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Predation on meiofauna by juvenile spot *Leiostomus xanthurus* (Pisces) in contaminated sediments from Charleston Harbor, South Carolina, USA

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ABSTRACT: Meiofauna are a major food source for estuarine juvenile fish despite the fact that meiofauna often live in close contact with sediment-associated contaminants. Although there is laboratory evidence that fish feeding on contaminated meiofauna can build up significant contaminant body burdens, whether or not fish predation on meiofauna is affected by sediment contamination in the field has not been well established. To answer this question, the number and taxa of meiobenthic prey items consumed by fish were compared between contaminated and uncontaminated habitats. A model predator, juvenile spot *Leiostomus xanthurus* (Pisces) was allowed to feed on natural meiobenthic communities in experimental sediment microcosms. Significantly more meiofauna were observed in the uncontaminated reference site (1060 nematodes per 10 cm^2, 177 copepods per 10 cm^2) than in the contaminated site (278 nematodes per 10 cm^2, 97.5 copepods per 10 cm^2). Although harpacticoid copepods were found in the foreguts of spot from both contaminated (mean 22.1 prey per fish) and uncontaminated (mean 13.7 prey per fish) sediments, there were few, if any, significant reductions in meiofauna abundance due to predation. There were differences between contaminated and uncontaminated sediments in taxa eaten by spot, but these differences were most likely due to differences between the meiofauna communities from the 2 sites, not differences in fish feeding behavior. Despite the potential adverse effects of eating meiofauna from contaminated sediments, juvenile spot do not avoid them.

KEY WORDS: Meiofauna · Copepods · Fish feeding · *Leiostomus xanthurus* · Selectivity · Charleston, SC · Contaminated sediments

INTRODUCTION

The ecological and trophic significance of meiobenthos in estuarine ecosystems is well documented (Gee 1989, Coull 1990, Coull et al. 1995). At least 70 species of estuarine fish, as well as a few decapods and birds, eat meiofauna (Gee 1989, Coull 1990, in press). However, meiofauna live in close association with sediments, where they are often chronically exposed to an array of contaminants. Well over 100 studies have shown meiobenthos to be sensitive indicators of environmental perturbation (Coull & Chandler 1992). In addition to numerous mortality-based toxicity tests, researchers have tested sublethal contaminant effects on life-history parameters, such as fecundity, developmental time and reproductive rates (e.g. Chandler 1990, Strawbridge et al. 1992, Green et al. 1996, Gregg et al. 1997, Lotufo 1997). There is also evidence that meiofauna living in contaminated sediments bioaccu-

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mulate contaminants rapidly and at body burdens comparable to those of macrobenthos (Wirth et al. 1994, DiPinto 1996, DiPinto & Coull 1997). Because meiofauna are eaten in great numbers by juvenile fish, the potential exists that these contaminants can be transferred up the food web.

Juvenile spot *Leiostomus xanthurus* Lacepidé between 21 and 45 mm feed almost exclusively on meiofauna (Feller & Coull 1995, McCall & Fleeger 1995). Juvenile spot allowed to feed on meiofauna in sediments contaminated with an organophosphate pesticide (DiPinto 1996) or polychlorinated biphenyls (PCBs) (DiPinto & Coull 1997) accumulated both contaminants. Fish that accumulated the pesticide exhibited a corresponding decrease in brain acetylcholinesterase activity (DiPinto 1996). Thus, there is evidence that prey from contaminated sediments may adversely affect the health of a predator. It is unclear whether predators on meiofauna in natural habitats can effectively utilize contaminated sediment habitats as adequate foraging grounds. Fish feeding behavior may be altered in the presence of contaminated sediments. Alternatively, fish may continue to feed normally, thereby compromising their health and fitness. Hinkle-Conn et al. (in press) found that spot did not alter their feeding behavior on meiofauna at high (122 ppm) polycyclic aromatic hydrocarbon (PAH) concentrations. Marshall & Coull (1996), using experimental microcosms amended with PAHs, found that juvenile spot consumed significantly fewer copepods in the contaminated (~1 µg mixed PAHs g^{-1} dry weight of sediment) versus uncontaminated control treatments. Although the difference was significant, the number of potential prey lost was small, and unlikely to be of energetic significance to the spot (Feller & Coull 1995, Marshall & Coull 1996).

