Nektonic macroinvertebrates in a wetland pond (Crescent Pond, Delta Marsh, Manitoba)

Brenda J. Hann
Department of Zoology, University of Manitoba
Winnipeg, Manitoba R3T 2N2

Introduction

Temporal and spatial variability in structure and composition of the macroinvertebrate community throughout the open-water season in wetland water bodies has been investigated in few studies (Laurie 1942; Macan 1949, 1965, 1966). The paucity of such studies is attributable at least in part to difficulties associated with sampling in a heterogeneous habitat, ranging from open water to dense submersed macrophytes to flocculent sediments, and in part to difficulties with taxonomic identifications of an extremely diverse fauna as well as lack of information on life histories of many species. Thus, priorities in wetland ecology can be clearly delineated: (1) taxonomy–the need to know species of invertebrates, diversity, life histories, generation times, etc. and (2) functional ecology–the need to know diet, nutrient and energy cycling, food web dynamics, use of fine particulate organic matter (FPOM) and coarse particulate organic matter (CPOM), both occurring as detritus derived from macrophytes, habitat complexity, and trophic linkages (Murkin and Kadlec 1986; Murkin and Batt 1987; Murkin and Wrubleski 1988; Krieger 1992).

Diversity and productivity of aquatic invertebrates in wetlands is remarkably high, yet little studied (Batzer and Wissinger 1996). In wetlands, interannual vagaries of water depth (flooding to drought conditions) and presence or absence of fish interact with seasonal subtleties of predator-prey relations and population dynamics (demographic stochastisticity) to accentuate the complexity of invertebrate communities.

Macroinvertebrates are important to waterfowl in northern prairie marshes (Murkin and Kadlec 1986). The densities and biomass of spring aquatic macroinvertebrates, in particular, influence waterfowl densities in marsh habitats. Swanson and Meyer (1977) found that waterfowl feed extensively on invertebrates during the spring to meet the high protein requirements of breeding and egg laying. Waterfowl use fish presence/absence as cues to estimate invertebrate densities in selecting breeding sites (Mallory *et al.* 1994). Differential responses among waterfowl species in strength of invertebrate-waterfowl associations for breeding and feeding (Murkin and Kadlec 1986) and invertebrate-macrophyte-waterfowl associations (Lillie and Evrard 1994).

Invertebrates constitute vital elements in the marsh food web in coastal wetlands as has been shown in recent studies of energy and biomass transfer using stable isotope techniques (Neill and Cornwell 1992; Keough *et al.* 1996). There is often considerable energy and biomass transfer between the aquatic and terrestrial habitats as many macroinvertebrates spend portions of their life cycle in each niche (Merritt and Cummins 1984).

The purpose of this study was to describe spatial and temporal patterns of nektonic macroinvertebrate abundance and community composition in a northern prairie marsh pond subject to varying amounts of predation pressure. In 1986, fish were present whereas in 1988, no fish were present until late summer. This report provides a preliminary examination of the nektonic community that will be followed by a comprehensive, species-specific treatment of abundance patterns.

Methods

Crescent Pond is a small littoral pond within the Delta Marsh, and a remnant oxbow of the Assiniboine River which formerly flowed northward into Lake Manitoba from 4,500 to 2,200 years BP (Teller and Last 1981). Although the pond has probably existed for 2,000 to 2,500 years, Goldsborough (1987) has documented the progressive in-filling and reduction in open-water area of the pond over the last 40 years. Water level regulation of the adjacent Lake Manitoba which began in 1960-61 may have contributed to the process, but Burchill (1987) suggested that Lake Manitoba water levels would have been relatively stable as a consequence of a decrease in precipitation variability even in the absence of the Fairford control structure.

The dominant submersed vegetation in Crescent Pond includes *Ceratophyllum demersum, Myriophyllum spicatum, Potamogeton zosteriformis, P. pectinatus* and

the macroalga *Chara sp.* The pond is surrounded by a marginal band of *Typha*, with *Phragmites* encircling this zone.

In 1986, macroinvertebrate sampling took place every three to four days (23 May - 5 October), using 1-L glass activity traps (modified from Murkin *et al.* 1983) at four locations (N, E, S, M) in Crescent Pond (Fig. 1). A total of six traps were placed per location (3 stakes, 2 traps/stake) with stakes located approximately 2 meters apart outside the marginal *Typha* band in the open water area of the pond. Activity traps were attached just below the water surface by hooks to wooden stakes. All traps were set with the opening of the funnel facing downwards toward the sediment-water interface in the evening and retrieved in the morning of the following day. Contents of the traps at each location were concentrated into a 250 mL polyethylene bottle with 10 mL of ethanol as a narcotizing agent. Mean abundances per trap were determined at each of the sites, then values for three marginal sites (N, E, S) were averaged and standard errors calculated. As there was only one open water site (M), standard error could not be determined.

Water temperature was recorded twice per week using maximum-minimum thermometers at each site. Water depth was determined weekly at both N and M sites using a calibrated depth stake. Water samples were collected weekly from the M site for analysis by the analytical chemistry laboratory at the Freshwater Institute, Department of Fisheries and Oceans, Winnipeg, MB.

