A Diver-Operated Sled for Sampling the Epibenthos

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Research and Resource Services
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October 1977

Fisheries & Marine Service Technical Report No. 738

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Fisheries and Marine Service

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Cat. no. Fs 97-6/738 ISSN 0701-7626

ABSTRACT

Sibert, J., B. A. Kask, and T. J. Brown. 1977. A diver-operated sled for sampling the epibenthos. Fish. Mar. Serv. Tech. Rep. 738: 19 p.

A diver-operated epibenthos sampler is described and tested. It is concluded that the device samples the fauna within 10 cm of the sediment water interface effectively and without bias with respect to taxa or location. Sampling is sufficient to detect differences in population densities. Comparisons are made with core samples. The "hyperbenthos" concept is discussed.

Key words: meiofauna: epibenthos, hyperbenthos, copepods, sampling.

RÉSUMÉ

Sibert, J., B. A. Kask, and T. J. Brown. 1977. A diver-operated sled for sampling the epibenthos. Fish. Mar. Serv. Tech. Rep. 738: 19 p.

Les auteurs donnent la description d'un échantilloneur de l'épibenthos, actionné par un plongeur, et le compte rendu de sa mise à l'essai. Ils concluent que l'appareil est en mesure de recueillir des échantillons de la faune à moins de 10 cm de l'interface entre les sédiments et l'eau sans que les données relatives aux taxa et à leur habitat soient faussées. L'échantillonnage suffit à déceler des différences de densité de population. Les auteurs établissent des comparaisons avec des prélèvements de carottes et abordent le concept de l'"hyperbenthos."

Mots-clés: méifaune, épibenthos, hyperbenthos, copépods, échantillonnage.

INTRODUCTION

During 1975-1976 a study was conducted of the meiofauna collected by benthic cores in the intertidal zone of the Nanaimo River Estuary (Kask and Sibert 1976). The purpose of the study was to estimate the productivity of the dominant harpacticoid copepods in the diets of juvenile salmonids. The results suggested that either the species utilized by the fish were not sampled adequately by the cores or that fish were feeding very selectively. Vagile meiofauna species living just above the sediment water interface might easily evade a coring device.

Design and testing of a new epibenthic sled sampler was undertaken. This new device should sample the water close to the bottom and should be sufficiently small and light to be operable by a SCUBA diver.

MATERIALS AND METHODS

The sled is illustrated in Fig. 1. Light-weight aluminum (2 mm gauge) was used to construct both the sampling box and the runner on which it rides. The mouth of the sampler is 10 cm square widening to a box 20 cm wide × 10 cm deep × 30 cm long, intended to reduce back pressure. The runner is constructed of a piece of sheet metal, 28 cm wide and 39 cm long. To prevent the sled from digging into the sediment, the runner is curled at the front. The triangular supporting struts, also of aluminum, are 10 cm high and slotted. The sampling box is attached to the support struts with bolts and wing nuts so as to allow adjustment of both height and angle in the sampling plane. A 100 μ mesh plankton net, approximately 90 cm long and fitted with a 100 μ codend, is tied over the back end of the sampling box. Under water, when being pushed by a diver, the net streams out behind the sampler and does not require a support frame. A plastic plate, with 100 μ mesh in the centre is used to form a covering for the mouth of the box. This is held in place by the diver when the sampler is under water but not in use. For removal of the sample, the sled is returned to the boat and the codend of the net unscrewed.

Testing of the sled was carried out on three occasions at high tide on the Nanaimo Estuary. After selecting a suitable site, a 100-m rope, marked out in 5-m intervals, was stretched across the tidal flat from a boat. Weights were attached at each end of the rope and buoys fastened to mark the rope's position. With the cover held over the mouth, the diver descended to the first transect, removed the mouth cover and swam the 5 m, pushing the sled ahead. The mouth was then re-covered with the 100 μ screen, allowing the contents of the sled and net to be flushed into the bucket while the diver ascended to the waiting boat. The first catch was removed and the diver repeated the process on nine alternate 5-m sections for a total of 10 replicates in a 100-m transect line.

In the laboratory, the samples were preserved in 10% formalin and rose bengal. Repeated decantation through a 44 μ sieve resulted in separation of organisms from the sediment and debris which occasionally occurred in the samples. Samples containing more than 500 animals were subsampled using a Folson splitter. After counting the samples on a dissecting microscope, the harpacticoid and calanoid copepods were identified to species.

