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by

Victor I. Golini

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May 1979

DEPARTMENT OF FISHERIES AND ENVIRONMENT
PROCESS RESEARCH DIVISION, NATIONAL WATER RESEARCH INSTITUTE
CANADA CENTRE FOR INLAND WATERS, BURLINGTON, ONTARIO

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Contents Subject to Modification

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INTRODUCTION

This study was designed to provide some knowledge of the taxonomic composition and relative abundance of benthic invertebrates from selected harbour habitats of Lake Ontario and Lake Erie subjected to dredging practices. Historically, the harbours and channels of the Great Lakes have been dredged rather regularly as a necessary prerequisite for efficient navigation. Sediments in some harbours and navigation channels are estimated to accumulate up to 60 cm annually, and this sediment must be removed in order to maintain an economically optimum carrying capacity of large vassels (Anon 1975). However, the necessity of dredging creates the problem of disposing safely the dredged material. Most of this material has usually been deposited out in the open lake in designated disposal areas, selected to avoid interference with beaches and potable water intakes. But redeposition of dredged sediment in the open water of lakes is generally recognized to cause resuspension of certain undesirable chemicals (Lee and Plumb 1974). Some of these chemicals, as phosphorus and nitrogen, enhance the growth of phytoplankton which contributes to hypolimnetic oxygen depletion as excessive volumes of algae accumulate and decompose on the lake bottom (Vollenweider 1968; Rao 1973; Vallentyne 1974). Ultimately, benthic invertebrates which under aerobic conditions normally regenerate organic matter settling to the bottom may also be adversely affected. Under the resulting anaerobic conditions, presence of chemical contaminants and presence of increasing amounts of suspended solids, the process of regeneration by the remaining benthic organisms is usually slower, incomplete and generally contributes to further ecological deterioration of the affected bodies of water (Lee and Plumb 1974).

MATERIALS AND METHODS

Benthos samples were taken from Hamilton Harbour in January and May 1978 and Oshawa Harbour, Whitby Harbour Lake Ontario, Wheatly Harbour and Port Stanley Lake Erie in May 1978. The sediment samples were taken with a mini-shipek with a bucket opening of 15 cm by 11 cm and a benthos corer of 10 cm diameter. The surface samples consisted each of one shipek bucket of sediments, while each benthos core taken at selected areas was sectioned usually at 1 cm interval. Each sample was washed over a bronze sieve with a screen of 100 mesh/cm to separate the invertebrates which were then preserved in 10% formalin. The invertebrates from each collection were subsequently sorted with fine forceps and the aid of a low power binocular microscope, separated and counted into major taxonomic groups according to Pennak (1953). The invertebrates of each group were preserved separately in appropriately labled glass vials with 10% formalin. A portion of the oligochaetes and chironomid larvae from four samples from Hamilton and Oshawa Harbours and three samples from Port Stanley and Whitby harbours were subsequently identified to the lowest possible taxonomic level.

For identification, specimens of oligochaetes were taken randomly from each sample, dehydrated by serial transfer from formalin into 60% to 95% to 100% ethanol and cleared in xylene. Each specimen was then mounted in Canada balsam on glass slides and the slides appropriately labled. The chironomid larvae were cleared in 35% KOH, passed through glacial acitic acid and dehydrated in 95% ethanol. Each chironomid specimen was then mounted with the head capsule separated from the rest of the larva under the same cover slip in Canada balsam on glass slides. The prepared specimens were identified with a Leitz Ortholux compound microscope, employing high magnification oil objective when required and the aid of relevant taxonomic keys: for the oligochaetes Brinkhurst et al (1968), Brinkhurst and Jamieson (1971) and Brinkhurst (1976); for the chironomids Mason (1968), Hilsenhoff (1975) and Oliver et al (1978).