In 1988, macroinvertebrate sampling occurred once per week (31 May - 23August). Sampling sites were established at several sites along transects (W-E, N-S) in the open water region of Crescent Pond (Fig. 1). Activity traps were attached to wooden stakes as in 1986, but pairs of traps were set with funnels directed horizontally and vertically. Traps were set in the evening for approximately 12 hours. At each site, contents of traps placed horizontally and vertically were kept separate for analysis. Mean abundances per trap were
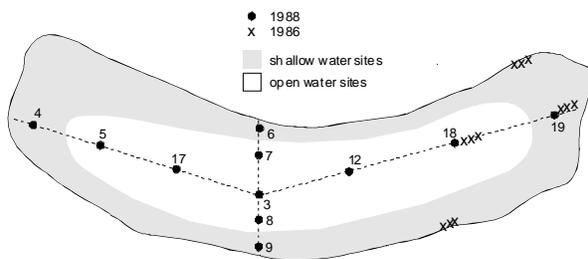
determined at open water (3, 5, 7, 8, 12, 17, 18) and marginal (4, 6, 9, 19) sites by first averaging values for horizontal and vertical traps at each site, then over all sites in each group. Water temperatures were recorded weekly at deep and shallow sites using maximum-minimum thermometers.

Macroinvertebrates were identified using Merritt and Cummins (1984), Pennak (1978), and Edmondson (1959).

Results

Water temperature (maximum and minimum) showed consistent patterns of variation over the summer months and varied little among sites in 1986 (Fig. 2). Mean maximum temperature was 22.5°C; mean minimum temperature was 18.6°C. Divergence between maxima and minima increased toward the end of the summer. Water depths declined substantially over the summer months and isopleths are shown for late May (Fig. 3a) and August (Fig. 3b).

Water chemistry parameters showed a consistent pattern over the season (Table 1, Figs. 4, 5). Specific conductance increased from 1,140 to almost 1,800 $\mu S \cdot cm^{-1}$, and alkalinity from 4,760 to over 7,000 $\mu eq \cdot L^{-1}$ over the open water season. Similarly, calcium, magnesium, potassium, and sodium ions showed gradual increases in concentration ($mg \cdot L^{-1}$) from May to October. The average pH was 8.34.

Dytiscid larvae showed peak densities in May at the marginal sites and throughout June at the open water site (Fig. 6a). These larvae are actively swimming predators that seize their prey effectively with large
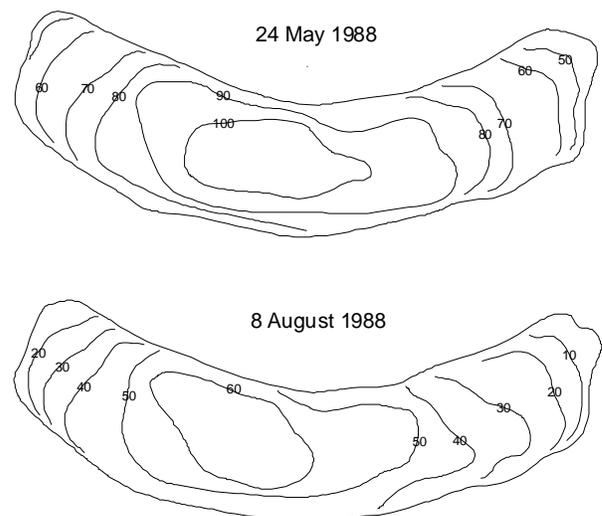

Figure 1. Crescent Pond sampling locations in 1986 and 1988.

Figure 2. Water depth isopleths for Crescent Pond in 1988.

Table 1. Water chemistry for Crescent Pond, 1986.