For the August samples, the species were counted to a sum of 100 animals of all species and a correction factor was applied to bring the individual counts to the total for that sample. No species counts were made in April.

RESULTS AND DISCUSSION

Locations of the three series of sled tows are illustrated in Fig. 2. The first transect on 6 April (Table 1) was oriented parallel to the axis of the estuary while the latter two, on 18 May and 17 August (Tables 2, 3) were normal to the axis of the estuary. Although attempts were made to choose a uniform area, the first series passed from a sand bottom to a sparse eelgrass bed. The second and third series were located over a predominantly sand bottom and were more uniform from start to finish. Counts were transformed by adding 1 and taking the common logarithm. The replicate 5 m transects were divided into an odd numbered group and an even numbered group. The results of the two-way analyses of variance are shown in Table 4. The taxon main effect was significant ($P<.001$) reflecting the differences in abundance of the various taxa found in the samples (cf. Tables 1-3). The interaction was non-significant ($P>0.1$) suggesting that the sled sampled all taxa consistently and without a location bias. In two cases, there was no significant difference between the odd and even numbered replicates. These results indicate that the sled samples adjacent, and presumably similar, areas consistently. In one case, April, the odd/even taxon main effect was marginally significant ($0.025<P<0.05$), but this transect was oriented differently from the other two and terminated in an eelgrass bed.

For the second test, the samples were divided into a first group (1-5) and a second group (6-10). The results of the two-way analyses of variance are shown in Table 5. Again all taxon main effects were highly significant and none of the interactions were significant. On two occasions, the first/last main effects were significant and on one occasion (May) they were not.

For the third test, taxa common to the three sets of data were selected. The results of the two-way analysis of variance are shown in Table 6. As in the previous analysis the taxon main effects were significant and none of the interactions were significant. The differences due to month were significant at the 2.5% confidence level.

These results suggest that the diver-operated sled sampled the epibenthic meiofauna consistently with respect to taxa in different locations or at different times of year. Further the sampling was sufficiently sensitive to detect both spatial and temporal differences when they existed.

Cores were not taken at the same time as the sled trials making direct comparisons impossible. Indirect comparisons can be made using data from cores taken in the same general area during the previous year (Kask and Sibert 1976). Table 9 compares the average number of harpacticoids per 10 cm^2 of sediment surface captured by the sled in 1976 and by cores in 1975. The differences are significant at $P<.002$ using a Mann-Whitney U Test (Siegel 1956). Other taxa show similar large differences. Clearly only a small fraction of the animals per unit area of sediment are accessible to the sled.

In spite of this apparent low accessibility, the numbers of animals per unit volume of water is quite substantial. The maximum harpacticoid density was 94080 m^{-3} and the average density was 9240 m^{-3} or between about 9 and 94 animals per ℓ within 10 cm of the sediment surface. Furthermore, the sled caught taxa not caught by the cores. For instance, calanoid copepods and barnacle nauplii were present in the sled samples in densities up to 15300 animals m^{-3}, but were absent from the cores. The species composition (Table 7, 8) of the harpacticoid population is different also. Harpacticus sp., Tisbe sp. and Heterolaophonte littoralis occur frequently in the sled samples but are not well represented in the cores. Harpacticus sp. is the dominant harpacticoid found in salmon stomachs.

Several authors have reported on the design (Russel 1928; Bossanyi 1951; Wickstead 1953; Frolander and Pratt 1962; Macer 1967) and use (Beyer 1958; Bossanyi 1957; Macer 1967; Crandell 1967; Hesthagen 1973; Boysen 1975) of similar devices aboard ship in deeper water. To our knowledge a diver-operated epibenthic sampler has not been previously described in the literature.

Beyer (1958) suggested that the assemblage of planktonic and epibenthic organisms found very near the bottom be called "hyperbenthos." Hesthagen (1973) concluded diel migrations from the bottom into the water column and light conditions are major factors in the ecology of the hyperbenthos. He also concluded that the hyperbenthos is an important link in the food web of demersal fishes. Anger and Valentin (1976) have questioned the reality of the hyperbenthos on the basis that sampling by ship-born epibenthic sleds is too crude, therefore, unrepresentative of the natural situation. A diver-operated device eliminates many of these objections because both penetration of the sampler into the sediment and patches of algae and detritus can be avoided.