RESULTS

The major taxa and absolute numbers of benthic invertebrates sorted from the various samples are listed in Table 1. The total numbers and percentage composition of these invertebrates are summarized in Table 2. To determine the relative density of invertebrates/m^2 from each sample in Table 1, the absolute number of each taxon from surface samples is devided by 0.02 m^2, the surface area of the mini-shipek bucket gape, and for benthos core sections the absolute number is devided by 0.008 m^2, the surface area of the benthos core opening. A total of 7191 invertebrate specimens were sorted from all the sampled habitats, comprising 60.4% oligochaetes, 29.4% nematodes, 6.0% copepods, 3.3% chironomids, 0.4% molluscs and 0.4% other taxa (Table 2). The other taxa consisted of few ostracods and cladocera ephippia from Hamilton Harbour, two small leeches and one coleoptera larva from Oshawa Harbour, and several ceratopogonid larvae primarily from Port Stanley. The seven oligochaetes found in the surface sediment sample from the disposal area in Hamilton Harbour in May were all in the cocoon stage. Generally, the oligochaetes predominated at over 90% of the sampled invertebrates in nearly all the sampled habitats, ranging from 42.8% in Oshawa Harbour to 100% in Whitby Harbour. The exceptionally low proportion of oligochaetes in the surface sediments of Oshawa Harbour was offset by the nematodes where they reached the highest proportion with 56.5% of the sampled invertebrates. In the remainder of the sampled habitats the nematodes occurred in relatively low concentration, but they appeared to increase in less eutrophic biotopes away from the harbour, 1 km south of Port Stanley where nematodes comprised 15.7% of the sampled invertebrates. The nematodes consisted almost of free-living rhabtitoids, except for a total of eight mermithids, probably Hydromermis spp., six from Oshawa Harbour and two from Port Stanley.

The scarcity of invertebrates in benthos cores below 10 cm sections indicates that these invertebrates occur essentially on the sediment surface. The larger proportion of oligochaetes relative to nematodes in the 40-cm core section from Oshawa Harbour indicates that oligochaetes tend to burrow deeper into the sediments. However, in Hamilton Harbour nematodes were found 10 cm below the sediment surface, while the oligochaetes ceased to occur below 5 cm of sediment. Both sphaeriids and gastropods occurred in relatively low concentration and consisted essentially of *Pisidium* sp. and *Physa* sp. respectively, including one shell of *Valvata tricarinata* found in the 10-cm core section from Oshawa Harbour. Since nearly 100% of the invertebrates from the benthos core from Hamilton Harbour were found in the first 9 cm of sediments, the results in Table 1 are shown only to the 12-13 cm section. Analysis of the remaining 1-cm sections down the entire 54 cm core length revealed no invertebrates, except two shells of *Physa gyrina* Say and eight ostracods in the 52-53 cm section, and ten ostracods and one vertebra from fish spinal chord at the 53-54 cm section. The benthos core from Hamilton Harbour revealed also a profuse concentration of semi-decomposed chips of wood together with the remains of cladocera carapaces from the 8-9 cm down to the 53-54 cm sections. Large volumes of the blue-green alga *Microcystis* were found in all the January surface sediment samples from Hamilton Harbour; some samples contained exclusively dense concentrations of *Microcystis* which was found also in the benthos core in decreasing volumes down to the 7-cm section. In the surface sediment samples of May from Hamilton Harbour *Microcystis* became relatively scarce, being repalced by large number of harpacticoid copepods which dominated in the benthos of this eastern section of Hamilton Bay. In this habitat copepods comprised 81.7% of the sampled invertebrates and 99.3% of the copepods from all the sampled habitats; the oligochaetes comprised 12.2% which included seven specimens in the cocoon stage from the disposal area.

