Three macroinvertebrate families dominate the benthos of the upper St. Lawrence River

John E. Cooper

Cooper Environmental Research, 1444 County Route 23, Constantia NY 13044

CooperEnvironmentalResearch.com   cooperesearch@twc.com

INTRODUCTION

Few habitats undergo as much seasonal change as do the shallow aquatic areas at northern latitudes: from an ice-covered surface and sediments that are devoid of living vegetation in winter to open water and profuse vegetation by mid-summer. These changes provide multiple seasonal habitat types that can support differing life history strategies that, in total, produce a complex and dynamic community. These features are characteristic of the bays of the upper St. Lawrence River that differ from the less physically complex structure in deep water that may have fewer macroinvertebrates.

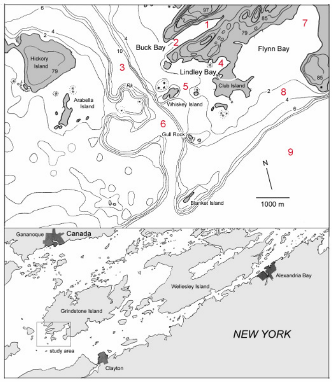

Figure 1. Sampling locations (red numbers) in three bays on Grindstone Island in the upper St. Lawrence River. Depth contours and land elevations are in meters.

SITE DESCRIPTION AND METHODS

- Three bays, Buck, Lindley, and Flynn, are part of Grindstone Island. These bays are bordered by marshes of cattail and grasses and have bottom sediments ranging from sand to sand-silt mixed with clay.
- Buck and Lindley bays were sampled with a ponar dredge for macroinvertebrates and sediment in May, July, and October, 1994, as a pilot program. Flynn Bay was sampled for sediment only.
- Sampling for macroinvertebrates in Flynn Bay was added in 1995: the three bays were sampled from May through September in 1995 to 1997. Samples were screened through a 500µ screen and preserved in formalin. Organisms were sorted and identified in the laboratory.
- Subsamples of sediment (120 ml) were taken at each station and fractions (sand, silt, clay) were determined by the dispersal method (Folk 1980). Three additional samples were taken for organic content determination by percent weight loss on ignition.
- Water temperature was recorded at 2 h intervals by automatic recorder in each bay. Other parameters measured were secchi depth, DO_2, pH, alkalinity, and conductivity with each biological sample.
- Non-parametric statistical tests were made on non-transformed data.
- Four community indices were calculated: Percent Dominants, Percent Chironomidae, Total Families, and Family Biotic Index.

RESULTS

- Dreissenidae dominated the macroinvertebrates in 1994 (54% by number) and in 1995–1997 (32% by number). There were 34 families in 51 taxa in 1994 and 45 families in 69 taxa in 1995–1997 (Table 1). Six families, Dreissenidae, Gammaridae, Chironomidae, Naididae, Asellidae, and Hydrobiidae, accounted for 87% of all organisms collected (Fig. 2).
- The invasive snail *Potamopyrgus antipodarum* (New Zealand Mud Snail) was collected at stations 2, 3, 7, 8, and 9 (83% at station 9). The native ornamented snail *Gyraulus crista* (Star gyro) was collected at stations 1, 2, 5, 7, and 8 (57% at station 7; Fig. 3)

Table 1. Living taxa collected in Buck, Lindley, and Flynn bays in 1994 and 1995–1997. Invasive species are in bold lettering. Taxa italicized at end of table were not identified to family and were not used in analyses.