|	20 May	27 May	4 June	12 June	20 June	2 July	7 July	21 July	5 Aug	14 Aug	20 Aug	27 Aug	2 Sept	15 Sept	22 Sept	7 Oct	20 Oct
TDN (µg/L)	1180	1410	1300	1210	1330	1520	1630	910	1270	1130	1450	1140	1650	1280	1590	710	1430
Na (mg/L)	130	140	161	170	171	159	165	151	165	168	179	182	191	205	200	198	202
K (mg/L)	14.3	15.0	17.2	17.8	19.1	11.5	22.9	22.9	23.3	22.5	21.7	21.8	23.2	24.0	24.2	24.6	24.6
Ca (mg/L)	42.0	43.0	49.0	48.0	46.0	44.6	48.4	43.7	50.6	52.7	48.7	56.0	59.9	59.9	57.9	52.0	50.5
Mg (mg/L)	45.0	48.3	54.7	55.3	55.3	57.9	60.0	57.9	57.4	61.0	63.8	70.0	72.7	75.9	75.4	72.4	74.6
Fe (mg/L)	0.04	0.04	0.04	0.04	0.04	0.08	0.08	0.04	0.08	0.08	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Mn (mg/L)	0.01	0.01	0.06	0.10	0.01	0.01	0.06	0.06	0.28	0.11	0.03	0.13	0.21	0.03	0.01	0.01	0.01
Cl (mg/L)	188	198	307	257	260	250	260	240	270	300	320	340	320	360	360	300	300
SO4 (mg/L)	79.2	79.2	99	99	110	100	110	100	110	120	140	140	120	160	160	120	120
SuspN (µg/L)	150	209	88	216		307	329	632	292	188	178	111	126	469	461	883	898
SuspC (µg/L)	1040	1610	576	1740		1710	1710	5640	2270	1330	1230	820	1090	3710	2940	5490	6420
pH	8.06	8.53	8.44	8.25	8.32	8.42	8.30	8.35	8.13	8.43	8.31	8.47	8.24	8.19	8.36	8.60	8.44
Cond@25°C (µS/cm)	1140	1200	1350	1400	1440	1460	1500	1410	1510	1550	1580	1640	1710	1780	1770	1770	1790
IC (µmole/L)	5200	5800	6400	5250	5300	5100	5600	6450	6600	5350	5500	5600	6400	7530	6660	5730	5820
OC (µmole/L)	1700	3500	2900	2400	2200	2150	2300	2450	2000	3000	1700	1600	2150	2520	2310	2480	2610
Alk (µeq/L)	4760	4890	5460	5452	5526	5770	5874	5676	6108	6404	6528	6810	7052	7122	6994	6984	7000
Org.Acid (µeq/L)						813	777	311	459	1	1	1	1	1	1	630	936
anions (µeq/L)	12087	13093	17153	14554	14924	15071	15995	15621	16904	16338	17438	18144	17900	20968	20157	17400	17749
cations (µeq/L)	11817	12591	14386	14792	14769	14197	15112	14096	15018	15529	16017	17025	17869	18761	18408	17790	18070
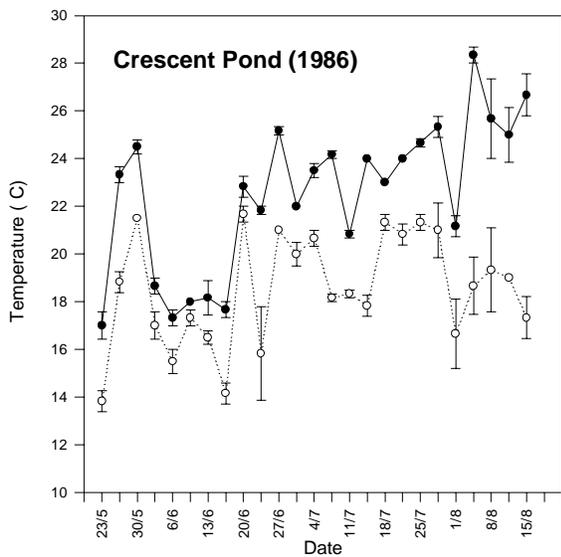
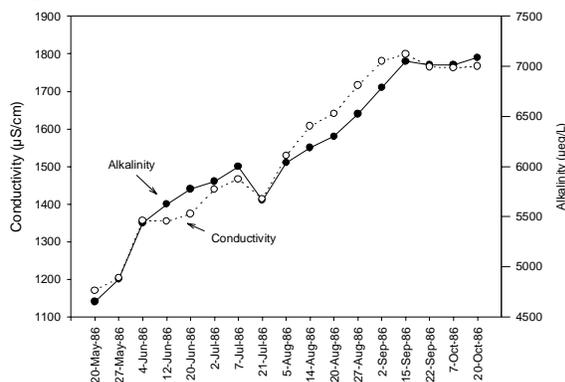Figure 3. Mean maximum and minimum water temperatures in Crescent Pond in 1986.

Figure 4. Specific conductance and alkalinity in Crescent Pond in 1986.
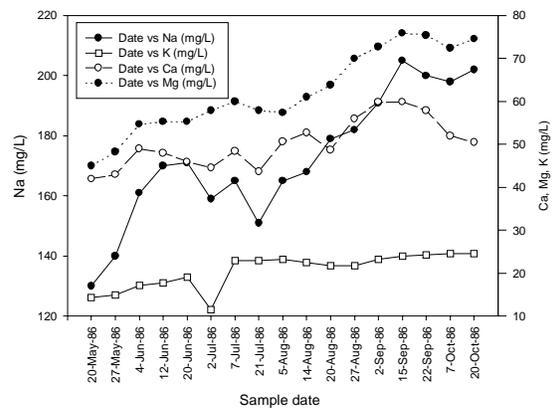

Figure 5. Concentrations of major ions in Crescent Pond in 1986.

mandibles. Dytiscid larvae typically seek moist soil in which to pupate so it may be that the larvae at the marginal sites in May were looking for pupation sites and then appeared again in July as adults. Dytiscid adults were present in highest numbers in early July in marginal sites (Fig. 6b). Several other Coleoptera adults were present throughout the season (e.g., *Acilius*, *Agabus*, *Hydaticus*, *Haliplus*, *Hydrobius*, *Hydrochara*) (Fig. 6c).

