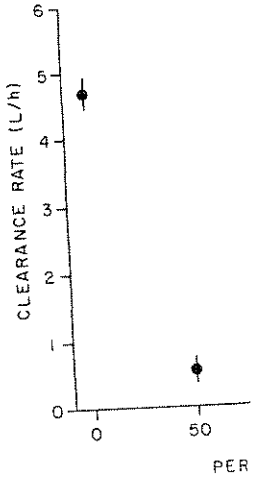
Table 4. Mean (standard error) increase in shell length (mm) of mussels (N = 10) in the two laboratory experiments after exposure to various concentrations of BRH suspended sediment.

Treatment	Days 0-14	Days 14-28
	Experiment 1	
0% BRH	0.40(0.13)	---
50% BRH	0.11(0.06)	---
100% BRH	0.06(0.04)	---
	Experiment 2	
0% BRH	0.75(0.14)	0.73(0.17
10% BRH	0.41(0.12)	0.28(0.13)
30% BRH	0.07(0.02)	0.04(0.03)

Actual Growth

In experiment 1, shell growth was greater in mussels from the 0% BRH chamber than mussels from the 50% BRH and the 100% BRH chambers (Table 4). In the second experiment, mussels in the 0% BRH chamber again exhibited greater growth than the mussels from the 10% and 30% BRH exposure chambers. Actual shell growth followed the same trend as the SFG and clearance rate measurements at Day 14 in both the first (Fig. 2) and second (Fig. 3) experiments and at Day 28 in the second experiment (Fig. 4).

Also of interest are the differences between the first and second 14-d growth periods in the second experiment. Mussels in the 0% BRH chamber grew virtually the same amount in the first 14 d as in the second 14. In the 10% BRH chamber, growth was reduced in the second period as compared to the first. This was reflected in the SFG values as well,



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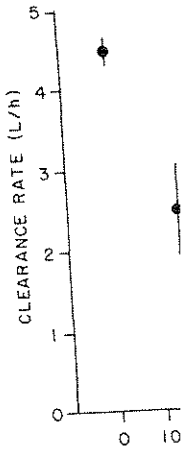

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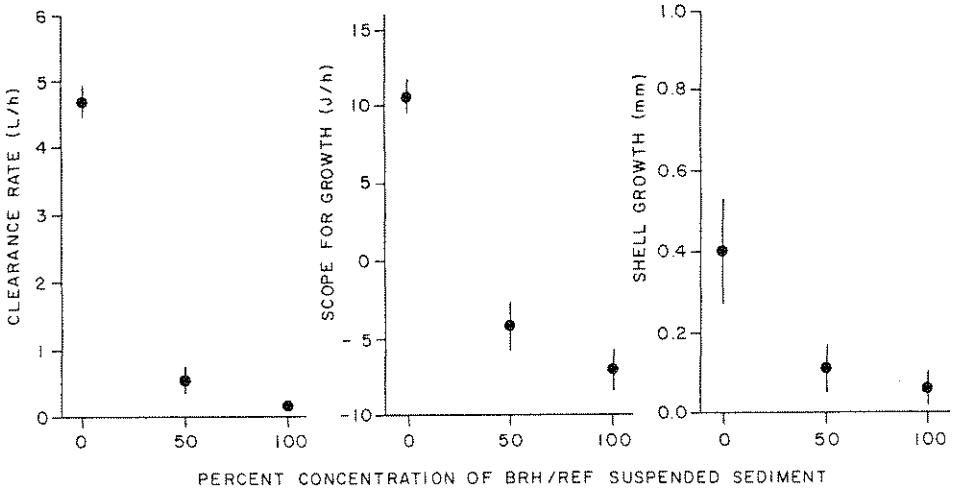


Fig. 2. The clearance rate, scope for growth, and actual growth increment response of mussels from the 0, 50, and 100% BRH treatments after 14 d. Each value represents the mean and standard error of 10 mussels.