			1994		1995–1997	
Taxa	Family		Total collected	Density (#/m²)	Total collected	Density (#/m²)
Turbellaria	Planariidae		99	91.7	1877	201.5
Oligochaeta	Naididae		531	491.7	6016	645.8
	Lumbriculidae		43	39.8	327	35.1
	Aeolosomatidae		62	57.4	260	27.9
Isopoda	Asellidae		82	75.9	3637	390.4
Amphipoda	Gammaridae	*Gammarus fasciatus*	2046	1894.4	19225	2063.9
	Hyalellidae	*Hyalella azteca*	0	0	309	33.2
Ephemeroptera	Caenidae		2	1.9	272	29.2
	Ephemeridae		3	2.8	132	14.2
	Baetidae		0	0	1	0.1
Odonata	Coenagrionidae		0	0	103	11.1
	Cordulidae		0	0	1	0.1
Neuroptera	Sisyridae		0	0	3	0.3
Trichoptera	Leptoceridae		40	37.0	584	62.7
	Helicopsychidae		9	8.3	586	62.9
	Odontoceridae		11	10.2	259	27.8
	Limnephilidae		7	6.5	237	25.4
	Polycentropodidae		37	34.3	143	15.4
	Hydroptilidae		4	3.7	92	9.9
	Molannidae		13	12.0	67	7.2
	Phyrganeidae		9	8.3	37	4.0
	Brachycentridae		1	0.9	26	2.8
	Lepidostomatidae		0	0	15	1.6
Lepidoptera	Pyralidae		13	12.0	68	7.3
Coleoptera	Elmidae		3	2.8	43	4.6
	Dytiscidae		0	0	11	1.2
	Psephenidae		0	0	1	0.1
Diptera	Chironomidae		2040	1888.9	14356	1541.2
	Ceratopogonidae		7	6.5	92	9.9
	Empididae		0	0	5	0.5
	Chaoboridae		0	0	2	0.2
Gastropoda	Hydrobiidae	various hydrobids	289	267.6	2465	264.6
		Gillia altilis	1	0.9	1	0.1
	Pleuroceridae	*Pleurocera virginica*	2	1.9	18	1.9
	Bithyniidae	***Bithynia tentaculata***	115	106.5	524	56.3
	Planorbidae	*Gyraulus circumstriatus*	43	39.8	527	56.6
		Gyraulus deflectus	40	37.0	475	51.0
		Promenetus exacuous	29	26.9	212	22.8
		Gyraulus crista	0	0	35	3.8
		Helisoma campanulatum	3	2.8	34	3.7
		Helisoma trivolvis	4	3.7	15	1.6
		Helisoma anceps	0	0	6	0.6
		Gyraulus parvus	5	4.6	1	0.1
	Valvatidae	*Valvata tricarinata*	12	11.1	372	36.9
		Valvata sincera	19	17.6	131	14.1
		Valvata lewisi	4	3.7	23	2.5
		Valvata piscinalis (introduced)	0	0	15	1.6
	Lymnaeidae	*Acella haldemani*	1	0.9	21	2.3
		Lymnaea stagnalis	8	7.4	15	1.6
		Stagnicola elodes	3	2.8	15	1.6
		Lymnaea obrussa	0	0	4	0.4
	Tateidae	***Potamopyrgus antipodarum***	0	0	29	3.1
	Ancylidae	*Ferrissia parallela*	27	25.0	63	6.8
		Laevapex fuscus	1	0.9	14	1.5
		Ferrissia californica	3	2.8	1	0.1
	Physidae	*Physa* sp.	88	81.5	291	31.2
Bivalvia	Unionidae	*Elliptio complanata*	6	12.0	14	1.5
		Lampsilis radiata	5	2.8	3	0.3
	Sphaeridae	*Sphaerium* sp.	311	288.0	655	70.3
	Pisidiidae	*Pisidium* sp.	128	118.5	595	63.9
	Dreissenidae	***Dreissena polymorpha***	7324	6781.5	26071	2798.8
		Dreissena rostriformis bugensis	15	13.9	851	91.4
Porifera	Spongillidae	*Spongilla lacustris* colonies	1	0.9	6	0.6
		Eunapius fragilis colonies	0	0	1	0.1
Nematoda	*nematode*		11	10.2	156	16.7
Hydracarina	*water mite*		0	0	4	0.4
Nematomorpha	*nematomorpha*		8	7.4	58	6.2
Hirudinea	*leech*		54	50.0	494	53.0
Coelenterata	*hydra*		0	0	2	0.2
Total collected			13622		83004	

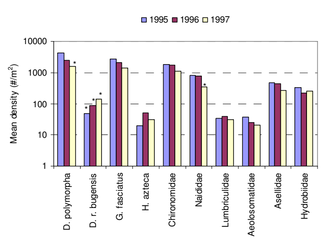

Figure 2. Mean density (#/m²) of Dreissenidae (*D. polymorpha* and *D. r. bugensis*), amphipods (*Gammarus fasciatus* and *Hyalella azteca*), Chironomidae, oligochaetes (Naididae, Lumbriculidae, Aeolosomatidae), Asellidae, and Hydrobiidae. An asterisk denotes a statistical difference within the taxa.