Ephemeropteran naiads (e.g., *Caenis* sp.) were most abundant from May to early July at both marginal and open water sites (Fig. 6d). Univoltine taxa typically have a peak in adult emergence in June and early July. Naiads remained present throughout the season, showing a slight increase in abundance again (e.g., *Cloeon* sp.) in late August and September. Bivoltine taxa have one summer generation, then the naiads that are produced will overwinter. Emergence patterns can vary with
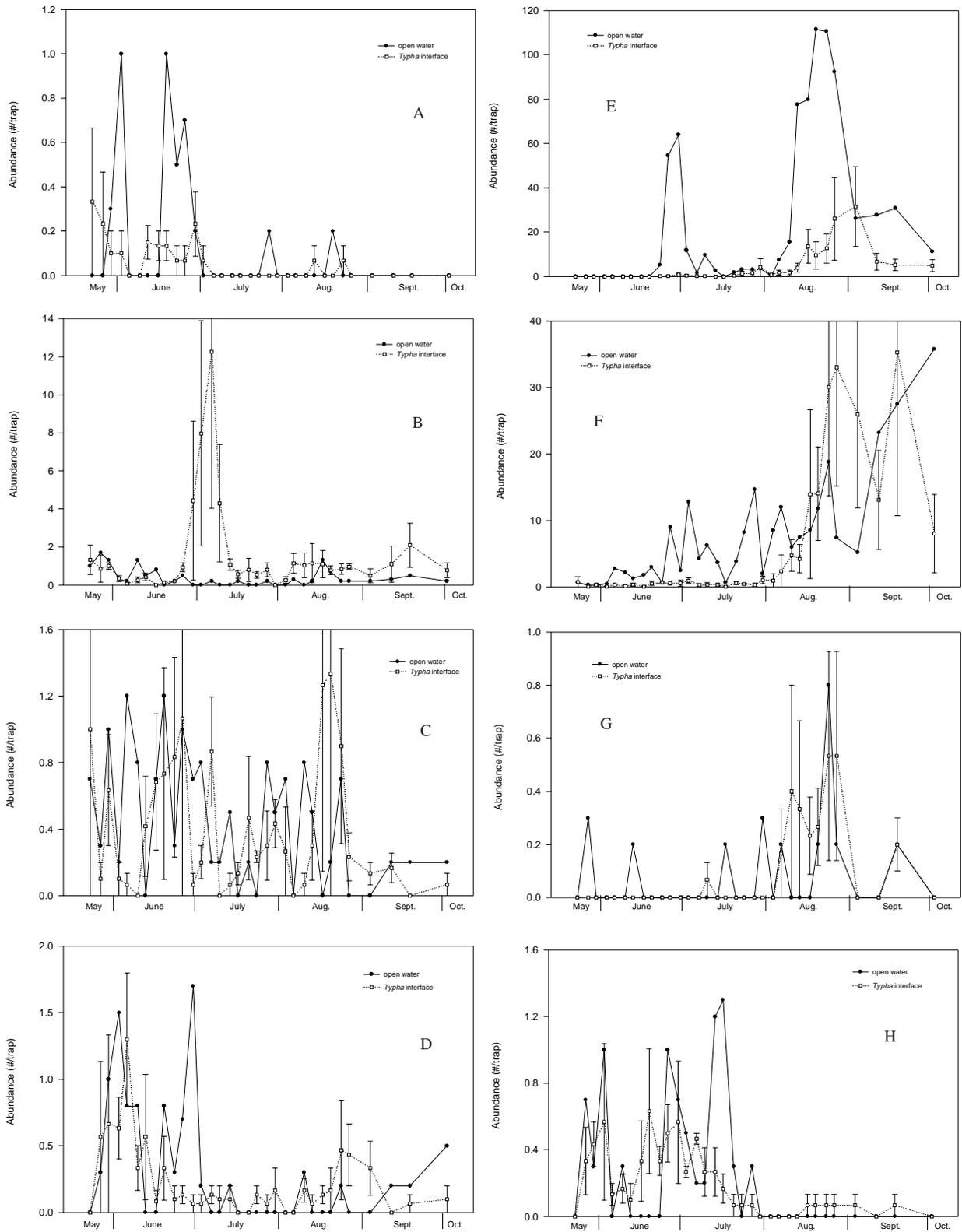