Although the chironomids occurred in relatively low numbers, they were found frequently in surface sediment samples and within the first 10 cm of the core samples. Most of these chironomid larvae belonged to the subfamily Tanypodinae which occurred down to 7 cm into the sediments; the two chironomids in the 15-20 cm core section from Whitby swamp were large larvae of *Chironomus plumosus*. The identification of chironomid larvae from surface sediment samples of the four harbours shown in Table 3 indicate that *Procladius* is the dominant genus in three of the four harbours. Oshawa Harbour, unlike the others, has the most diverse fauna comprising five of the identified six genera of chironomids, dominated by *Orthocladius* sp. and followed by *Psectrotanypus* sp. and by equal proportions of *Procladius* sp., *Diplocladius* sp. and *Parachironomus* sp. The other genus, *Stictochironomus* sp., was found only at Port Stanley.

The oligochaetes selected randomly for identification comprised about 21% of the total number from collections with more than 100 specimens, while most or all of the specimens from smaller collections were identified. The majority of the identified oligochaetes (Table 3) lacked specific diagnostic characters, thus limiting their identity to the level of Tubificidae without hair setae. These oligochaetes were placed in the genus Limnodrilus spp. since they resembled most closely specimens which keyed out to species belonging to this genus. Limnodrilus spp. represented 63.5% of the oligochaetes from Hamilton Harbour where five species were identified, dominated by 17.9% L. hoffmeisteri Claparede and followed by nearly equal proportions of L. cervix Brinkhurst, L. claparedeianus Ratzel, L. profundicola (Varril) and Tubifex cf. tubifex (Muller). A similar oligochaete fauna occurred in Port Stanley Harbour represented by 67.6% Limnodrilus spp. and seven identified species dominated by 12.1% L. hoffmeisteri, and including 6.1% Potamothrix vejdovskyi (Harbe) and the single record of the naid Vejdovskyella intermedia (Bretscher). The oligochaete fauna of Oshawa and Whitby Harbours was found to be rather similar with six and seven identified species respectively, and with nearly half the percentage, 35% to 38%, of Limnodrilus spp. compared to the other two harbours. Peloscolex multisetosus was recorded only from these two harbours; in Whitby Harbour it was the dominant species at 22.4%, followed by Potamothrix vejdovskyi at 15.5%. In Oshawa Harbour Tubifex cf. tubifex was the dominant species at 38.9%, followed by P. multisetosus at 13.0%. Potamothrix moldaviensis Vejdovskyi and Mrazek was recorded only from Whitby Harbour.

DISCUSSION

The benthic invertebrate fauna from the sampled habitats was found in general dominated by oligochaetes, as expected from numerous related studies (Brinkhurst 1967, 1970; Johnson and Matheson 1968; Johnson and Brinkhurst 1971). However, the oligochaetes along the north-eastern shore of Hamilton Bay were found dominant in January but not in May when the copepods became the most abundant group. The presence of significant number of oligochaete cocoons from this site in May indicates that differences in relative abundance of the major taxa may be influenced by life-cycle patterns in addition to abiotic factors. Hence, sampling the various habitats simultaneous in May was justified in order to eliminate the seasonal influence in the abundance pattern of these invertebrates.

The predominance of oligochaetes in harbour sediments may be related to abiotic factors (Johnson and Matheson 1968), although Brinkhurst (1964) considered in a review of several hypotheses that the abundance of oligochaetes may be influenced by total organic matter in the sediments. The oligochaete fauna in this study was found to be predominated essentially by Limnodrilus spp., although the species dominance varied among Limnodrilus hoffmeisteri, Peloscolex multisetosus and Tubifex cf. tubifex depending on the harbour habitat. The identification of oligochaetes to species, and often to generic level, is based mainly on characters of the sexual organs found primatily in mature specimens. Both immature and post-adult specimens normally lack these diagnostic features (Brinkhurst, pers. comm.) which limit their identity to some particular taxon above the species level. Among some mature specimens, however, there were some specimens of closely related species which were difficult to separate definitively into one species, e.g. L. claparedeianus and L. maumensis Brinkhurst and Cook, L. hoffmeisteri and L. profundicola. Also Tubifex tubifex and Iliodrilus templetoni (Southern) are quite similar in the immature stages and are difficult to separate with confidence. With the exeption of Tubifex cf. tubifex, only five cases of closely related species or even possible hybrids, were among the analysed samples of Limnodrilus spp.; in such cases the specimen was placed in either one or the other species.