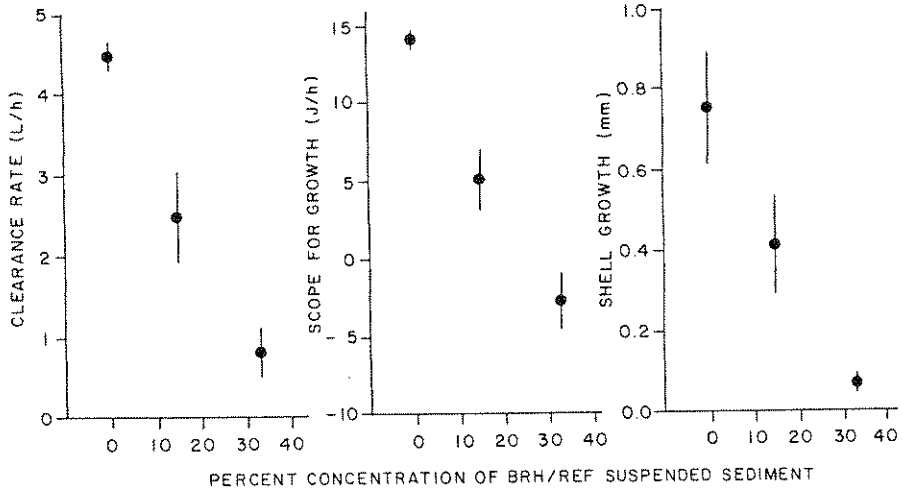


Fig. 3. The clearance rate, scope for growth, and actual growth increment response of mussels from the 0, 10, and 30% BRH treatments on Day 14 of the second experiment. Each value represents the mean and the standard error of 10 mussels.

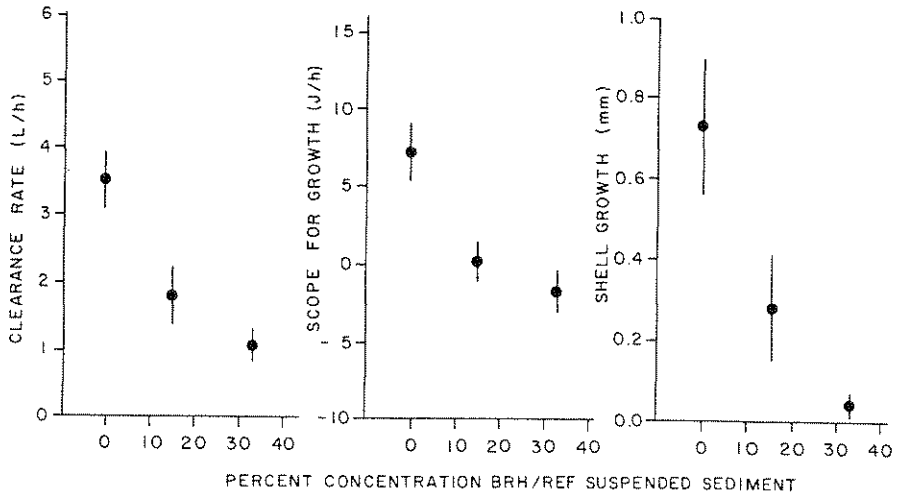


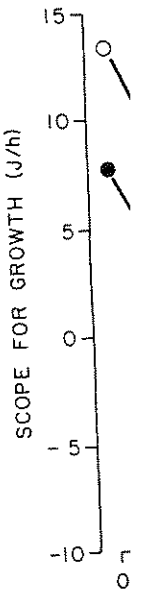
Fig. 4. The clearance rate, scope for growth, and actual growth increment response of mussels from the 0, 10, and 30% BRH treatments after a 28-d exposure. Each value represents the mean and standard error of 10 mussels.

where values were reduced during the second growth period (Table 3). Mussels from the 30% BRH chamber exhibited very little growth in either 14-d period. These data suggest a good relationship between SFG and actual shell growth.