Figure 6. Seasonal abundance (numbers per trap) of macroinvertebrates in Crescent Pond in 1986. A. Dytiscidae (Coleoptera) larvae. B. Dytiscidae (Coleoptera) adults. C. other Coleoptera adults. D. Ephemeroptera naiads. E. Corixidae nymphs. F. Corixidae adults. G. Notonectidae nymphs and adults. H. Anisoptera (Odonata) naiads.
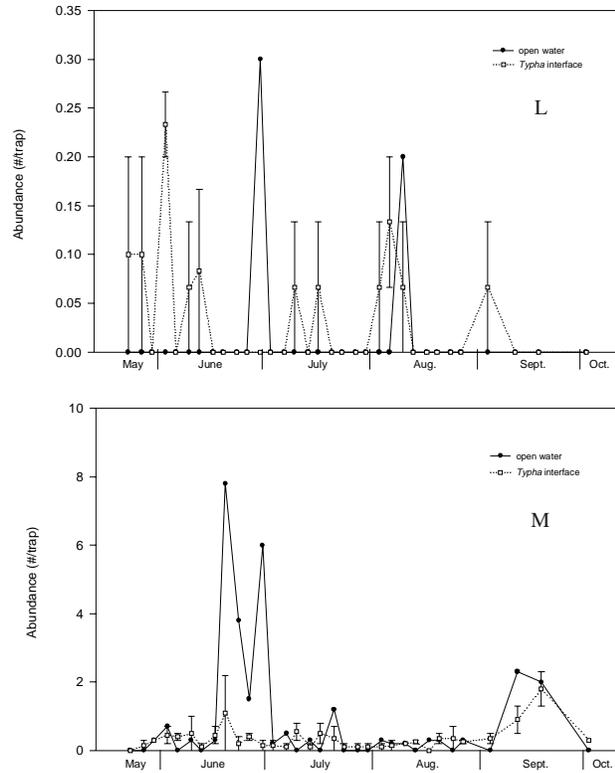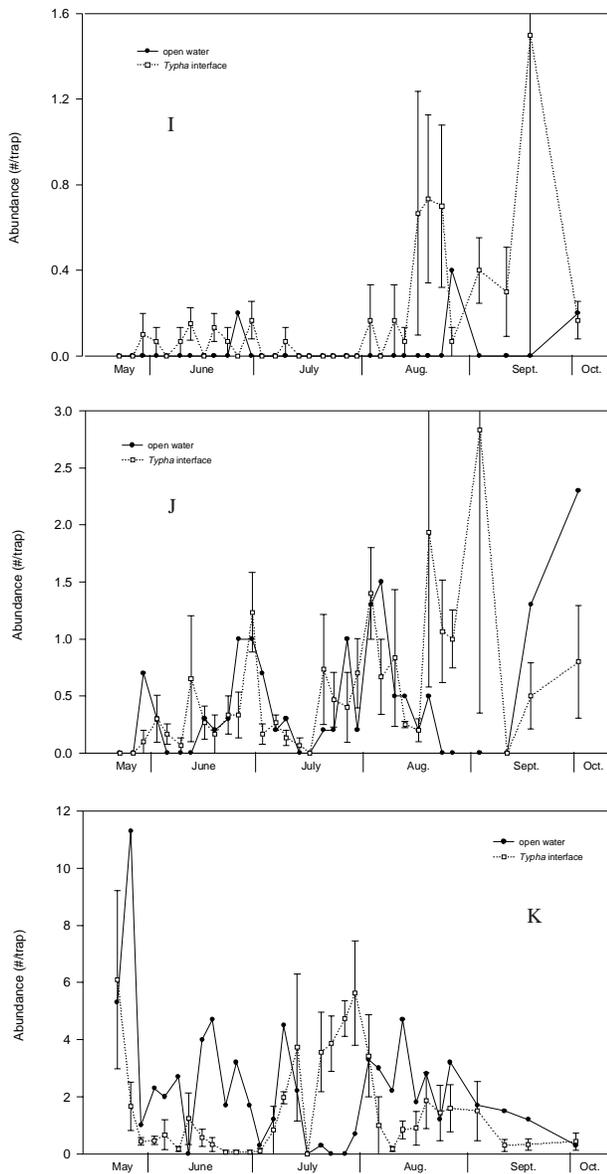
Figure 6 (continued) I. Zygoptera (Odonata) naiads. J. *Hyallela azteca* (Amphipoda). K. Water mites (Acari). L. Hirudinea. M. Fish.

