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MACROINVERTEBRATE ASSOCIATIONS WITH AQUATIC MACROPHYTES AND ARTIFICIAL SUBSTRATES

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ABSTRACT. Macroinvertebrate populations associated with Myriophyllum exalbescens, Potamogeton richardsonii, *and* Vallisneria americana *were compared with those on plastic 'plants' similar in morphology to* P. richardsonii. *The density of organisms varied according to macrophyte species* (Myriophyllum ≫ Potamogeton > Vallisneria). *The plastic imitations did not differ significantly from* Potamogeton *in the total numbers of macrophytes they harboured at two different sampling periods during the growing season. A similar macroinvertebrate species composition occurred in association with the three plant species and with the artificial substrates.*

INTRODUCTION

The importance of aquatic macrophytes (aquatic vascular plants and macroscopic algae) in the overall productivity of lakes with extensive littoral zones has been clearly demonstrated (Foerster and Schlichting 1965, Mason 1977). One of the main reasons for this enhanced productivity is the presence of numerous invertebrates associated with the plants, the so-called phytomacrofauna (Gerking 1957). The latter are probably a major food source for various other animals in the food chain. The plants themselves are sites for the attachment of eggs, larvae, and pupae; they also provide visual protection for both predator and prey, and grazing areas for numerous invertebrates that feed on the attached algae (phycoperiphyton).

The purpose of the present study was to determine to what extent the association between macroinvertebrates and aquatic macrophytes is determined by the surface morphology of the plants rather than by some other characteristics. The populations of macroinvertebrates on three common species of macrophytes were compared with those found on an artificial substrate similar in form to one of the plant species.

MATERIALS AND METHODS

This study was carried out in 1974 in Lake Opinicon, Ontario (Lat. 44° 33'N, Long. 76° 20'W), where the Biological Station of Queen's University is located. This is a hard-water mesotrophic lake, 750 hectares in area. About one half of the lake is sufficiently shallow to support the growth of macrophytes, of which there are about 15 common submerged species (Crowder *et al.* 1977).

Plants of *Myriophyllum exalbescens* Fern., *Potamogeton richardsonii* (Benn) Rydb., and *Vallisneria americana* Michx. were collected from the lake on 18 May 1974 and planted in pots, which were then set out in 2 m of water in a bay relatively free of other aquatic macrophytes. Alongside the live experimental planting, ten plastic imitation 'plants' were set out. These were made from stiff white plastic and black electric tape attached to an anchored string 'stem' with a styrofoam float attached to the stem tip: they had the general 'leaf' size and form of *P. richardsonii* foliage.

Samples for analysis were collected by a diver, who lowered a plastic bag over each plant or substrate and broke off the stem or string at the sediment-water interface. Ten samples of each species were collected at 2-week intervals between 74/6/5 and 74/8/5, and at 4-week intervals from 74/8/5 until 74/10/6. The plastic plants were sampled on two occasions, 74/6/18 (4 replicates) and 74/7/73 (6 replicates). In each sample, individual eggs (or egg groups when these were obvious), larvae, pupae, and other forms were

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enumerated if they were attached to the plant or were retained by a 0.2 mm nylon mesh screen into which the contents of the plastic bag had been washed. A list of macroinvertebrates found is available from the authors on request. Following Korinkova (1971), the number of invertebrates per unit plant surface area was chosen as the preferential method of expressing results. To do this the dry weight of the sampled plants was obtained and converted to area. Calculated areas in $cm^2\ g^{-1}$ dry weight (± SE) were as follows: – *Myriophyllum* 761 ± 98, *Potamogeton* 546 ± 28, Vallisneria 1417 ± 67. One-way analysis of variance was used to compare different species sampled on the same date. In cases where the data were not parametric, a Kruskall-Wallis test was used.