Figure 3. The invasive snail *Potamopyrgus antipodarum* (left; range 4–5.5 mm SL) from station 9 and the native ornamented snail *Gyraulus crista* from station 7 (right; shell diameter 2 mm). The pink color is from stain used in samples.

- Water temperature increased gradually from about 10°C in the first week of May to a seasonal high of approximately 27°C in mid-July in each year (Fig. 4)
- *G. fasciatus* and Chironomidae were collected at all stations but *H. azteca* was collected only at station 7. Naididae represented 90% of all annelids and occurred at all stations with greater mean density at stations 4 and 7 (1435/m²; 1482/m²). Lumbriculidae mean density was greatest at station 1 (123/m²); Aeolosomatidae mean density was similar at stations 4 and 7 (64/m²; 62/m²) and neither family occurred at deep water stations. Asellidae mean density was greatest at station 7 (2240 /m²) as was Hydrobiidae density (793/m²); both families had low density at deep water stations. Stations 4 and 7 had widely different sand and organic matter values (Table 2).

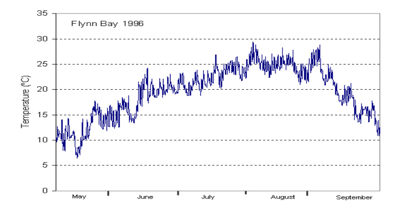

Figure 4. Water temperature in Flynn Bay in 1996. Water temperature could vary by 8°C over a 12 hr period.

Table 2. Mean depth, percent sand, silt, and clay, and chemical parameters by station with one SE in parentheses. pH ranged from 7.8 to 8.1 (SE=0.05–0.1, N=148) and mean secchi depth at stations 3, 6, and 9 was 8.2 m (SE=0.15, N=46).

	Buck Bay			Lindley Bay			Flynn Bay		
Station	1	2	3	4	5	6	7	8	9
Depth (m)	1 (0.04)	3 (0.1)	16 (0.3)	1 (0.06)	4 (0.12)	16 (0.4)	1 (0.2)	3 (0.12)	17 (0.3)
Sand (%)	38 (2)	60 (5)	44 (8.7)	98 (0.4)	86 (1)	13 (0.7)	10 (0.3)	93 (0.5)	12 (0.6)
Silt (%)	15 (1.3)	28 (3.9)	35 (18.3)	1 (0.3)	11 (0.9)	63 (2.8)	65 (3)	5 (0.4)	65 (2.7)
Clay (%)	47 (3.3)	12 (1.9)	21 (9.6)	1 (0.2)	3.4 (0.6)	24 (2.2)	25 (2.8)	2 (0.05)	23 (2.2)
Organic matter (%)	13 (0.3)	5 (0.4)	5 (0.2)	0.4 (0.03)	1.5 (0.07)	6 (0.01)	11 (0.4)	0.8 (0.04)	7 (0.1)
Alkalinity (ppm $CaCO_3$)	110 (6.5)	119 (2.4)	121 (1.1)	116 (2.3)	120 (2.2)	121 (1.9)	107 (4.7)	117 (2.1)	119 (1.6)
Conductivity (µmhos)	274 (9.4)	286 (5.2)	290 (5.4)	283 (8.9)	291 (5.2)	288 (6)	272 (9.1)	286 (6.2)	286 (6.6)
Bottom oxygen saturation (%)	101 (5.4)	98 (4.0)	93 (4.8)	96 (5.1)	96 (5.1)	92 (5.3)	106 (5.2)	102 (4.2)	96 (4.9)

- Deep water stations had significantly fewer Total Families ($F_{8,18}$=9.9, P<0.0001) and Percent Chironomidae ($F_{8,18}$=6.0, P<0.0001), which resulted in greater Percent Dominants ($F_{8,18}$=5.38, P=0.001) and Family Biotic Index ($F_{8,18}$=4.93, P=0.002).