The current study describes the first attempt to measure predation on natural meiofauna communities at *in situ* contaminant concentrations and with field-collected contaminated sediments. The objective of the study was to determine if fish fed differently on meiofauna in field-collected contaminated versus uncontaminated sediments. Juvenile spot were allowed to feed on natural meiofauna communities to determine if different numbers or different taxa were consumed between contaminated and non-contaminated sites. The null hypothesis of this experiment was that meiobenthos-eating fish do not consume different numbers or kinds of prey items in contaminated versus relatively uncontaminated sediments. If fish ate more copepods in contaminated sediments, one explanation could be that copepod behavior was affected by the presence of contaminants. Copepods may avoid contaminated sediments, possibly spending more time at the sediment surface or in the water column, where they are more likely to be eaten. If fish eat fewer copepods in contaminated sediments, the most parsimonious explanation is that the fish can detect, perhaps by taste, that either copepods or sediments contain higher concentrations of contaminants. Clearly, if predator consumption of a major food source is reduced by sediment contaminants, there could be important trophic consequences for the predator species and the estuarine foodweb as a whole.

METHODS

Environmental characteristics of creeks. The experiments were conducted with sediments collected from a 'contaminated' and a 'reference' salt marsh creek in Charleston Harbor, South Carolina, USA. Diesel Creek (contaminated) drains an industrial watershed that is part of an EPA (US Environmental Protection Agency) CERCLA ('Superfund') site, while Parrot Creek (reference) drains a suburban watershed with no obvious source of contaminants. Physicochemical data on the creeks was collected by the South Carolina Department of Natural Resources (DNR) as part of their Tidal Creek Project. At both creeks, approximately 2 l of the upper 2 cm of sediment was collected for measurement of total organic carbon (TOC) and nitrogen (TON), sediment grain size, trace metals, hydrocarbons, PCBs and pesticides. Chemical analyses were conducted by the National Marine Fisheries Service in Charleston. Briefly, TOC and TON were analyzed by a Perkin Elmer Elemental Analyzer (950°C combustion temperature). Metals were analyzed by inductively coupled plasma spectroscopy (ICP) (As, Cd, Cr, Cu, Ni, Pb and Zn), graphite furnace atomic absorption (As, Cd, Pb), or cold-vapor atomic absorption (Hg). PAHs were quantified by capillary gas chromatograph and high performance liquid chromatography (HPLC). Chlorine compounds (PCBs, pesticides) were analyzed by electron capture detection gas chromatography (ECD-GC). Sediment grain size was determined by weighing dried sediment retained on the appropriate sieve sizes. Salinity was measured using a Hydrolab DataSonde 3.

Sample collection. Juvenile spot *Leiostomus xanthurus* of 31 to 53 mm standard length were collected by seine (2 mm mesh) from Grice Cove, Charleston. Upon entrapment, the fish were held underwater in the seine and then scooped up with plastic beakers and transferred to coolers full of water to minimize shock. The fish were transferred to empty microcosms (see below) and starved 24 h before the start of the experiment.

Whole sediment experiments were conducted in outdoor water tables in microcosms made of PVC pipe (20 cm inner diameter × 25 cm height) with two 8 cm diameter windows cut 13.5 cm up from the base to

allow water to pass through (cf. Smith & Coull 1987, Coull et al. 1995). Sediment was collected from each site by using the microcosms' PVC walls to core an area of intertidal sediment during low tide to approximately 8 cm deep, several cm below the redox layer. The bottoms of the microcosms were sealed with a 30 × 30 cm metal sheet. Microcosms were returned from the field and placed in a water table, with the contaminant treatments downstream to minimize contamination of reference microcosms. The microcosm windows were covered with 63 µm mesh to prevent meiofauna from escaping and coarsely filtered sea water was introduced slowly to the water table (salinity 23 ppt). Final water level was maintained below the height of the microcosms by the windows, at a depth of approximately 10 cm. The microcosms were then allowed to equilibrate overnight.