Scope for Growth-Exposure Relationship

The Day 14 SFG-exposure concentration data (Fig. 5) suggested that the relationship between these two variables was not linear, therefore, the SFG data was log 10 transformed prior to regression analysis. To avoid negative values (i.e., -7.14 for the 100% BRH treatment), each SFG number was increased by 8 prior to log 10 transformation. Regression analysis of the data indicated a significant ($p<0.001$, $R^2 = 0.99$) inverse relationship between SFG and BRH exposure concentration.

The Day 28 SFG data consisted of only three data points, therefore, regression analysis was not appropriate with these limited degrees of freedom (Fig. 5). Visual inspection of the data suggested a similar pattern of reduced SFG as that observed on Day 14 in the 10% and 30% BRH treatments.



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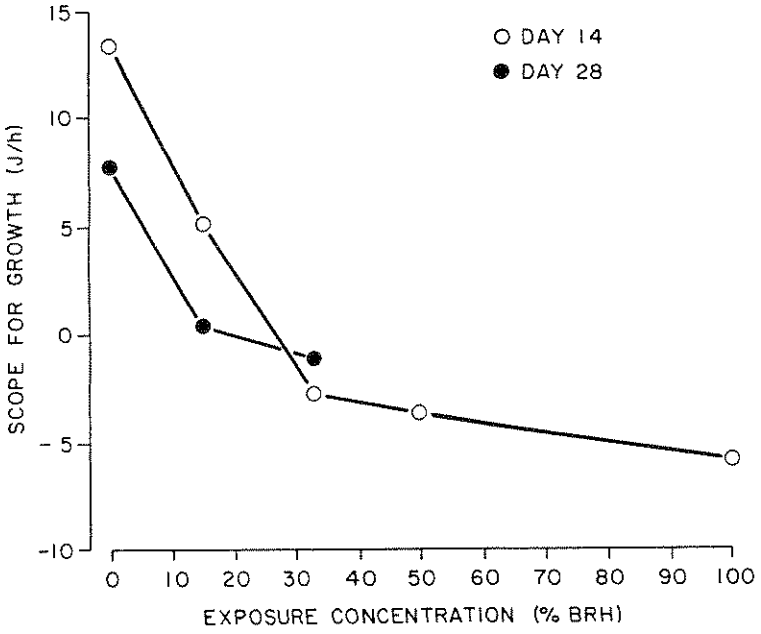

Fig. 5. Relationship between mussel scope for growth and measured BRH exposure concentration on Days 14 and 28 in the laboratory experiments. Points are connected by hand to indicate pattern between BRH dose and SFG response in mussels.

Field Experiments

The estimated BRH exposure concentrations present at the four CLIS stations are listed in Table 5. Maximum exposure (0.8 mg/L) occurred at the 400E station 2 wk post-disposal (T+2). The CNTR station was not deployed during this time period because of the dumping operation. Predicted BRH exposures decreased rapidly after this collection date.

Scope for growth measurements completed on mussels returned from the field after one-month deployments in CLIS indicated only small differences among stations. Mussels deployed at the 400E station during the actual dumping were lost. This was unfortunate because this station probably would have received the largest "dose" of BRH suspended sediment in the field.

Table 5. The estimated amount of BRH suspended material (mg/L) required to produce the measured tissue residue values of mussels deployed in CLIS. Each value was calculated based on laboratory-generated PCB residue-exposure concentration relationships. Cruise collection corresponds to the number of weeks after completion of the disposal operation that mussels were retrieved from Long Island Sound.

Collection Cruise	Stations		
	CNTR	400E	100E
T=0			0.6
T+2		0.8	0.4
T+8	0.2	0.3	0.1
T+12	0.1	0.1	0.0

The first collection that included mussels from all four field stations was at 8 wk postdisposal. A slight reduction in clearance rate was observed in mussels from the CNTR station compared to those from the 1000E and REFS stations. The SFG value for the CNTR mussels was also lower than for the mussels collected at the other three stations.

Mussels returned from two subsequent monthly field collections, 12 and 16 wk postdisposal, showed no differences among any of the stations for either the SFG index or the individual physiological parameters measured.