The data presented here do not support the concept of a unique near-bottom community containing a characteristic assemblage of species. The calanoid species represented in our samples are typically euryhaline and are generally found in estuarine waters. Their abundance may reflect habitat preferences near the bottom in estuarine environments. The harpacticoid copepods fall into two groups, infaunal and epifaunal, with the epifaunal species predominating.

ACKNOWLEDGEMENTS

We wish to thank Barbara Windecker for her assistance in collecting and counting the samples, and for identifying the copepods taken in the tows.

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Table 1. Numbers of individuals per 5 m sled tow, (0.5 m^2, 0.05 m^3), 6 April 1976.

ABBREVIATIONS:

Harp. = adult harpacticoid copepods and copepodites
Copepod naup. = copepod nauplii
Nema. = nematodes
Worms = micro-annelids (naideae, capitellidae)
Amph. = amphipods (primarily gammaridae)
Cumac. = cumaceans
Bivalves = micro pelecypods
Ost. = ostracods
Cal. = calanoid copepods
Barn. naup. = cirridede nauplii
Larval dec. = decapod larvae
Tun. = tunicates (Oikopleura sp.)
Acar. = acarina
Ecto. = ectoproct cyphonautes larvae
Gast. = gastropod
Gast. egg = gastropod egg
Barn. cypris = cirripede cypris
Euph. = euphausia
Echin. larvae = echinoderm larvae

Sample no.	Harp.	Copepod naup.	Nema.	Worms	Amph.	Cumac.	Bivalves	Ost.	Cal.	Barn. naup.	Larval dec.
1	899	2569	1059	74	10	1	2	5	78	93	5
2	73	110	25	8	2		2	1	124	77	2
3	51	165	42	19	1		2	1	223	110	2
4	47	174	30	41			1		217	152	6
5	39	172	26	32					223	236	1
6	93	181	53	13					97	78	1
7	286	320	186	48	2		1	1	188	253	2
8	208	534	67	107	1		1	1	468	512	1
9	4704	9192	152	32	152		16	16	304	344	
10	1556	1464	224	92	8	4			400	508	

Larval fish	Fish egg	Tun.	Acar.	Ecto.	Gast.	Gast. egg	Barn. cypris	Euph.	Echin. larv.
11	2	2	1	2					
2				6	1				
		4		3	3				4
		7		3	3				
		8		7	3				3
		3		2	7	1	1		2
		4		6	10				2
		17		11	17			1	5
					32				
		24		4	16				4

Table 2. Numbers of individuals per 5 m sled tow, 18 May 1976. Abbreviations as in Table 1.

Sample no.	Harp.	Copep. naup.	Nema.	Worms	Amph.	Cumac.	Medusae	Ost.	Cal.	Barn. naup.	Larval dec.	Mysid	Tun.	Acar.	Gast.	Gast. egg
1	174	81	7	2	4		2	3	127	32		17	4			
2	99	181	73	13	1	6			112	31	1	21	11	2	4	
3	108	257	42	8	4	1			72	35	1	2	51		3	1
4	264	101	32	12	4	1		1	767	5		32	2			1
5	948	993	3541	623	2	22			122	9		3				2
6	277	348	172	27	1	6			382	1		15	4			1
7	193	167	68	30	1	1		1	135	10		5	7			3
8	149	754	142	73	3	9			129	20		7	8			1
9	240	396	59	14	1	13			588	14		3	15			2
10	214	525	32	16	1	2		1	434	14		14	8			2

Table 3. Numbers of individuals per 5 m sled tow, 17 August 1976. Abbreviations as in Table 1.

