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THE MID-SUMMER INSECT COMMUNITIES OF FRESHWATER TIDAL WETLAND MACROPHYTES, DELAWARE RIVER ESTUARY, NEW JERSEY

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ABSTRACT. *The insect communities of 3 freshwater wetland macrophytes,* Peltandra virginica, Bidens laevis *and* Impatiens capensis *were studied. Of the 32 families collected, 11 were common to the three macrophytes with the coleopteran family Coccinellidae being the most ubiquitous family. Differences in the insect communities of the macrophytes were found but they were overshadowed by the low number of individuals collected. Lack of herbivorous insects coupled with few signs that marsh macrophytes were grazed suggests that most plant biomass entered wetland food chains via detrital pathways. It appears that freshwater tidal wetlands may support a lower density and diversity of insects than other types of freshwater wetlands.*

INTRODUCTION

Delaware River freshwater tidal wetlands are highly productive wetlands (Whigham and others, 1978) dominated by combinations of perennial and annual emergent macrophytes (Good and Good, 1975; McCormick, 1970; McCormick and Ashbaugh, 1972; Whigham and Simpson, 1975). While the vegetation of these wetlands is well studied, little data exist on the insect fauna associated with this vegetation (McCormick, 1970; McCormick and Ashbaugh, 1972). Shapiro (1970) listed 73 species of butterflies that either were collected or were expected to occur in the area of Tinicum Marsh near Philadelphia. His listing, however, provides little information on specific butterfly-plant interactions. Shapiro also listed other insects that were collected during his survey of the area. Most notable were the presence of *Cirrhophanus tranqulifer* (Lepidoptera: Noctuidae) which feeds on *Bidens polylepis* and the larva of *Arzama obliqua* (Lepidoptera: Noctuidae) that bores into and then feeds on cattail stems. This paper presents the results of a study to define and compare the insect communities of 3 macrophytes in the high marsh habitat of the Hamilton Marshes, the northernmost freshwater tidal wetland in the Delaware Estuary located on Crosswicks Creek near Trenton, New Jersey.

The high marsh is the largest habitat of the wetland being 169 ha in aerial extent (Whigham and Simpson, 1976). The most widespread vegetation of this habitat is the mixed vegetation type dominated by the annual *Bidens laevis* (bur marigold). Several other important species including the perennials *Peltandra virginica* (arrow arum), *Sagittaria latifolia* (arrow head) and *Acorus calamus* (sweet flag) and the annuals *Polygonum arifolium* (halberd-leaved tearthumb), *Impatiens capensis* (jewel weed) and *Zizania aquatica* (wild rice) also occur in this habitat. *Peltandra* and *Acorus* reach peak standing crop by mid-July while the other species reach maximum standing crop in September. The net annual production of this vegetation type has been estimated to be 2346 gm m^{-2} (Whigham, et al., 1978).

METHODS

Insects were collected from *Peltandra, Bidens* and *Impatiens,* the three macrophytes with the highest frequency of occurrence in the wetland

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(Whigham and Simpson, personal observation), growing in a typical high marsh area on 15 dates between 17 June and 12 August 1975. Three plants of each species were studied for one half hour with every insect collected or recorded from each plant during that period. Collections were made on sunny days between 1030 and 1430 hours to minimize time and weather effects. *Peltandra* was sampled on 14 occasions, *Bidens* on 13 occasions and *Impatiens* on 11 occasions. Even though the catching on sight collection technique is rudimentary, it was chosen because it is a useful technique when the number of samples taken is high and the area observed is small (Chauvin, 1967) and because we encountered great difficulties when we tested sweeping and other standard entomological sampling techniques (Southwood, 1966).

All insects were identified to family using Arnett (1960), Borror and DeLong (1971) and Curran (1965). For each plant species studied, the abundance, dominance and degree of constancy of each insect family was calculated using the following equations modified from equations used for vegetation analysis (Smith, 1974):

$$\text{ABUNDANCE} = \frac{\text{Total individuals of family}}{\text{Number of samples taken}}$$

$$\text{DOMINANCE} = \frac{\text{Total individuals of family} \times 100}{\text{Total number of insects}}$$

$$\text{DEGREE OF CONSTANCY} = \frac{\text{Number of samples in which a family was present} \times 100}{\text{Number of samples taken}}$$