abundance, locality, and from year to year within the same species (Brittain 1982).

Corixid nymphs peaked (e.g., *Hesperocorixa*) in late June to early July, then declined, and showed a second more substantial peak in abundance from mid-August throughout September, particularly in the open water (Fig. 6e). Corixid adults showed the highest abundance at marginal sites from late August to October (Fig. 6f). Notonectids, which lurk at the water surface awaiting prey, peaked in abundance in late August and September and were more frequently trapped at marginal sites (Fig. 6g).

Odonates, voracious "sit-and-wait" predators, were present throughout the season among vegetation, although dragonfly naiads (Anisoptera) (e.g., *Aeschna*) were most abundant from May to early August (Fig.

6h). Adults typically emerge in August and September, lay eggs, then either eggs or naiads overwinter. Damselfly naiads (Zygoptera) (e.g., *Coenagrion, Enallagma, Lestes*) peaked in late August to October (Fig. 6i) and probably overwinter as late instar naiads, emerge in spring, lay eggs, then mature over the summer and early autumn. Emergence periods differ between species and for the same species between years (Kormondy and Gower 1965).

Amphipods (*Hyalella azteca*), both pre-reproductive and reproductive adults, were present early in the spring and probably overwintered as adults (Fig. 6j). These released their young and die, so large individuals are gone from the population by May. Juveniles produced during spring reproduction are steadily recruited into the population, mature as young adults in July and
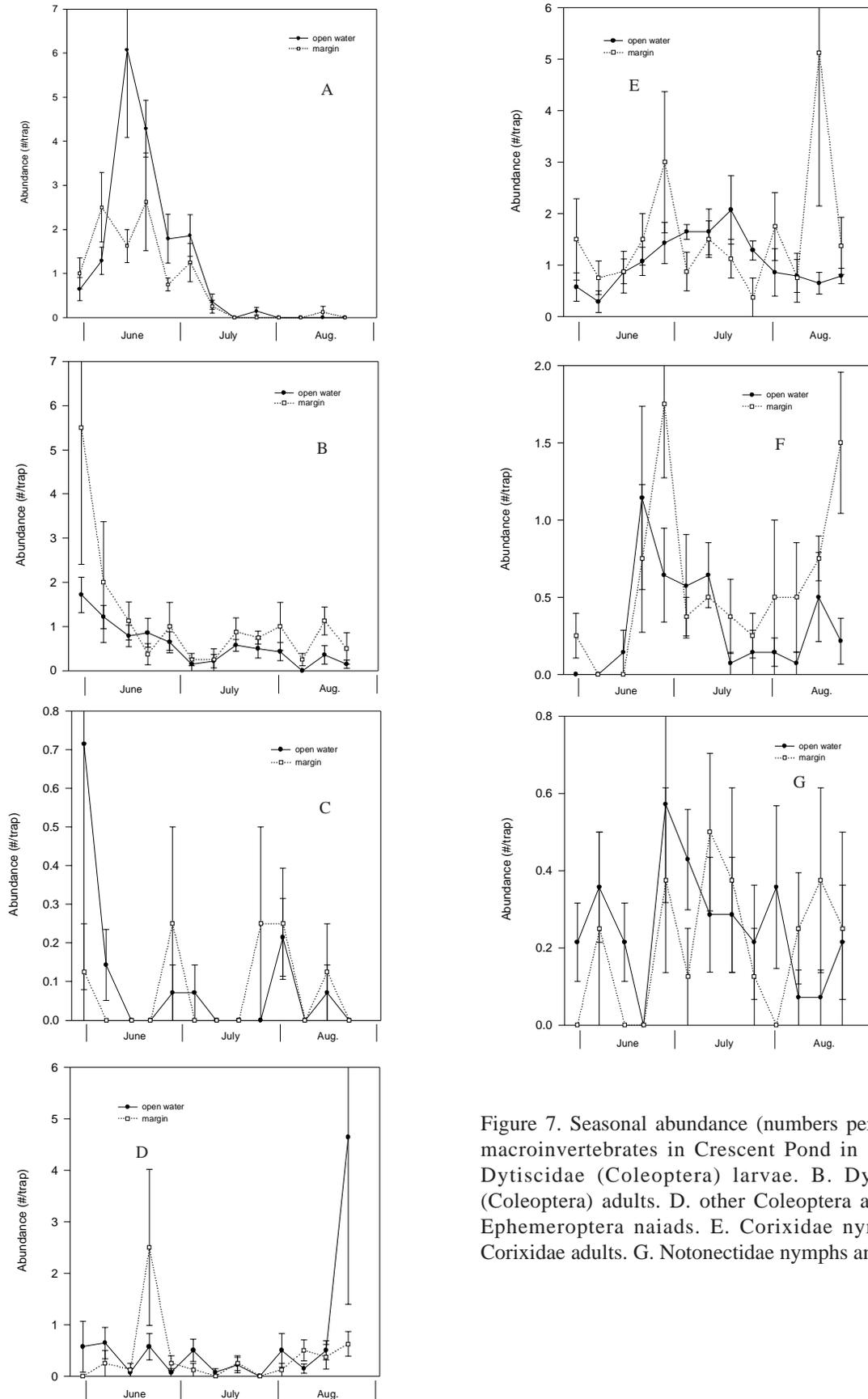
Figure 7. Seasonal abundance (numbers per trap) of macroinvertebrates in Crescent Pond in 1988. A. Dytiscidae (Coleoptera) larvae. B. Dytiscidae (Coleoptera) adults. D. other Coleoptera adults. D. Ephemeroptera naiads. E. Corixidae nymphs. F. Corixidae adults. G. Notonectidae nymphs and adults.
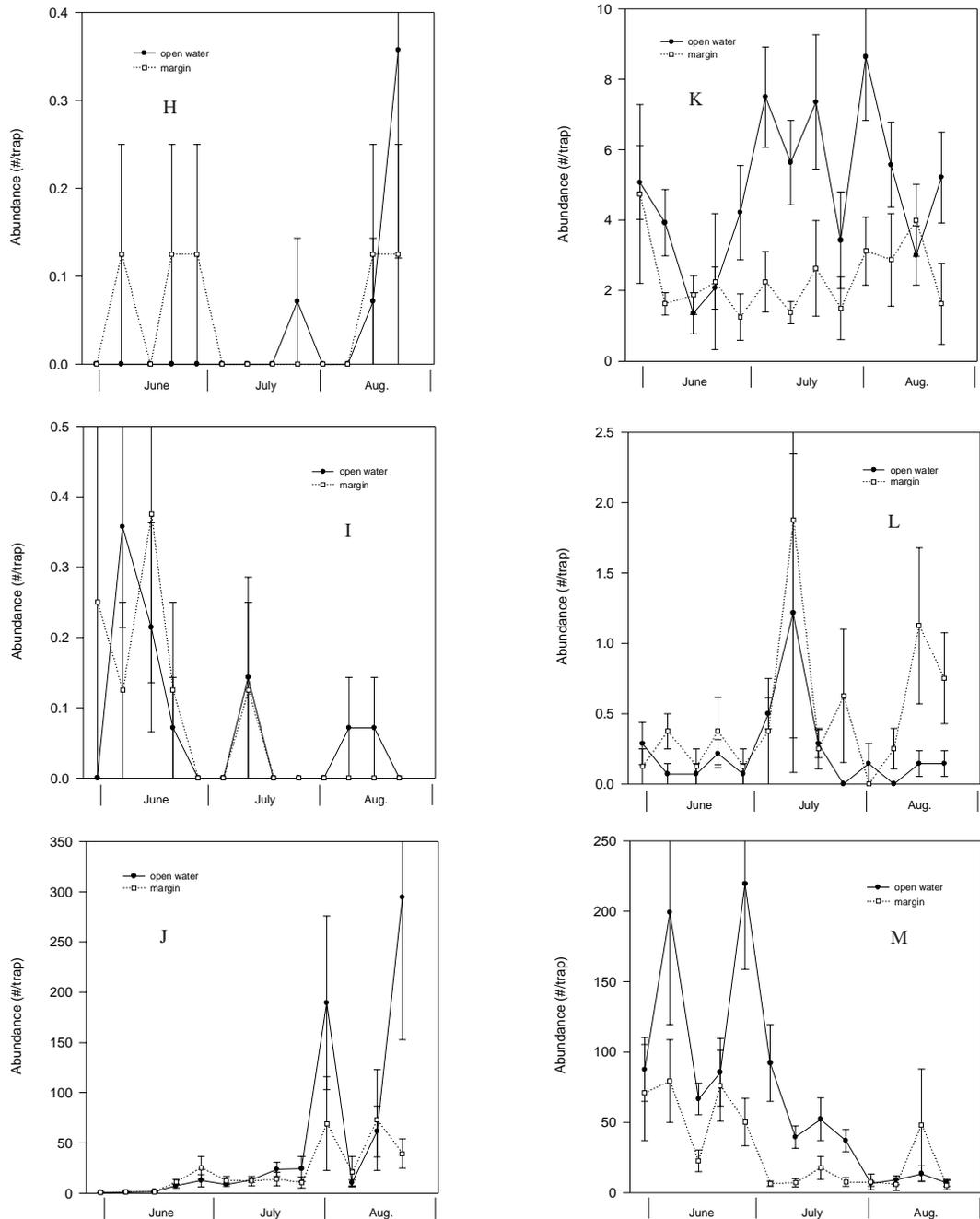
Figure 7 (continued) H. Anisoptera (Odonata) naiads. I. Zygoptera (Odonata) naiads. J. *Hyallela azteca* (Amphipoda). K. Water mites (Acari). L. Hirudinea. M. Conchostraca.