Sample no.	Harp.	Copepod naup.	Nema.	Worms	Amph.	Cumac.	Medusae	Bivalves	Ost.	Cal.	Barn. naup.
1	450	374	634	12	3	3	10	17	3	206	150
2	1070	1180	1945	110	4	20	15	19	6	467	265
3	202	229	297	45	1	4	4	8		93	59
4	233	500	444	14	5	3	4	3	2	239	75
5	159	273	79	6	3		14	3		264	45
6	461	395	1042	5		2	2	4	1	129	17
7	408	238	455	10	2		4	4	1	166	57
8	161	262	135	9	3	1	3	1		287	30
9	36	255	104	2			6			189	46
10	70	46	60	2			2	4		34	7

Sample no.	Mysid	Tun.	Acar.	Ecto.	Gast.	Gast. egg	Barn. cypris	Echin. larv.	Isopod
1	1	9	107	1	4		7		
2	1	22	101	10	8	11	20		1
3		9	12	1	1	3	34		1
4		11	4	1	3	1	25		
5	1	19	2	6	1	1	5		1
6		2	1	4	1	3	7	1	
7		5	2			9	5		
8					1	2	1		1
9		17		4	1	15		1	
10		3				1			

Table 4. Analyses of variance to test odd and even replicates.

Source	D.F.	Mean square	F	Significance
		Date: 6 April 1976		
Odd/even	1	1.62831	5.719	.025<P<.05
Taxon	9	8.20395	28.813	P<.001
Interaction	9	0.09859	0.346	.1<P
Error	80	0.28473		
Total	99	1.00131		
		Date: 18 May 1976		
Odd/even	1	0.00671	0.036	0.1<P
Taxon	9	6.70785	36.247	P<.001
Interaction	9	0.10947	0.592	0.1<P
Error	80	0.18506		
Total	99	0.76937		
		Date: 17 August 1976		
Odd/even	1	0.00500	0.020	0.1<P
Taxon	9	5.66543	22.336	P<.001
Interaction	9	0.09048	0.357	0.1<P
Error	80	0.25364		
Total	99	0.72828		

Table 5. Analyses of variance to test first and last replicates.

Source	D.F.	Mean square	F	Significance
		Date: 6 April 1976		
First/last	1	2.67046	9.905	.01<P<.025
Taxon	9	8.20395	30.428	P<.001
Interaction	9	0.11711	0.434	0.1<P
Error	80	0.26962		
Total	99	1.00131		
		Date: 18 May 1976		
First/last	1	0.00705	0.038	0.1<P
Taxon	9	6.70785	35.743	P<.001
Interaction	9	0.08623	0.459	0.1<P
Error	80	0.18767		
Total	99	0.76937		
		Date: 17 August 1976		
First/last	1	6.36156	39.453	P<.001
Taxon	9	5.66543	35.136	P<.001
Interaction	9	0.20553	1.275	0.1<P
Error	80	0.16124		
Total	99			

Table 6. Analysis of variance testing differences between 6 April, 18 May, and 17 August counts.

Source	D.F.	Mean square	F	Significance
April/May/August	2	1.13144	5.995	$0.01 < P < 0.025$
Taxon	9	23.84769	126.365	$P < 0.001$
Interaction	18	0.60673	3.215	$0.1 < P$
Error	270	0.18872		
Total	299	0.93233		

Table 7. 18 May 1976 sled samples Nanaimo Estuary copepod counts by species.

Sample no.	Harpacticoids															Calanoids								
	Total harpacticoids	Harpacticus sp.	Dactylopodia sp.	Tisbe sp.	Tachidius discipes	Microarthridion littorale	Huntemannia jadensis	Amphiascus sp.	Family Ectinosomidae	Mesochra pygmaea	Nitocra spinipes armata	Heterolaophonte sp.	Unidentified adult	Unidentified copepodite	Total calanoids	Eurytemora hirundoides	Oithona sp.	Centropages sp.	Eucalanus bungii bungii	Pseudocalanus minutus	Acartia sp.	Calanus plumchrus	Unidentified
1	174	101	5	10	7	14	1	2	1				7	26	127	82	20	1					24
2	99	20	1	5	19	17	9	1	6				3	18	112	55	30		3	1			23
3	108	8		1	39	17	8		3				2	30	72	24	36	1					11
4	264	4	1	6	59	27	14	2	9	2			3	137	767	750	8		3		6		
5	948	7		6	247	358	78	6	38	3	1		3	201	122	109	3					1	9
6	277	1	1	4	93	88	9		9	3		1	5	63	382	318	26		5				33
7	193	6		5	78	11	10			1			12	70	135	111	19		2				3
8	149	6		3	53	24	33	1	3				1	25	129	77	21						31
9	240	2		1	85	27	20		6				2	97	588	531	24		2				31
10	214	9		4	100	8	8		1			1	5	78	434	397	14	1	3				19

Table 8. 17 August 1976 sled samples Nanaimo Estuary copepod counts by species.