Experimental procedure. The entire experiment was conducted twice (May 6 and May 8, 1997). Each experiment consisted of 6 microcosms from each of the 2 creeks (1 contaminated, 1 uncontaminated). Of the 6, 3 microcosms were randomly selected (by random number table) as fish treatments and the other 3 were left as no-fish controls. Immediately before the experiment began, three 2.0 cm inner diameter cores (4 cm deep to include the redox layer) were taken from each microcosm to estimate initial (before fish addition) meiofaunal abundances in each microcosm. The core holes were filled with cured silicon plugs in order to avoid providing a refuge for meiofauna to escape predation. Three juvenile spot were added to each of the 3 fish treatments from each creek. Such spot densities are common at low tide in South Carolina tidal creeks (Smith & Coull 1987). The entire water table was covered by a dark tarp to minimize external disturbance, and the fish were allowed to feed for 4 h. Fish were observed feeding in all microcosms before and after the covering of the microcosms, and there were spot feeding pits present in all of the microcosms.

After 4 h, another set of three 2.0 cm cores was taken in both the fish and no-fish microcosms. We deliberately chose a 4 h feeding period because nematodes can only be observed up to 2.5 h after ingestion (Scholz et al. 1991). All initial and final cores were fixed in 90% ethanol and Rose Bengal. All fish in the microcosms survived the experiment and, after the final cores had been taken, were immediately removed and fixed in 90% ethanol.

In the lab, sediment was rinsed through a 63 µm sieve, and meiofauna that remained on the sieve were identified to the lowest possible taxon. Fish were dissected and the contents of their digestive tracts likewise enumerated. Only whole animals or heads of prey and only those from the foregut of the fish were counted. Prey animals in the hindguts of the fish were too dismembered to determine species.

Statistics. The model used was a partially hierarchical, multiway analysis of variance, with density of a particular taxon as the main effect (Y) and Site (contaminated vs reference creek), presence of Fish predators (yes or no), Time (initial vs final), Experiment (1 or 2), and Microcosm replicate (1, 2 or 3) as main effects. Because the 12 microcosms were divided into different treatments, Site, Fish and Experiment are all nested within the random Microcosm variable for the full model, Y = Site | Fish | Time Experiment Microcosm (Site × Fish × Experiment). The most interesting term for purposes of testing differences in fish feeding was the Site × Fish × Time interaction. A significant interaction would suggest that a different number of prey were consumed by fish at different sites relative to initial prey densities, i.e. that fish fed differently in contaminated versus reference creeks.

To compare frequencies of various prey taxa in the sediment to frequencies in the fish guts—in essence to determine if fish fed selectively—the natural log (L) of the odds ratio (O) was estimated (Gabriel 1979) following the equation $O = p_1 (1 - p_2)/p_2 (1 - p_1)$, where p_1 is the proportion of prey taxa in the fish diet and p_2 is the proportion of prey taxa in the environment. The magnitude and sign of L indicate degree of positive or negative selection. Because copepods only occupy the upper cm of sediment in muddy substrata (Decho & Fleeger 1988, Coull et al. 1989) and juvenile spot take bites of sediment <1 cm deep (Billheimer & Coull 1988), we felt justified calculating selectivity by the fish. All statistics were conducted using SAS (1996).

RESULTS

Environmental characteristics of creeks

The contaminated creek (Diesel) had higher concentrations of all the heavy metals (except Ni), PCBs, PAHs, and pesticides measured (Table 1). The reference creek (Parrot) was slightly enriched in TOC and TON, but contaminant level is clearly the major environmental difference between the 2 sites. Grain size, which is known to be a major environmental factor in structuring meiofaunal communities (McIntyre 1969, Giere 1993), was fairly similar between the 2 creeks, with > 75% of the particles in the silt (63 to 500 µm) fraction. Although these data were collected in summer 1995, other studies (data not shown) indicate that there is little annual variation in contaminant concentrations. Yearly salinity ranged from 15 to 22 ppt for the contaminated creek, and 20 to 28 ppt for the reference creek; at the time of collection, salinity was 20 and 23 ppt, respectively.

Table 1. Environmental characteristics of the 2 tidal creeks in South Carolina from which sediment and meiofauna were collected

	Diesel Creek (contaminated)	Parrot Creek (reference)
As (ppm)	19.4	17.0
Cd (ppm)	0.32	0.0
Cr (ppm)	130.5	64.8
Cu (ppm)	62.0	16.7
Hg (ppm)	0.10	0.05
Ni (ppm)	13.2	17.5
Pb (ppm)	36.2	19.6
Zn (ppm)	194.4	67.3
Total PAHs (ppb)	15637	250
Total pesticides (ppb)	14.6	1.4
Total PCBs (ppb)	47.5	3.6
Sand/silt/clay (%)	3/80/17	3/92/5
Total organic carbon (%)	2.1	3.4
Total organic nitrogen (%)	0.12	0.3
Salinity range (ppt)	15–22	20–28