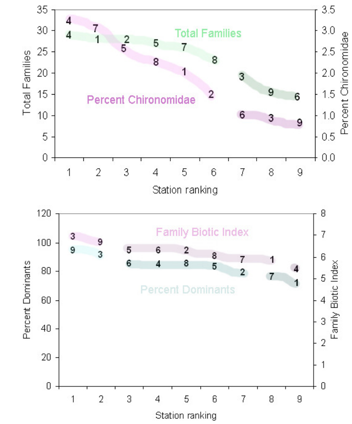

Figure 5. Comparison of station ranking for Total Families and Percent Chironomidae (upper panel); and Percent Dominants and Family Biotic Index (lower panel). Stations connected by a common color are not significantly different in ranking. All years combined.

- Two species of unionid clams, *Elliptio complanata* and *Lampsilis radiata,* were collected alive from 1994 to 1996. *E. complanata* was collected at all stations other than 6 and 7 (range 1.5–78.2 mm, mean = 63.2 mm SL). *L. radiata* was collected at stations 2, 4, 6, and 8 (range 4.2–32.5 mm, mean = 20.8 mm SL). Evidence of Dreissenidae colonization (byssal threads) was seen in unionid mussels as short as 22 mm in *E. complanata* and 25 mm in *L. radiata*. The last *living* unionid mussel was collected in 1996.

DISCUSSION

- Water depth was a controlling factor in the four indices. The Family Biotic Index was least affected by community composition. Deep water stations were beyond the photic zone so there was no vegetation to serve as food or refuge.
- No taxa showed a significant statistical relationship of mean density with bottom oxygen saturation, conductivity, alkalinity, or pH but mean density was significantly less at deep water stations for most taxa ($F_{8,126}$=28.5; P<0.0001).
- Three taxa, Gammaridae, Oligochaeta, and Chironomidae, were among the five more abundant by number and density from 1972 to 2016 (excluding Dreissenidae); the other taxa being Gastropoda and Asellidae depending on river location (Farrell, J. M. et al. 2010; Haynes, J. M., and J. C. Makarewicz 1982; Kinney. W. L. 1972; and Tall, L., A. et al. 2016)
- The New Zealand Mud Snail was previously reported from the St. Lawrence River near Kingston in 1994 (Zaranko et al. 1997) and now occurs in all of the Great Lakes (USGS 2021).

REFERENCES

Farrell, J. M., K. T. Holeck, E. L. Mills, C. E. Hoffman, and V. J. Patil. 2010. Recent ecological trends in lower trophic levels of the international section of the St. Lawrence River: a comparison of the 1970s to the 2000s. Hydrobiologia 647:21–33.

Folk, R. L. 1980. The Petrology of Sedimentary Rocks. Hemphill Publishing Company, Austin, Texas.

Haynes, J. M., and J. C. Makarewicz. 1982. Comparison of benthic communities in dredged and undredged areas of the St. Lawrence River, Cape Vincent, NY. Ohio J. Sci. 82:165–170.

Kinney. W. L. 1972. The macrobenthos of Lake Ontario. Proc. 15th Conf. Great Lakes Research 53–79.

Tall, L., A. Armellin, B. Pinel-Alloul, G. Methot, and C. Hudon. 2016. Effects of hydrological regime, landscape features, and environment on macroinvertebrates in St. Lawrence River wetlands. Hydrobiologia 778:221–241.

USGS.2021. https://nas.er.usgs.gov (accessed 20 January 2021).

Zaranko, D. T., D. G. Farara, and F. G. Thompson. 1997. Another exotic mollusk in the Laurentian Great Lakes: the New Zealand native *Potamopyrgus antipodarum* (Gray 1843)(Gastropoda, Hydrobiidae). Can J. Fish. Aquatic Sci. 54:804–814.