DISCUSSION

The first objective of this study was to assess the SFG index as a measure of sublethal effect in the mussel after exposure to a dredged material in the laboratory and the field. Laboratory experiments indicated that reductions in SFG, clearance rate, and shell growth were inversely related to BRH exposure concentrations. In addition, PCB tissue residues in mussels from the same experiment indicated that mussels exposed to approximately twice the dose of BRH sediment (1.5 and 3.3 mg/L, respectively, for the 10% BRH and 30% BRH treatments) exhibited twice the PCB tissue residue concentration, 1840 and 3690 ng/g dry weight, respectively, for the 10% and 30% BRH treatments (Lake et al., in press).

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Based on these data, it would appear that increased exposure to BRH sediment resulted in increased tissue residues which resulted in a corresponding decrease in SFG, clearance rates, and actual growth in mussels.

The reduction in the physiological condition of mussels after exposure to BRH sediment was not unexpected considering the contaminants present in this material. Large quantities of PCBs (6800 ng/g), polynuclear hydrocarbons (PAHs) (9800 ng/g), and trace metals (Cu and Cr at 2380 and 1430 µg/g, respectively) were reported in the BRH dredged material (Lake et al., 1985). The relationship between BRH exposure levels and mussel tissue residues for each of these contaminants will be presented in a subsequent paper (Lake et al., in press).

Reductions in the SFG of mussels, exposed to some of the same contaminants present in BRH dredged material, have been reported by other investigators. Stickle et al. (1985) reported an inverse relationship between SFG of mussels and water-soluble fraction aromatic hydrocarbon concentrations. Widdows et al. (1982) have demonstrated reductions in the SFG of mussels esposed to the water-accommodated fraction of North Sea oil. Gilfillan (1975) reported a net decrease in carbon flux in M. edulis after exposure to crude oil extracts. Copper was also found to reduce the SFG of M. edulis (Moore et al., 1984).

In addition to the fact that BRH material affected SFG, the shape of the dose-response curve at Day 14 is also of interest (Fig. 5). This relationship was best described by a curvilinear regression equation. These data imply that exposure to some BRH concentration between 0 and 1.5 mg/L would have no effect on SFG in mussels, that is, a possible "threshold" concentration of BRH material is required to cause adverse physiological effects. Testing of this hypothesis would require additional experiments with reduced levels of BRH material. A similar trend was displayed by the 28-d data, with a relatively small SFG difference between mussels exposed to 1.5 mg/L and 3.3 mg/L compared to mussels exposed to no BRH material.

The individual physiological parameters indicated that the reductions in SFG may be related exclusively to decreased clearance rates. Absorption efficiencies, respiration rates, and ammonia excretion rates were similar among treatments at Day 14 and Day 28. The impact of BRH suspended sediment on clearance rate was consistent in both

experiments and almost identical to that between SFG and BRH levels (Figs. 2-4). This type of response was observed by Stickle et al. (1985) and Widdows et al. (1982) in M. edulis after exposure to oil extracts. Gonzalez et al. (1979) reported reduced clearance rates in M. edulis after exposure to No. 2 heating oil. In addition, Nelson et al. (1985) found lower clearance rates in mussels after exposure to BRH dredged material. Reductions in clearance (feeding) rate have been observed in other species as well. Gilfillan et al. (1976) reported a reduction in filtration in the soft-shelled clam, Mya arenaria, from areas exposed to oil spills. Stickle et al. (1984) found that reductions in the SFG of the gastropod, Thais lima, after exposure to hydrocarbons, were primarily due to feeding rate.

One explanation for the reduced clearance rates in the present study has been suggested by histopathological observations. Mussels from BRH treatments showed a loss of cilia from the gill filaments, while those exposed to REF sediment alone were normal (Yevich, pers. comm.). This information is consistent with the fact that clearance rate was the parameter most affected by the BRH exposures. The present study augments the evidence in the literature that clearance rates are particularly sensitive to pollutants similar to those present in the BRH dredged material.