Table 2. Mean meiofauna abundance (no. per 10 cm^2) ± SE collected from the experimental microcosms (n = 12 per creek) before fish feeding

Prey taxon	Diesel Creek (contaminated)	Parrot Creek (reference)
Microarthridion littorale	55.6 ± 8.5	153 ± 19.9
Nannopus palustris	15.3 ± 1.8	0.43 ± 0.2
Enhydrosoma spp.	7.10 ± 1.3	2.71 ± 0.4
Paronychocamptus wilsoni	13.7 ± 2.2	9.1 ± 2.1
Other harpacticoid species	8.51 ± 1.6	11.9 ± 1.4
Total harpacticoids	97.5 ± 12.3	176.5 ± 20.2
Total nematodes	278 ± 23.0	1055 ± 73.3

Meiofauna from sediment

Nematodes, annelids and harpacticoid copepods were recovered from the experimental microcosms. Among the harpacticoids, 4 taxa predominated: *Microarthridion littorale*, *Nannopus palustris*, *Enhydrosoma* spp. and *Paronychocamptus wilsoni*. Pre-fish mean densities were 278 per 10 cm^2 for nematodes and 97.5 per 10 cm^2 for copepods for the contaminated sediment and 1055 per 10 cm^2 for nematodes and 176.5 per 10 cm^2 for copepods for the reference sediment (Table 2). *M. littorale* was the predominant copepod in both creeks, comprising 70% of total harpacticoid species in the contaminated creek and about 50% of total harpacticoids in the reference creek (Table 2). Variances in mean abundance of total nematodes and total copepods were compared by ANOVA. For nematodes, Site ($p < 0.01$) and the Fish × Time interaction ($p < 0.05$) were significantly different (Table 3). For copepods,

Table 3. ANOVA table. Model: Y = Site | Fish | Time Experiment Microcosm (Site × Fish × Experiment). df = degrees of freedom, F = F-statistic, p = probability of the F-statistic

Source	df	Total nematodes F	p	Total copepods F	p
Site	1	118	0.0001	3.40	0.08
Fish	1	0.65	0.43	0.81	0.38
Site × Fish	1	0.002	0.96	0.84	0.37
Time	1	3.20	0.09	3.19	0.09
Site × Time	1	0.03	0.86	0.64	0.43
Fish × Time	1	4.80	0.04	0.001	0.98
Site × Fish × Time	1	1.46	0.24	7.53	0.01
Experiment	1	0.48	0.50	0.62	0.44
Microcosm (Site × Fish × Time)	19	1.55	0.17	6.94	0.0001

the triple interaction, Site × Fish × Time ($p = 0.01$), and Microcosm ($p < 0.01$) were significant.

Although there were differences between the 2 creeks in sediment copepod abundance, there were no differences between initial and final numbers of copepods related to the presence/absence of fish (Fig. 1). Surprisingly, copepod abundance in the no-fish treatments in the reference creek was almost double that of the fish treatments (Fig. 1). The relatively small apparent standard errors were based on the mean squared terms from the ANOVA. Thus, since there was only one mean squared term for the interaction, all of the least squared means have the same value for the standard error. For nematodes, abundance values in the reference creek sediments were 3 to 5 times higher than mean abundances in the contaminated creek sediments ($p < 0.001$; Fig. 2). Treatments with fish predators had decreased numbers of nematodes (Fig. 2). These differences were only significant in the contaminated creek sediments ($p < 0.05$), although more nematodes were actually eaten in the reference creek treatments (Fig. 2).

Meiofauna in fish guts

Fish were observed to feed during the experiments. All fish were recovered after the experiments, and 29 of the 36 were observed to have meiofauna in their foreguts. Of the 7 fish that were empty of recognizable parts, 4 were from the contaminated creek (Diesel) and 3 were from the reference creek (Parrot). No identifiable animal parts were collected from the hindgut of any fish. Only harpacticoid copepods and annelid body parts were identified in gut contents. Annelid parts were rare, in pieces, and unidentifiable to species level. No nematodes were found in any gut.