	Harpacticoids													
Sample no.	Total harpacticoids	Harpacticus sp.	Dactylopodia sp.	Tisbe sp.	Tachidius discipes	Microarthridion littorale	Huntemannia jadensis	Amphiascus undosus	Family Ectinosomidae	Mesochra sp.	Nitocra spinipes armata	Heterolaophonte littoralis longisetigera	Parastenhelia hornelli	Paraleptastacus spinicauda
1	450		31.5	4.5	72.0	9.0	4.5		40.5	90.0		175.5	9.0	
2	1070	10.7	10.7		117.7	10.7	32.1	74.9	117.7	53.5		139.1	203.3	
3	202		2.0	2.0	60.6	4.0	16.1	6.1	28.3	20.2		14.1	28.3	
4	233	4.7	41.9		48.9		11.6	2.3	30.3	2.3		4.7	44.3	
5	159		1.6		49.3		3.2	1.6	63.6	3.2			20.7	4.7
6	461				73.8	4.6	9.2	4.6	248.9	13.8			32.3	9.2
7	408	4.1	12.2		81.6		57.1		159.1		4.1		57.1	12.2
8	161	1.6		1.6	51.5		8.1		53.1	1.6			8.1	4.8
9	36			1.0	14.4		2.1		10.3	1.0			2.1	1.0
10	70		2.0		32.0		2.0	2.0	16.0	2.0		1.0	4.0	

Table 8 (cont'd)

Sample no.	Harpacticoids							Calanoids						
	Ameira minuta	Amonardia normani	Paralaophonte congenera congenera	Amphiascoides neglectus	Heterolaophonte capillata	Cyclopoid	Unidentified copepodite	Total calanoids	Eurytemora americana	Oithona sp.	Acartia clausi	Oncaea sp.	Corycaeus sp.	Unidentified copepodite
1							13.5	206	4.1	105.0		2.1		94.8
2		21.4	74.9	10.7			192.6	467	6.7	293.5				166.8
3		2.0	8.0				10.1	93	3.7	35.3		3.7		50.2
4		4.7	4.7			7.0	25.6	239	26.3	122.0		12.0		79.0
5	1.6		3.2		1.6		4.8	264	2.6	148.0	2.6			111.0
6							64.5	129	7.7	67.1		5.2		49.0
7		8.2					12.2	166	21.6	81.3		5.0		58.1
8		9.7	3.2			11.3	6.4	287	60.3	97.6		5.7		123.4
9	1.0					1.0	2.1	189	26.5	92.6	1.9	5.6		62.4
10							9.0	34	3.4	21.5		1.1	1.1	6.8

Table 9. Comparison of the numbers of harpacticoids per 10 cm^2 of sediment sampled by sled in 1976 and cores in 1975. The core data are from Kask and Sibert 1976. Numbers in brackets indicate standard error, sample size, and station.

Date	Sled	Cores
April	1.59	10.0 ($\pm$3.7, n=3, Stn. 10)
May	0.53	61.7 ($\pm$20.8, n=5, Stn. 7)
August	0.65	61.7 ($\pm$20.0, n=5, Stn. 7)