Among the sampled harbours, only Oshawa harbour was dominated by nematodes with a percentage composition similar to that of the shallow zone (10-35m) of Lake Ontario (Golini 1979). The greater species diversity and abundance of benthic invertebrates in the littoral and sublittoral zone of the lake may be adversely affected if dredged sediments are disposed indiscriminantly in this zone. The disposal area in Hamilton Harbour is one example illustrating both how impoverished is the benthic fauna relative to disposal of dredged sediments at this site, and how maintaining these sediments in confined areas helps to minimize adverse effects on benthic invertebrates of adjacent areas.

TABLE 1. NUMBER OF BENTHIC INVERTEBRATES FROM SURFACE SEDIMENTS AND BENTHOS CORE SECTIONS SAMPLED IN 1978 FROM VARIOUS HARBOUR HABITATS FROM LAKE ONTARIO AND LAKE ERIE.

Invertebrates	HAMILTON HARBOUR																								
	Surface samples Jan.								May					Benthos core sections in cm											
	1	2	3	4	5	6	7	8	1	2	3	4	D*	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13
Nematoda	0	0	0	0	0	0	0	0	3	7	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0
Oligochaeta	16	9	10	5	44	205	207	137	17	12	6	22	7	40	0	7	4	0	0	0	0	0	0	0	0
Crustacea																									
Asellus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pontoporeia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copepoda	0	0	0	0	0	0	0	0	270	25	4	130	0	0	0	0	0	0	1	0	0	0	0	0	0
Mollusca																									
Sphaeriidae	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomidae	6	0	6	15	11	7	11	10	5	0	4	0	0	1	0	2	0	0	1	0	0	0	0	0	0
Other Taxa	0	0	0	0	0	0	0	0	9	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Disposal area

TABLE 1. NUMBER OF BENTHIC INVERTEBRATES FROM SURFACE SEDIMENTS AND BENTHOS CORE SECTIONS SAMPLED IN 1978 (cont.) FROM VARIOUS HARBOUR HABITATS FROM LAKE ONTARIO AND LAKE ERIE.

Invertebrates	OSHAWA HARBOUR													
	Surface samples										Core sections in cm			
	1	2	3	4	5	6	7	8	9	10	0–5	5–10	10–15	35–40
Nematoda	1	58	0	1	910	34	930	94	10	24	4	0	0	0
Oligochaeta	3	233	192	281	21	5	153	403	256	15	102	4	3	4
Crustacea														
Asellus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pontoporeia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copepoda	0	0	0	0	1	0	0	0	0	0	2	0	0	0
Mollusca														
Sphaeriidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	0	0	0	0	1	2	0	0	0	0	0	1	0	0
Chironomidae	5	0	2	2	3	0	2	0	1	2	0	0	0	0
Other Taxa	1	1	0	0	0	0	0	0	0	5	0	0	0	0

TABLE 1. NUMBER OF BENTHIC INVERTEBRATES FROM SURFACE SEDIMENTS AND BENTHOS CORE SECTIONS SAMPLED IN 1978 (cont.) FROM VARIOUS HARBOUR HABITATS FROM LAKE ONTARIO AND LAKE ERIE.