Six harpacticoid species were identified in sediment samples, and the same 6 appeared in fish gut contents

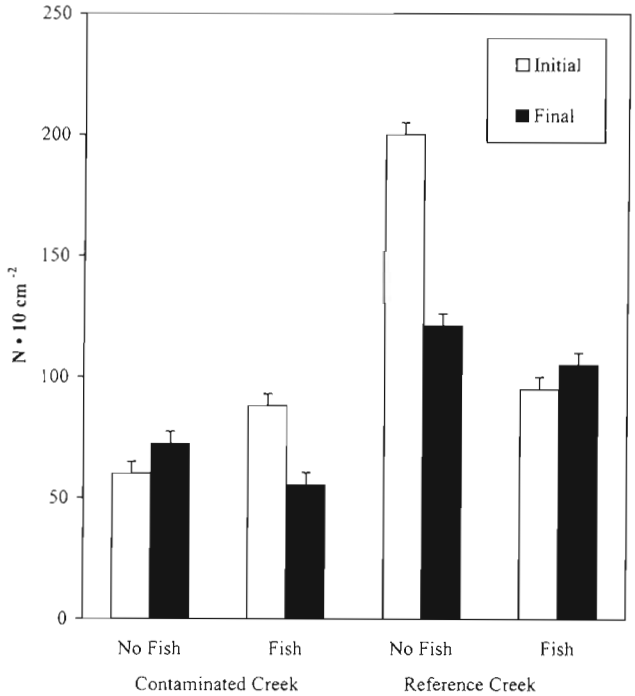

Fig. 1. Mean abundance (+SE) of harpacticoid copepods initially and after 4 h in treatments with fish and without fish in sediment collected from a contaminated and a reference creek. n = 3 microcosms per treatment

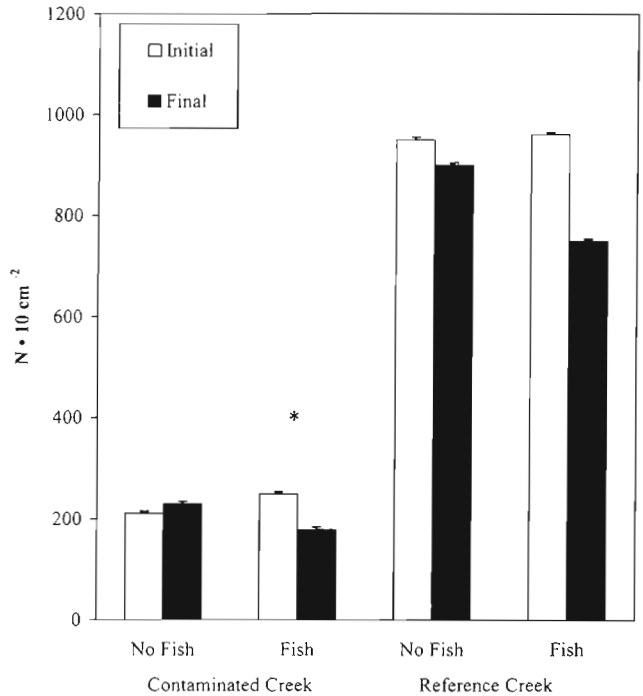

Fig. 2. Mean abundance (+SE) of nematodes initially and after 4 h in treatments with fish and without fish in sediment collected from a contaminated and a reference creek. n = 3 microcosms per treatment. *p < 0.05

(Tables 2 & 4), with *Microarthridion littorale*, *Nannopus palustris*, *Enhydrosoma* spp., and *Paronychocamptus wilsoni* predominating. Fish from the contaminated microcosms contained a greater number of copepods in their foreguts, a mean of 22.1 per fish, with 6 of the 18 fish containing greater than 30 copepods. Fish from the reference microcosms had fewer copepods in the gut, a mean of 13.7 copepods per fish, with only 1 of 18 fish containing more than 30 copepods; but because of high variance there was no significant difference among the means ($p > 0.05$).

Of the 4 taxa, *Microarthridion littorale* and *Nannopus palustris* were found at the highest frequency in fish from both reference and contaminated microcosms: 31.3 and 21.5% of all copepods, respectively, for contaminant microcosms and 26.6 and 24.1%, respectively, for reference microcosms (Table 5). However, differences in selectivity existed between the 2 sample sites. In contaminated microcosms, *N. palustris* was taken in proportion to its abundance, while in reference microcosms, spot strongly selected for *N. palustris* ($L = 4.92$; Table 5). The percentage of *N. palustris* in fish guts (24.1%) was an order of magnitude higher than in the sediments (0.23%) for the reference creek microcosms. In both treatments, *Paronychocamptus wilsoni* was selected against, as was the predominant copepod, *M. littorale* (Table 5). *Enhydrosoma* spp. and 'other' harpacticoid taxa were found in slightly higher frequency in fish foreguts than in sediments. In general, frequencies for prey species found in fish guts were similar between the contaminated and reference microcosms (Table 5), even though the densities of copepods in the sediments themselves were not similar (Table 4).