RESULTS

Thirty-two families in 6 orders were collected (Table 1) with 75% of the families collected on *Peltandra*, 59% on *Bidens* and 50% on *Impatiens*. Only 11 families, the coleopterans Curculionidae (snout beetles), Coccinellidae (ladybird beetles), Lampyridae (fireflies) and Languriidae (lizard beetles), the dipterans Dolichopodidae (long-legged flies), Otitidae (picture-winged flies), Syrphidae (flower flies) and Tachinidae (deer and horse flies), the hemipteran Anthocoridae (minute pirate bugs) and the homopterans Aphidae (plantlice) and Cicadellidae (leafhoppers) were common to all 3 macrophytes. *Peltandra* averaged 5.71 ± 0.43 SE families and 10.50 ± 0.99 SE individuals per sample, *Bidens* averaged 4.76 ± 0.50 SE families and 26.23 ± 6.56 SE individuals per sample and *Impatiens* averaged 3.72 ± 0.44 SE families and 11.72 ± 3.70 SE individuals per sample. One way analysis of variance showed that there were significant differences in both the number of families ($F_{2,35} = 4.37$, $\alpha = .05$) and number of individuals ($F_{2,35} = 4.12$, $\alpha = .05$) collected on the 3 macrophytes.

Five families had constancy values over 50 with Coccinellidae the only family with a constancy greater than 60 for all 3 macrophytes (Table 2). Coccinellidae was the most consistent visitor to *Peltandra* and *Impatiens* having a constancy value exceeding 90 for both species, and Curculionidae with a value of 92 was the most consistent visitor to *Bidens*. Syrphidae had a constancy value over 60 for both *Peltandra* and *Bidens*, Cicadellidae exceeded 50 for *Bidens* and Languridiae was 50 for *Peltandra*. Dominance values over 9 were found for 4 families (Curculionidae, Coccinellidae, Syrphidae and Tachnidae) collected on *Peltandra*, 4 families (Curculionidae, Tachnidae, Aphidae and Cicadellidae) collected on *Bidens* and 3 families (Coccinellidae, Tachinidae and Aphidae) collected on *Impatiens* (Table 2). With the exception of Coccinellidae collected on *Bidens*, those species with dominance values in excess of 9 were the only species with abundance values exceeding 1 (Table 2). Two families, Tachinidae and Cicadellidae, showed distinct abundance patterns during the study period with Tachinidae largely collected before mid-July and Cicadellidae collected after early July.

DISCUSSION

The number of insects associated with high marsh macrophytes during the day averaged 16.23 ± 2.71 SE but that average was only 11.36 ± 1.04 SE individuals per sample if we exclude Aphidae which was collected in substantial numbers on 2 dates (Table 1). Coccinellidae was the most ubiquitous family occurring in all but

TABLE 1. Patterns of occurrence of insect families collected on *Peltandra, Bidens* and *Impatiens* in the Hamilton Marshes between 17 June and 12 August 1975.

Peltandra

	6/17	6/19	6/24	6/27	7/1	7/3	7/10	7/18	7/22	7/29	8/5	8/8	8/11	8/12
O. Coleoptera														
Canthoridae														
Chrysomelidae			1											
Curculionidae	1	1		5	4	3	1		1		3		1	1
Coccinellidae	1	3	1	1	3	2	3	1	2	4	3	3	2	
Histeridae				1										
Lampyridae	1						1	1	2					
Languriidae		1	1	2	1	1		1	1					
Scarabaeidae														
Staphylinidae														
O. Diptera														
Chironomidae			2											
Culicidae	1													
Dolichopodidae									3		2	1		1
Muscidae								1						
Otitidae										2	1	2	3	
Sciaridae														
Sciomyzidae														
Simuliidae			1											
Syrphidae	1	3			1		1		1	1	1	3	3	
Tabanidae	1						1				1			
Tachinidae	4	8	6		1		4							1
Tipulidae							3							
O. Hemiptera														
Anthocoridae									4					
Miridae					1									
O. Homoptera														
Aphidae														1
Cicadellidae							1					1	2	
Flatidae														
Membracidae				1								1		
O. Hymenoptera														
Apidae											1			
Braconidae														
Formicidae														1
Halictidae														
O. Orthoptera														
Acrididae					1									
Total Individuals	10	16	12	11	13	6	15	4	14	7	12	11	11	5
Total Families	7	5	6	6	8	3	8	4	7	3	7	6	5	5

Bidens

	6/19	6/24	6/27	7/1	7/3	7/10	7/11	7/18	7/22	7/29	8/5	8/8	8/11
O. Coleoptera													
Canthoridae				1									
Chrysomelidae		1											
Curculionidae	4		1	1	1	2	4	5	3	2	3	6	5
Coccinellidae				4		1		1	2	1	1	2	3
Histeridae													
Lampyridae						1							
Languriidae				2									
Scarabaeidae								1					
Staphylinidae								1					
O. Diptera													
Chironomidae													
Culicidae													
Dolichopodidae													
Muscidae													
Otitidae				3									1
Sciaridae								1					
Sciomyzidae													1
Simuliidae													
Syrphidae	3	1	1				1	1	1	1			
Tabanidae													
Tachinidae	21	9	27	9				1		2			
Tipulidae													
O. Hemiptera													
Anthocoridae										1			
Miridae													
O. Homoptera													
Aphidae					83	58	1	1					
Cicadellidae						4	6	7	3	1		8	18
Flatidae													
Membracidae											1		
O. Hymenoptera													
Apidae													
Braconidae											1		
Formicidae													
Halictidae													
O. Orthoptera													
Acrididae													
Total Individuals	28	11	29	20	86	66	12	19	9	8	9	16	28
Total Families	3	3	3	6	4	5	4	9	4	6	7	3	5