	WHITBY HARBOUR							
Invertebrates	Swamp core sections in cm					Core #10 sections in cm		
	0-5	5-10	10-15	15-20	20-40	0-5	5-10	10-15
Nematoda	0	0	0	0	0	0	0	0
Oligochaeta	5	2	1	0	0	54	5	2
Crustacea								
Asellus sp.	0	0	0	0	0	0	0	0
Pontoporeia sp.	0	0	0	0	0	0	0	0
Copepoda	0	0	0	0	0	0	0	0
Mollusca								
Sphaeriidae	0	0	0	0	0	0	0	0
Gastropoda	0	0	0	0	0	0	1	0
Chironomidae	0	0	0	2	0	0	0	0
Other Taxa	0	0	0	0	0	0	0	0

TABLE 1. NUMBER OF BENTHIC INVERTEBRATES FROM SURFACE SEDIMENTS AND BENTHOS CORE SECTIONS SAMPLED IN 1978 (cont.) FROM VARIOUS HARBOUR HABITATS FROM LAKE ONTARIO AND LAKE ERIE.

Invertebrates	WHEATBY HARBOUR											WHEATLEY HARBOUR		
	Surface samples											Surface samples		
	1	2	3	4	5	6	7	8	9	10	Industrial Ck mouth	3	4	5
Nematoda	0	3	0	0	1	0	0	0	0	0	0	0	0	0
Oligochaeta	9	26	8	32	48	6	26	9	22	82	112	21	56	141
Crustacea														
Asellus sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Pontoporeia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copepoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca														
Sphaeriidae	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	0	9	1	0	1	1	0	0	0	0	0	0	0	0
Chironomidae	0	0	1	5	0	0	0	0	2	0	0	0	0	0
Other Taxa	0	1	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 1. NUMBER OF BENTHIC INVERTEBRATES FROM SURFACE SEDIMENTS AND BENTHOS CORE SECTIONS SAMPLED IN 1978 (cont.) FROM VARIOUS HARBOUR HABITATS FROM LAKE ONTARIO AND LAKE ERIE.

Invertebrates	PORT STALEY HARBOUR									
	Surface samples									
	1	2	3	4	5	6	7	8	9	1 km south Port Stanley
Nematoda	6	0	2	0	0	0	2	0	5	20
Oligochaeta	86	293	195	110	121	37	90	97	162	104
Crustacea										
Asellus sp.	0	0	0	0	0	0	0	0	0	0
Pontoporeia sp.	0	0	0	0	0	0	0	0	0	0
Copepoda	0	0	0	0	0	0	0	0	0	0
Mollusca										
Sphaeriidae	1	2	0	0	0	0	1	0	0	2
Gastropoda	3	2	0	0	0	0	0	0	0	0
Chironomidae	1	0	1	8	9	5	0	0	6	1
Other Taxa	2	0	2	2	1	1	1	0	1	0

TABLE 2. TOTAL NUMBERS AND PERCENTAGE COMPOSITION OF THE MAJOR BENTHIC INVERTEBRATE TAXA FROM THE VARIOUS HABITATS SAMPLED IN 1978 FROM SURFACE SEDIMENTS AND BENTHOS CORE SECTIONS.

Invertebrates	LAKE ONTARIO																				LAKE ERIE							
	Hamilton Harbour						Oshawa Harbour				Whitby Harbour						Industr. Ck Mouth		Wheatly Harbour Surface		Port Stanley				TOTAL	
	Surface I*		Core I		Surface V*		Surface		Core		Surface		Swamp Core		Core #10						Surface		1km S.		All Habitats	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Nematoda	0	0	2	9.1	11	2.1	2062	56.5	4	3.3	3	1.0	0	0	0	0	0	0	0	0	14	1.1	20	15.7	2166	29.4
Oligochaeta	633	90.3	15	62.2	64	12.2	1562	42.8	113	94.2	268	91.2	3	60.0	61	98.4	112	100	218	100	1191	96.0	104	81.9	4344	60.4
Crustacea																										
Asellus sp.	0	0	0	0	0	0	0	0	0	0	1	0.3	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0
Pontoporeia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copepoda	0	0	0	0	429	81.7	1	0.0	2	1.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	432	6.0
Mollusca																										
Sphaeriidae	0	0	0	0	1	0.2	0	0	0	0	1	0.3	0	0	0	0	0	0	0	0	4	0.0	2	1.6	8	0.1
Gastropoda	2	0.3	0	0	1	0.2	3	0.1	1	0.8	12	4.1	0	0	1	1.6	0	0	0	0	3	0.2	0	0	23	0.3
Chironomidae	66	9.4	4	18.2	9	1.7	17	0.5	0	0	8	2.7	2	40.0	0	0	0	0	0	0	30	2.4	1	0.8	237	3.3
Other Taxa	0	0	1	4.5	10	1.9	7	0.2	0	0	1	0.3	0	0	0	0	0	0	0	0	11	0.1	0	0	30	0.4
Total Number	701		22		525		3652		120		294		5		62		112		218		1253		127		7191	
Number of Samples	8		32		5		10		4		10		5		3		1		3		9		1		91	