RESULTS

Seasonal Changes in Number of Macroinvertebrates Associated with Plants

Seasonal changes in numbers of eggs are shown in Figure 1a. The eggs were mainly those of Gastropoda, Chironomidae, and Acari. A few Trichoptera pupae were also found. Numbers rapidly reached a peak in early June, and declined again to a relatively low level by early July. *Potamogeton* harboured a statistically greater number of eggs than the other two species at the time of peak abundance. There were no consistent differences between the three species in the proportions of different egg types found.

Apart from eggs and pupae, organisms associated with the macrophytes consisted mainly of adult Gastropoda, Chironomidae larvae, Trichoptera larvae, Hydra, Oligochaeta, Acari, Turbellaria, and Ephemeroptera larvae, the most common taxa being Chironomidae and Oligochaeta. Seasonal changes are shown in Figure 1b. Total macroinvertebrate numbers reached a peak about two weeks after that of eggs. In *Myriophyllum*, the numbers declined dramatically by the beginning of July, while in *Potamogeton* and *Vallisneria* no such marked drop occurred. At the 5% level of significance, the population of macroinvertebrates associated with *Myriophyllum* was higher than that on *Vallisneria* throughout the growing season, and greater than that on *Potamogeton* from 6 June until 23 July. A significantly greater population size on *Potamogeton* as compared to *Vallisneria* was only found at certain sampling dates. The spring peak was mainly due to Chironomidae, Oligochaeta, Gastropoda, and *Hydra* (Table 1). A

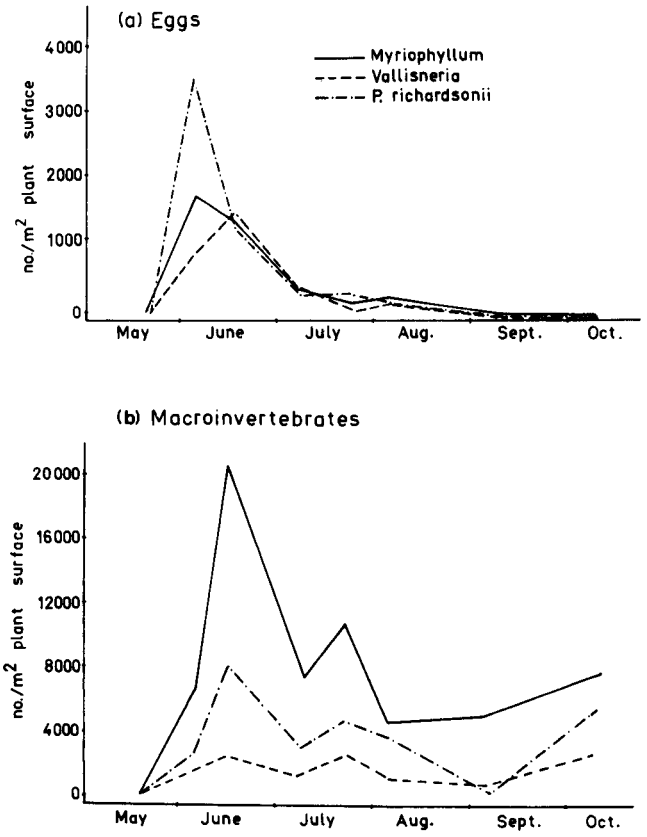

FIG. 1. Estimated abundance of macroinvertebrates and their eggs, associated with macrophytes in the experimental planting. A. Eggs. B. Macroinvertebrates.

second peak in late July could be attributed to an abundance of small Chironomidae, and early-instar Ephemeroptera nymphs. Diversity indices showed no consistent differences between the number of different taxa on the three plant species (results not shown).

Comparison of Number of Macroinvertebrates on Natural and Artificial Substrates

Total numbers of macroinvertebrates and numbers of predominant taxa found on the three plant species and on the plastic plants at two dates (74/6/18 and 74/7/23) are shown in Tables 1 and 2. The invertebrate population associated with *Potamogeton* and the artificial substrates did not differ significantly at either sampling date. The percentage of Oligochaeta was higher on the plastic than on *Potamogeton*; other taxa differed only slightly, and total numbers of invertebrates were comparable. Numbers of macroinvertebrates on the artificial substrates were significantly higher than on *Vallisneria* and lower than on *Myriophyllum*.