August, and produce a second generation of young which overwinter as juveniles. Similar life history patterns have been observed in West Blue Lake, MB (Biette 1969) and in a northern Ontario lake (Lindeman and Momot 1983). Water mites (Acari) were consistently abundant at all sites throughout the season (Fig. 6k). Leeches (Hirudinea) (e.g., *Erpobdella punctata, Glossiphonia complanata*) were present throughout the season (Fig. 6l). Mollusca, not quantitatively sampled

in this study, include *Lymnaea stagnalis, Physa gyrina, Stagnicola elodes, Gyraulus circumstratus, Helisoma sp.*

In 1986, *Pimephales promelas* (fathead minnows) and *Culaea inconstans* (5-spined stickleback) were present throughout the season in the open water areas, with peak abundance in late June and early July, then again in late September and October (Fig. 6m).

Dytiscid larvae showed the same pattern of abundance as in 1986, with peak numbers from May to early July in open water, with no discernible difference between vertical and horizontal traps (Fig. 7a). Dytiscid adults peaked in late May and early June at marginal sites, but substantial numbers of adults were found throughout the season (Fig. 7b). Very few dytiscid adults were trapped in the horizontally placed traps. Small numbers of other coleopterans (larvae and adults) were found throughout the season (Fig. 7c).

Corixid nymphs were present in low abundance throughout the season, showing a late summer peak in marginal areas as seen in 1986 (Fig. 7d). Corixid adults were rare in 1988 (Fig. 7e) in comparison with 1986. They peaked in late June and August, especially in marginal areas. Notonectids (Fig. 7f) and odonates (both dragonflies and damselflies) (Fig. 7g,h) were relatively sparse in 1988. Notonectids showed no clear seasonal or spatial pattern of distribution. Damselflies were generally more abundant in June in open water. Ephemeropteran naiads peaked in mid-June, and increased again in late August (Fig. 7i), as in 1986.

Amphipods peaked in August, and virtually all were trapped in horizontally placed traps (Fig. 7j). Water mites (Acari) were abundant from May to August, with considerably higher numbers retrieved from the vertically placed traps in open water (Fig. 7k). Leeches (Hirudinea) were present in numbers comparable to 1986 (Fig. 7l) and peaked in early July and mid-August at marginal sites. Conchostraca were remarkably abundant in the absence of fish predators, especially from May to early July, and most were trapped in the vertically placed traps (Fig. 7m) in open water. In 1988, no fish were collected until late in August when a few fathead minnows were found. Water temperatures were similar to those recorded in 1986.

A preliminary food web diagram has been assembled using available information (Fig. 8) but dietary interactions have not yet been fully investigated.

Discussion

The macroinvertebrate taxa found in Crescent Pond during this study represent a large subset of the regional faunal pool. The macroinvertebrate fauna is dominated by larvae of insects, whereas the microinvertebrate fauna consists overwhelmingly of Entomostrata, including Cladocera, Copepoda, and Rotifera (Zrum and Hann 1995). Fish eat many of these before they leave the water or as they are about to do so, and therefore play an integral role in influencing the translocation of insect biomass from aquatic to terrestrial environment.

Murkin *et al*. (1991) documented that total invertebrates and functional groups (predator-parasite,
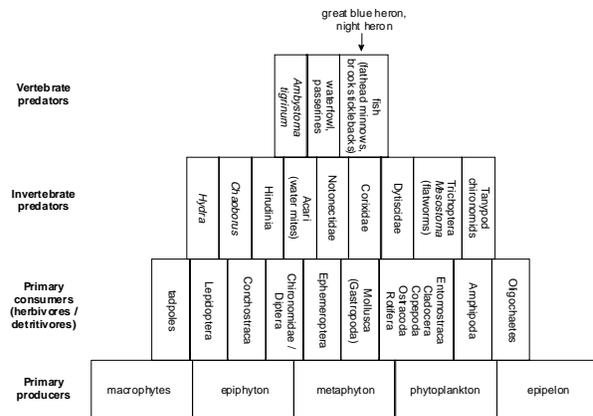

Figure 8. Trophic level diagram for Crescent Pond.

herbivore-detritivore) occurred at highest densities, biomass and species richness in midsummer in open water sites with dense submersed vegetation at normal water depths. However, in a preliminary reconnaissance of Crescent Pond benthos and phytomacrofauna, Wright (1969) found higher densities of crustaceans (primarily amphipods) and dipterans (chironomids) at open water sites in spring and fall and considerable variability in invertebrate abundance existed between sites dominated by different macrophytes. Most taxa in Crescent Pond in our study also exhibited either early or late summer peaks in abundance, rarely peaks at both time periods. However, densities in the two studies cannot be directly compared as a consequence of different sampling methods. Wright (1969) used Ekman dredge samplers, thereby emphasizing the benthic invertebrates, whereas Murkin traps which accentuate the water column organisms (nekton) were used in our study. In addition, the higher degree of taxonomic resolution employed in our study necessarily leads to finer subdivision of temporal patterns which can be discerned among taxa.

In an attempt to generalize spatial distribution patterns, Murkin *et al*. (1992) showed that nekton densities (total nekton, cladocerans, corixids, ostracods) at the emergent macrophyte-open water interface were consistently lower than densities in open water subjected to fluctuating water levels. However, when spatial patterns of individual taxa were examined in our study, certain groups showed consistent preference for marginal areas, while others were generally found in open water, and yet others showed no preference.

Several taxa, for example, dytiscid larvae, ephemeropteran larvae, amphipods, and conchostracans, occurred in markedly lower abundance in the presence of fish in 1986. Of these, only dytiscid larvae are themselves predators, but all are typically consumed readily by planktivorous fish. Macan (1966) similarly found that coleopteran larvae were decimated after the

introduction of fish into a pond. Further detailed examination of effects of fish predation on the macroinvertebrate fauna awaits their identification to species.

Several groups of macroinvertebrates are underrepresented in this study as a consequence of the sampling methods employed which relied on active swimming behaviour of the individual macroinvertebrate organism. Surface swimmers (e.g., Gyrinidae, Velidae) and those taxa in which individuals are relatively immobile or firmly attached to substrata (e.g., case-building trichopterans, flatworms, phytophilous chironomids, snails, bryozoans, *Hydra*, and leeches) were not accurately quantified.

Acknowledgments

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