* I = January
V = May

TABLE 3. NUMBER AND PERCENT COMPOSITION OF OLIGOCHAETES AND CHIRONOMID LARVAE IDENTIFIED FROM SURFACE SEDIMENT SAMPLES FROM SOME HARBOURS OF LAKE ONTARIO AND LAKE ERIE.

Species	LAKE ONTARIO														LAKE ERIE			
	Hamilton Harbour					Oshawa Harbour					Whitby Harbour				Port Stanley			
Station No.:	3	5	7	8	%	3	4	5	9	%	2	4	9	%	2	5	9	%
Oligochaeta																		
Tubificidae																		
Limnodrilus cervix	0	3	3	4	6.9	1	0	0	0	0.9	0	1	0	1.7	1	0	0	1.0
L. claparedeianus	0	4	1	1	4.1	0	0	0	1	0.9	0	1	1	3.5	2	1	0	3.0
L. hoffmeisteri	0	7	7	12	17.9	1	0	1	7	8.3	1	0	5	10.3	7	4	1	12.1
L. profundicola	0	1	2	3	4.1	2	0	0	1	2.8	0	0	0	0	0	1	0	1.0
Potamothrix vejdovskyi	0	0	0	0	0	0	0	0	0	0	0	7	2	15.5	4	2	0	6.1
P. moldaviensis	0	0	0	0	0	0	0	0	0	0	0	1	0	1.7	0	0	0	0
Peloscolex multisetosus	0	0	0	0	0	0	0	0	14	13.0	3	3	7	22.4	0	0	0	0
Tubifex cf. tubifex	1	0	0	4	3.4	18	0	5	19	38.9	1	1	2	6.9	3	1	4	8.1
Limnodrilus spp.	9	29	34	20	63.5	13	0	3	22	35.2	7	8	7	37.9	20	16	31	67.6
Naididae																		
Vejdovskyella intermedia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1.0
Total identified	10	44	47	44	100	35	0	9	64	100	12	22	24	100	37	25	37	100
sampled	10	44	207	137		192	281	21	256		26	32	24		293	121	162	
Chironomidae																		
Tanypodinae																		
Procladius sp.	6	11	7	10	100	0	1	0	0	12.5	0	5	2	100	0	7	4	80.5
Psectrotanypus sp.	0	0	0	0	0	1	0	1	0	25.0	0	0	0	0	0	0	0	0
Orthocladinae																		
Orthocladius sp.	0	0	0	0	0	1	1	1	0	37.5	0	0	0	0	0	0	0	0
Diplocladius sp.	0	0	0	0	0	0	0	1	0	12.5	0	0	0	0	0	0	0	0
Chironominae																		
Chironomini																		
Stictochironomus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	19.5
Parachironomus sp.	0	0	0	0	0	0	1	0	0	12.5	0	0	0	0	0	0	0	0
Total identified	6	11	7	10	100	2	3	3	0	100	0	5	2	100	0	7	6	100
sampled	6	11	11	10		2	3	3	0		0	5	2		0	9	6	

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