Shell growth increments of mussels (Table 4; Figs. 2-4) indicate that the relative effects of BRH sediment shown by SFG are supported by actual changes in shell size. Agreement between the SFG index and actual growth has been reported by Bayne and Worrall (1980) for mussels and Gilfillan and Vandermeulen (1978) in Mya arenaria. The close correspondence between the SFG response and the shell length data in the present study supports the use of standardized conditions to measure relative sublethal effects in mussels.

To summarize the laboratory portion of the study, a consistent, adverse response was observed in the mussel after exposure to BRH suspended sediment. Increased exposure to BRH resulted in increased tissue residue concentrations of contaminants which were inversely related to physiological condition. Relative differences in SFG were supported by changes in shell growth. The nonlinear relationship between SFG and exposure concentration indicated the possibility that a threshold concentration of BRH material may be required to elicit a negative SFG response.

The relationship between SFG and exposure concentration at the four CLIS field stations was not as straight forward as that in the laboratory. Exposure conditions in the field during each mussel deployment were not characterized to the extent that they were in the laboratory, therefore, the dose-response comparisons were more qualitative than quantitative.

The estimates of BRH exposure in the field indicated that the maximum concentration (0.8 mg/L) occurred during the dumping operation. During this collection, no decrease in SFG was noted. One possible explanation is that this concentration was too low to cause a reduction in SFG. The estimated maximum BRH exposure concentration in the field (0.8 mg/L) was about half that of the lowest concentration in the laboratory (1.5 mg/L), implying that the signal in the field may have been "weaker" than that present in the laboratory experiments. This field level may be below the speculative threshold concentration suggested previously. Another theory concerns the mode of exposure. Laboratory exposure conditions were fairly constant whereas field conditions were more dynamic. Limited field data indicated that mussels in the field received inconsistent, periodic exposures to BRH material (Paul, personal comm.). The effect this type of exposure has on the mechanisms controlling accumulation and subsequent physiological effects are unknown.

The second objective of this research was to make a qualitative comparison between the concentration of BRH estimated to produce an effect in the laboratory with that in the field. Laboratory experiments indicated that M. edulis provided a clear response to a little as 1.5 mg/L of suspended BRH sediment, as evidenced by the clearance rate, SFG, and actual growth measurements. Based on these data, exposure to BRH material at concentrations between 0 and 1.5 mg/L would be predicted to produce an adverse physiological effect in field-exposed mussels. The field data indicated no clear relationship between SFG and tissue residues. The estimated maximum exposure concentration in the field (0.8 mg/L) was approximately half that of the lowest laboratory BRH exposure (1.5 mg/L). Based on this information, the concentration estimated to produce an adverse SFG effect in the field would be greater than 0.8 mg/L.

Comparison of these two values indicated that the field estimate (>0.8 mg/L) was within the range predicted from the

laboratory data (0-1.5 mg/L). The possible existence of an effective threshold BRH concentration, suggested by the laboratory dose-response curve, may help to explain the lack of effect in the field and the presence of one in the laboratory. Nonetheless, the laboratory and field estimates provide a good qualitative comparison of the effects of BRH material on mussels. Based on these data, it is believed that the pretesting of dredged material in the laboratory, using the SFG of M. edulis as one test method, can provide valuable information in the evaluation of possible effects of dredged material before disposal in the marine environment.

SUMMARY

The physiological condition of the mussel Mytilus edulis was investigated after exposure to a dredged material in both the laboratory and the field.

Scope for growth values were lower after a 28-d laboratory exposure to BRH concentrations of 1.5 mg/L or more. Observed reductions in SFG, due to reduced clearance rates, were reinforced by a concomitant decrease in actual growth.

Field exposures of mussels deployed after disposal of BRH in Long Island Sound resulted in no large changes in SFG values at the dumpsite. Exposure levels of BRH suspended sediment during this period were estimated to be less than 1.0 mg/L.

The concentration of BRH suspended sediment estimated to affect SFG in field-exposed mussels (>0.8 mg/L) was very similar to that estimated from laboratory experiments (0-1.5 mg/L).

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