Table 4. Mean number of benthic copepods ± SE found in the foreguts of juvenile spot (n = 18 per creek) after 4 h of feeding

Prey taxon	Diesel Creek (contaminated)	Parrot Creek (reference)
Microarthridion littorale	8.6 ± 2.0	4.8 ± 1.2
Nannopus palustris	6.5 ± 1.6	3.9 ± 1.7
Enhydrosoma spp.	2.8 ± 0.9	1.4 ± 0.4
Paronychocamptus wilsoni	0.06 ± 0.06	0.4 ± 0.2
Other harpacticoid species	4.1 ± 1.0	3.2 ± 1.6
Total harpacticoids	22.1 ± 5.0	13.7 ± 2.3
Total nematodes	0	0

DISCUSSION

Numerous studies have shown that many juvenile fish predators consume meiofauna profusely, but rarely reduce overall meiofauna densities to any signif-

Table 5. Percentage abundance of benthic copepods initially in the sediment treatments and in the fish foreguts after 4 h of feeding. L = natural log of the odds ratio (see 'Methods') (± SE). No nematodes were found in fish guts. 'Other harpacticoid species' included at least *Coullana* sp. and *Stenhelia* sp.

Prey taxon	Diesel Creek (contaminated)			Parrot Creek (reference)		
	% in sediment	% in foregut	L ± SE	% in sediment	% in foregut	L ± SE
Microarthridion littorale	47.3	31.3	−0.67 ± 0.12	71.5	26.6	−1.94 ± 0.07
Nannopus palustris	24.0	21.5	−0.14 ± 0.64	0.23	24.1	4.92 ± 3.08
Enhydrosoma spp.	7.0	9.0	0.28 ± 0.11	4.3	8.4	0.71 ± 0.95
Paronychocamptus wilsoni	12.8	0.1	−5.00 ± 2.90	8.4	1.9	−1.55 ± 1.19
Other harpacticoid species	9.0	15.8	0.66 ± 0.85	15.6	22.2	0.39 ± 0.23

icant degree at m^2 or larger scales (e.g. Hicks 1984, Gee 1987, Webb 1991, Henry & Jenkins 1995, McCall & Fleeger 1995). There is little evidence from field or microcosm studies that meiofauna communities are controlled by 'top-down' forces (i.e. predation; Coull in press). Meiofauna reproduce so rapidly in estuaries that even mimicked predation of up to 90% may make no impact on population densities of some copepods (Woods & Coull 1992). Thus, meiofauna thriving in polluted sediments may provide a continuous trophic 'pipeline' for contaminant movement to predators.

Predation does not appear to be responsible for the differences in meiofauna abundance between treatments in the present study. While final densities in fish treatments were generally lower than initial densities and generally less than in the no-fish controls (Figs. 1 & 2), the high variance in the no-fish treatments caused within-treatment variance to be higher than the among-treatment variance. Perhaps more replicate microcosms and experiments may have reduced the variance, but resources were limited and numbers of both microcosms and experiments were consistent with past experiments. Although sediment in each creek was collected within a 2 to 3 m^2 area, meiofaunal densities are known to be patchier on even smaller scales (Findlay 1981, Sun & Fleeger 1991).

Abundance of nematodes was significantly greater ($p = 0.0001$) and abundance of copepods greater ($p = 0.08$) in the reference creek sediments (Tables 2 & 3). One could argue that the reduced abundances in the contaminated creek sediments were due to the contamination, but there is no evidence that the reduced abundances had a functional effect or posed any risk to those organisms that occupied the habitat. In their review, Coull & Chandler (1992) pointed out that meiofaunal abundance is not a good indicator of pollution; about half of the >100 studies reviewed found an increase in meiofaunal abundance and about half found a reduction correlated with contaminant presence. Comparative field surveys relating abundance and contaminant loads (exactly what we have in our initial, pre-fish data) are equivocal and provide little insight into contaminant effects on ecosystem processes.