Impatiens

	6/19	6/24	6/27	7/1	7/3	7/10	7/18	7/22	7/29	8/8	8/11
O. Coleoptera											
Canthoridae											
Chrysomelidae											
Curculionidae								1			
Coccinellidae		1		1	1	1	1	1	2	2	1
Histeridae											
Lampyridae						1		2			
Languriidae											
Scarabaeidae											
Staphylinidae											
O. Diptera											
Chironomidae											
Culicidae											
Dolichopodidae		1				2	3		2		
Muscidae										1	
Otitidae							2			1	1
Sciaridae											
Sciomyzidae											
Simuliidae											
Syrphidae								2			
Tabanidae											
Tachinidae	11	9	6	6							2
Tipulidae											
O. Hemiptera											
Anthocoridae										1	
Miridae											
O. Homoptera											
Aphidae						44					
Cicadellidae								3			1
Flatidae											1
Membracidae											
O. Hymenoptera											
Apidae											
Braconidae							2		4		
Formicidae											
Halictidae											
O. Orthoptera											
Acrididae				1							
Total Individuals	12	11	7	8	3	48	8	10	9	7	6
Total Families	2	3	2	2	3	4	4	6	4	6	5

TABLE 2. Abundance, dominance and constancy values for the insect communities of *Peltandra, Bidens* and *Impatiens.*

	Peltandra			*Bidens*			*Impatiens*		
	Abundance	Dominance	Constancy	Abundance	Dominance	Constancy	Abundance	Dominance	Constancy
O. Coleoptera									
Canthoridae	–	–	–	.07	.29	7.69			
Chrysomelidae	.07	.68	7.14	.07	.29	7.69	–	–	–
Curculionidae	1.50	14.38	71.42	2.84	10.85	92.80	.27	2.34	27.27
Coccinellidae	2.07	19.86	92.85	1.15	4.39	61.53	1.09	9.37	90.90
Histeridae	.07	.68	7.14	–	–	–	–	–	–
Lampyridae	.35	3.42	28.57	.07	.29	7.69	.27	2.34	18.18
Languriidae	.57	5.47	50.00	.15	.58	7.69	.09	.78	9.09
Scarabaeidae	–	–	–	.07	.29	7.69	–	–	–
Staphylinidae	.07	.68	7.14	.07	.29	7.69	–	–	
O. Diptera									
Chironomidae	.14	1.36	7.14	–	–	–			
Culicidae	.07	.68	7.14	–	–	–	–	–	–
Dolichopodidae	.50	4.79	28.57	.15	.58	15.38	.72	6.25	36.36
Muscidae	.07	.68	7.14	–	–	–	.09	.78	9.09
Otitidae	.64	6.16	35.71	.30	1.17	15.38	.45	3.90	36.36
Sciaridae	–	–	–	.07	.29	7.69	–	–	–
Sciomyzidae	–	–	–	.07	.29	7.69	–	–	–
Simuliidae	.07	.68	7.14	–	–	–	–	–	–
Syrphidae	1.07	10.27	64.28	.76	2.93	61.53	.27	2.34	18.18
Tabanidae	.21	2.05	21.42	–	–	–	–	–	–
Tachinidae	1.71	16.43	42.85	5.30	20.23	46.15	3.09	26.56	45.45
Tipulidae	.21	2.00	7.14	–	–	–	–	–	–
O. Hemiptera									
Anthocoridae	.28	2.78	7.14	.07	.29	7.69	.07	.78	9.09
Miridae	.07	.68	7.14						
O. Homoptera									
Aphidae	.07	.68	7.14	11.00	41.93	30.76	4.00	34.37	9.09
Cicadellidae	.28	2.73	21.42	3.69	14.07	61.53	.45	3.90	27.27
Flatidae	–	–	–	–	–	–	.09	.78	9.09
Membracidae	.14	1.36	14.28	.15	.58	15.38			
O. Hymenoptera									
Apidae	.07	.68	7.14	–	–	–	–	–	–
Braconidae	–	–	–	.07	.29	7.69	–	–	–
Formicidae	–	–	–	–	–	–	.63	5.46	27.27
Halictidae	.07	.68	7.14	–		–	–	–	–
O. Orthoptera									
Acrididae	.07	.68	7.14				.09	.78	9.09