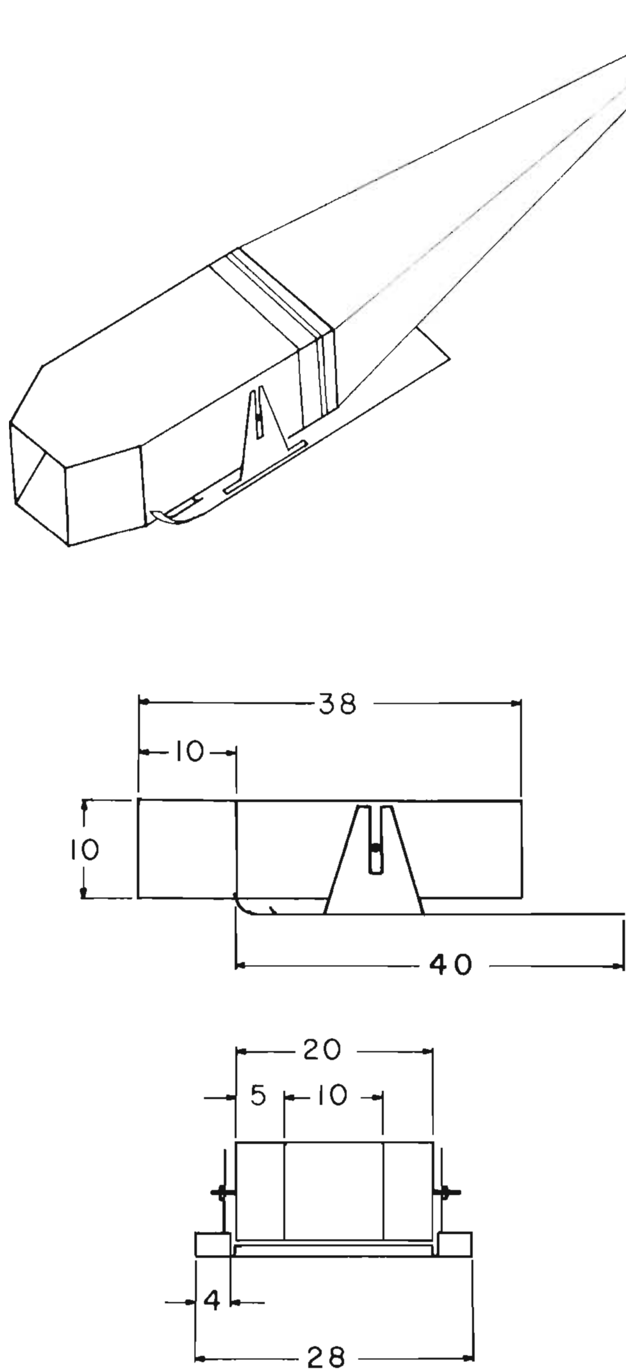

Fig. 1. A diver operated epibenthic sled. Dimensions in centimeters.

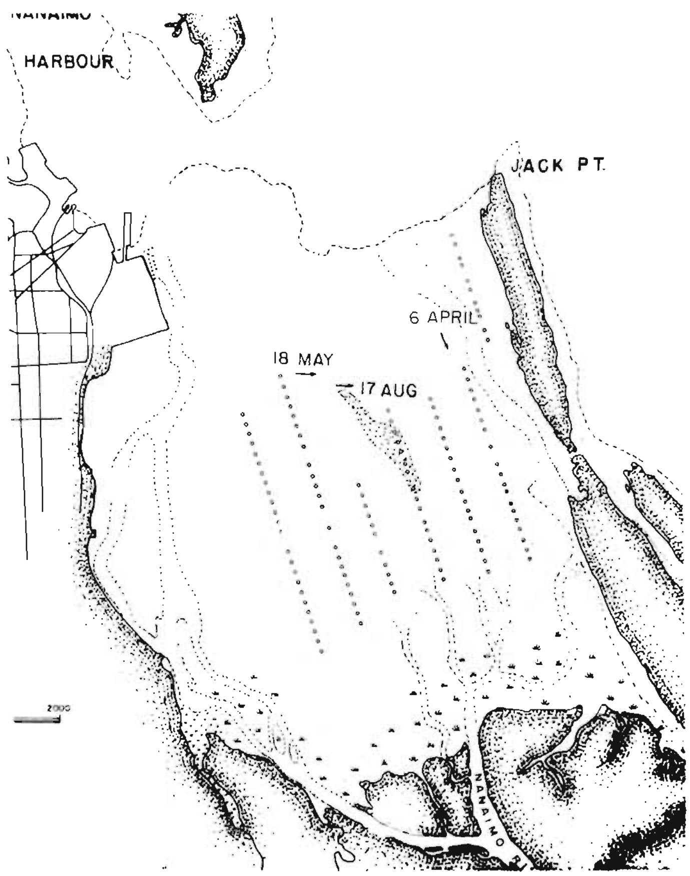

Fig. 2. Location of the three transects sampled on the Nanaimo River Estuary. Location and direction of transects indicated by arrows.