Why were there no nematodes in the fish guts, particularly since they were reduced in the fish-feeding treatments (significantly so in the contaminated site, but also in the reference site; Fig. 2)? We knew *a priori* that nematodes are digested within 2.5 h (Scholz et al. 1991), and thus conducted our experiment for only 4 h with the hope of observing nematodes in the fish guts. Because Coull et al. (1995) found nematodes to be reduced by about 50% in sediment in which an Australian fish fed, and found them to be completely absent in fish guts after 6 h feeding trials, 4 h seemed a reasonable length for the current study. Coull et al. (1995) in fact recommended that '...similar future experiments be conducted for no longer than 4 h'. Digestion seems the only reasonable explanation for the lack of nematodes in fish guts in the current study. The fact that nematodes were approximately 5 times more abundant in our Charleston Harbor reference creek than in the contaminated creek sediments (Fig. 1), seemed to be immaterial to the feeding fish. Copepods were the primary prey item of choice, as they have been in most other juvenile fish feeding studies involving meiofauna (e.g Gee 1989, Coull 1990, in press, McCall & Fleeger 1995).

Spot ate proportionately more harpacticoid copepods in sediments from the contaminated creek (Table 4), even though there were more copepods available per unit area in sediments from the reference creek (Table 3). It would be difficult to argue based on the current data that predation was higher in the contaminated microcosms, but it is clear that the presence of contaminated sediment (Table 1) certainly did not cause a reduction in fish feeding. The enrichment of certain copepod species in the fish guts is most likely due to differences in copepod habitat niche rather than a difference in effort on the part of the fish, since the spot are most likely feeding non-selectively (Feller & Coull 1995). For example, *Nannopus palustris*, which was selected for in the reference creek microcosms, but consumed at *in situ* proportions in the contami-

nated creek microcosms (Table 5), is a relatively large, epibenthic species, which could account for its higher frequency in fish guts. In contrast, *Paronychocamptus wilsoni*, a species selected against by the fish, lives deeper in the sediment, where it is probably less available. The numbers of copepods consumed in 4 h (22.1 and 13.7 per fish for the contaminated and reference creek microcosms, respectively) are in concordance with published estimations (Feller & Coull 1995) that spot of our study size consume 100 to 500 copepods d^{-1} in order to meet their daily ration.

In this short-term feeding experiment, juvenile spot either did not detect the presence of contaminants in meiofauna or sediments or did not alter their feeding behavior if they did detect elevated contaminant levels. These results are consistent with those of Hinkle-Conn et al. (in press), who found no change in the number of feeding strikes by spot between contaminated sediment and reference treatments, and Marshall & Coull (1996), who found that, although spot predation on meiofauna was reduced by PAH contamination, the reduction was small and not of energetic importance to the fish. In the current study, spot were collected from a relatively uncontaminated creek; it is possible that fish native to a contaminated habitat would respond differently to the presence of contaminants or, if logistics had allowed a long-term feeding trial, a longer fish exposure may have elicited a different response. Gregg et al. (1997) reported a reduction in feeding rate on meiofauna by darter gobies *Gobionellus boleosoma* in PAH-contaminated sediments, but pointed out that the fish are still prevalent in contaminated habitats.

Estuarine sediments are a sink for hydrophobic toxicants, and spot that live in chronically contaminated estuaries can exhibit changes in biotransformative or antioxidant enzyme levels (Roberts & Sved 1987) or decreases in phagocytic activity (Weeks & Warriner 1984). Although contaminant body burdens were not measured in the current study, there is experimental evidence that copepods exposed to pesticides accumulate the contaminants and transfer them to spot predators, resulting in a decrease in brain acetylcholinesterase levels in the spot (DiPinto 1996). Copepods can also transfer sediment-associated PCBs to juvenile spot predators (DiPinto & Coull 1997). Assuming metals and PAHs can be trophically transferred in a similar fashion, then fish, such as spot, that are effective at foraging in contaminated sediments could be at risk. Because spot take bites of sediment, they can accumulate more toxicants from the sediment directly than from contaminated prey in the sediments (DiPinto 1996, DiPinto & Coull 1997, Gregg et al. 1997). Despite the potential for the negative effects of exposure to sediment toxicants, juvenile spot actively fed on meiofauna and the associated sediments from our contaminated tidal creek.

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