one sample for *Peltandra* and *Impatiens* and in 8 of 13 samples for *Bidens*. Based on constancy values (Table 2), several families showed clear species preferences with Languriidae preferring *Peltandra,* Cicadellidae preferring *Bidens* and Curculionidae and Syrphidae showing preference for both *Peltandra* and *Bidens* over *Impatiens*. No families, except perhaps Formicidae (ants), showed a preference for *Impatiens* which had both the smallest number of families and individuals collected on it when the Aphidae are excluded. Most likely the ants were exploiting floral nectar which is produced throughout the growing season (Carroll and Janzen, 1973). The reasons that *Impatiens* attracted fewer insects are not clear, but *Impatiens* is considered emetic and poisonous to live stock (Palmer, 1949), and may similarly affect insects. *Peltandra* may, likewise, be unsuitable for certain groups. Aphidae, known to be greatly affected by host quality (Kennedy and Stroyan, 1959), were notably absent from *Peltandra* when they were at high densities on *Bidens* and *Impatiens*.

Of those families found in abundance, only the homopterans Aphidae and Cicadellidae and the coleopteran Curculionidae are strictly herbivorous, although several other families, most notably Tachinidae and Syrphidae, may feed on nectar and other plant exudates (Swan and Papp, 1972). The lack of herbivorous insects in the high marsh was reflected by the macrophytes which generally showed little or no evidence of grazing (R. L. Simpson, personal observation). It should be noted, however, that some species are heavily grazed. We observed that *Hibiscus palustris* (marsh mallow), a minor component of the high marsh flora, was rather heavily grazed. J. Stevenson (personal communication) has reported that a related species, *Hibiscus moscheutos,* was heavily grazed (> 40%) during the growing season in a freshwater marsh on the eastern shore of Chesapeake Bay. Additionally, McCormick and Ashbaugh (1972) have reported that insect outbreaks on *Nuphar* were responsible for large amounts of herbivory in another Delaware River freshwater tidal wetland.

Herbivory appears to be relatively unimportant in other wetlands dominated by herbaceous vegetation. Smalley (1960) found that < 1% of the *Spartina alterniflora* in a Georgia salt marsh was grazed with the salt marsh grasshopper *Orchelimum fidicinium* accounting for most of the herbivory. He concluded that most of the net primary production of the marsh entered the detritial food chain. Recent studies of the common reed *Phragmites communis* in Czechoslovakian wetlands have estimated that 10-20% of the annual production of the common reed is lost to invertebrates, mostly insects, with about a third of the stems affected (Skuhravy, 1978). In Britain, Haslam (1970) has observed > 80% kill of *Phragmites* shoots by reedbugs, but she noted that insect damage in *Phragmites* wetlands was generally much lower.

Although differences in the insect communities of the 3 macrophytes existed, the paucity of insects in the high marsh overshadowed them. Because of the low number of herbivorous insects, the macrophytes of the high marsh were little affected by grazing. Thus it appears that most of the vegetation produced in the high marsh habitat enters wetland food chains via detrital pathways where at least part of it was available to the larval stages of several groups, particularly the dipterans, collected in this study. These pathways have not been fully elucidated, but currently available data (Odum and Heywood, 1978; Simpson, et al., 1978; Whigham and Simpson, 1976) suggests that the transformation of this detritus is quite rapid in freshwater tidal wetlands.

On the assumption that our data are representative of a characteristic epifaunal community on high marsh macrophytes, it appears that there may be enough data to show that there are distinct differences in insect communities of various freshwater wetlands. Insect communities of Ontario wetlands were dominated, far and away, by dipterans (Judd, 1949, 1953, 1958, 1960, 1961). Similar dominance patterns were found in a Michigan bog (Witter and Croson, 1976) and a Czechoslovakian common reed swamp (Skuhravy, 1978). Cameron (1972) noted a dominance of diptera in San Francisco Bay salt marshes and Davis and Gray (1966) found diptera to be most abundant in *Spartina patans* areas of a North Carolina salt marsh while homopterans were most abundant in *Spartina alterniflora, Juncus* and *Distichlis* areas.

In our study, more families were in the Order Diptera than in any other order but only 2 of those families (Syrphidae and Tachinidae) were, at any time, dominant and/or abundant (Table 2); 2 coleopteran families (Curculionidae and Coccinellidae) were consistently the most abundant and dominant. The only salient vegetation difference between our study area and those sampled by other investigators is that their wetlands were dominated by grasses, sedges and/or leatherleaf whereas the Hamilton Marshes are dominated by several broadleaf macrophytes. The latter may, for some unknown reason, support lower densities and species diversity of insects.

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