TABLE 1. Percentage of major taxa associated with aquatic macrophytes and plastic imitations of Potamogeton.

Taxon	74/6/18				74/7/23			
	Myriophyllum	*Potamogeton*	*Vallisneria*	Artificial Substrate	*Myr.*	*Pot.*	*Vall.*	Artificial Substrate
Gastropoda	5.2	7.6	3.6	1.1	2.3	5.0	5.0	6.2
Chironomidae	43.2	69.7	30.9	57.5	52.9	54.9	50.3	38.9
Trichoptera	2.2	1.7	1.5	0.8	2.1	4.2	4.0	4.6
Amphipoda	1.3	0.1	0.0	0.9	1.2	1.5	0.7	6.0
Hydra	9.0	4.0	20.6	3.0	0.0	3.3	1.8	5.2
Oligochaeta	38.4	14.4	15.5	34.5	19.0	11.3	14.4	27.9
Acarina	0.7	1.9	18.0	0.4	1.4	14.0	15.4	3.3
Turbellaria	0.7	0.0	8.0	1.0	0.0	0.3	2.0	3.0
Ephemeroptera	0.2	0.1	0.0	0.2	19.4	3.5	4.3	1.5
Other	2.7	0.5	1.9	0.6	1.7	3.5	2.1	3.4
Total no. families of macroinverts. present on plant	20	19	13	17	19	20	24	23

TABLE 2. Abundance estimates of macroinvertebrates on natural plants and plastic imitations. Brackets indicate treatments which are not *significantly different at the 5% level.*

Species or Type of Substrate	No. of Macroinvertebrates m^{-2} 74/6/18	Surface Area (m^2) ± S.E. 74/7/23
Myriophyllum	20,152 ± 2242	10065 ± 1920
Vallisneria	2,045 ± 444	2674 ± 1057
Potamogeton	7,862 ± 2001	4642 ± 800
Artificial substrate	4,665 ± 369	3807 ± 235

DISCUSSION

In the present study, populations of macroinvertebrates associated with submerged macrophytes showed similar seasonal trends to those reported by Bownik (1970), Dvorak (1970), Krull (1970), and Korinkova (1971). Thus there was first a spring peak of eggs followed by a peak in larval and adult invertebrates. The predominant invertebrates were chironomids and oligochaetes, but representatives of 80 other taxa were present. There were marked differences in the abundance of invertebrates on different macrophytes, the number per square meter of plant surface at the height of the spring peak being 20,000, 7860, and 2040 for *Myriophyllum, Potamogeton,* and *Vallisneria* respectively. The fact that species with finely-divided leaves support a higher invertebrate population has been previously noted (Gerking 1957, Krull 1970).

In contrast to results published by Harrod (1964), there were no consistent differences in the species composition of phytomacrofauna associated with the three plant species. Nor were there marked differences between the artificial substrates and the *P. richardsonii* in their invertebrate fauna. Soszka (1975) also found that artificial substrates in form resembling *Potamogeton perfoliatus* (a species very similar to *P. richardsonii*) harboured a macroinvertebrate fauna similar in species composition and abundance to that found on living plants. This is not surprising since, as is noted by Soszka, the macrophytes are utilized more as a life substrate than as a direct food source. Plants and artificial substrates may be colonized by similar periphyton (Macan and Kitching 1972, Soszka 1975), though in other studies (Foerster and Schlichting 1965, Bownik 1970) each macrophyte species was found to have a somewhat characteristic periphyton. These results then suggest that growth form and leaf morphology are the main factors determining the size of the macroinvertebrate population, rather than some characteristic(s) unique to the living plant.

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