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Terrestrial Insects Associated With Lythrum salicaria, Phragmites australis, and Typha angustifolia in a Hudson River Tidal Marsh

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Abstract

The insect fauna of freshwater tidal marshes in New York State is not well known. This study examined terrestrial insects associated with the three dominant plant species, Lythrum salicaria, Phragmites australis, and Typha angustifolia, in a freshwater tidal marsh of the Hudson River at two stations during early spring and summer, 1996. Aboveground biomass, stem density, and biomass per stem of the three plant communities differed with season and station. Insect taxa, biomass, and density also differed among the three plant communities. Representatives from eight insect orders were identified. Insect orders found in the spring were Coleoptera, Diptera, Homoptera, Hymenoptera, and Lepidoptera. These same orders were represented during the summer with the addition of the orders Collembola and Thysanoptera. The scale Chaetococcus phragmitidis (Homoptera) was the most abundant insect in both stations. It represented 74 % of the total insect biomass on P. australis in the spring and 60 % in the summer. The moth larva Lymnaecia phragmitella (Lepidoptera) was another abundant species, accounting for 85 % of the total insect biomass on T. angustifolia in the spring and 29 % in the summer. It was found primarily on T. angustifolia in both seasons at both stations. Lythrum salicaria had the most diverse insect fauna. Insect density and biomass did not vary with plant biomass, stem density, or biomass per stem. Results suggest that if T. angustifolia were replaced by either L. salicaria or P. australis, insect communities would change.

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Introduction

Freshwater tidal marshes are biologically and structurally diverse, and are characterized by nearly freshwater conditions, daily tidal flooding, and plant and animal communities dominated by freshwater species (Odum et al. 1984). Their vegetation is dominated by grasses, rushes, sedges, cattails, and a variety of broad-leaved herbaceous plants. Freshwater tidal marshes are nurseries for many fish and bird species. Freshwater tidal marshes support a large diversity of vertebrate and invertebrates. Of these invertebrates, little is known about the insect fauna (Odum 1984). In brackish marshes in Maryland, herbivorous insects grazed 10-30% of plant production, illustrating one impact insects can have on wetlands (Cahoon 1986).

Three dominant plant species in the upper intertidal zone of freshwater tidal marshes in the northeastern United States are purple loosestrife (Lythrum salicaria), narrowleaf cattail (Typha angustifolia), and common reed (Phragmites australis) (Mitsch and Gosselink 1993). Lythrum salicaria is a cespitose perennial herb 1-3 m in height. It was introduced into northeastern North America from Europe in the early 1800s. Since then it has aggressively invaded wetlands, where it can form dense, nearly monotypic stands that can displace native vegetation and endanger rare wetland species (Thompson et al. 1987). Freshwater non-tidal marshes with extensive L.salicaria stands have been found to support lower biodiversity and have experienced a loss of native vegetation and a reduction in waterfowl and muskrat populations (Hight and Drea 1991).

Typha angustifolia is native to the Atlantic Coast and gradually became established inland with the early railroad, canal, and highway systems (Mills 1991). It is a

rhizomatous perennial and usually grows in relatively pure stands generally 1-3 m in height (Niering 1985). Its fruits form a velvety brown spike that is a food source for moth larvae and its nutrient-rich underground parts are eaten by muskrats.

Phragmites australis is a perennial rhizomatous grass that grows to a height of 1.5-4.0 m. It is found on every continent except Antarctica. The species is indigenous to North America. It is considered to be an aggressive invasive plant that after establishment can form dense monotypic stands and crowd out other wetland species such as T. angustifolia (Marks et al. 1994).

In New York, Maryland, and Massachusetts, 55 insect genera in the orders Coleoptera, Hemiptera, Homoptera, Lepidoptera, and Orthoptera were found associated with L. salicaria by aspirating and netting (Hight 1990). In central New York, 25 genera in the orders Coleoptera, Diptera, Hemiptera, Hymenoptera, and Lepidoptera were found on or in Typha latifolia (Claassen 1921). Insects associated with P. australis have been studied in Europe but not in North America. Twenty-one genera in the orders Diptera, Homoptera, and Lepidoptera were found on P. australis at an Austrian lake (Imhof 1979). All herbivorous insects on P. australis were found living beneath the leaf sheath or in the stem with the exception of an aphid (Homoptera).

Inaccessibility of marshes is one reason marsh insects have generally been ignored (Imhof 1979). Tall vegetation, tidal flooding, and muddy conditions add to the difficulty of studying marsh insects. Overwintering insects have been extracted from L. salicaria, P. australis, and T. angustifolia in a tidal freshwater marsh on the Hudson River in New York State (Erik Kiviat unpublished data). Taxa, density, and biomass of insects differed among

the three plant species. The terrestrial insect fauna associated with the three plant species in freshwater tidal marshes in New York State is otherwise not well known.

The objective of this study was to characterize and compare insect faunas living on or in L. salicaria, P. australis, and T. angustifolia in a freshwater tidal marsh on the Hudson River with respect to their taxa, density, and biomass during two seasons of the year. These data will provide information on the relationships between the three plant species and their respective insect communities. It will also form a baseline for future study of the roles these insects play in the marsh food web and other ecosystem processes.

Methods

This research was conducted at Tivoli North Bay, a 150 ha tidal freshwater marsh of the Hudson River located in the Town of Red Hook in Dutchess County, New York (Fig. 1). The marsh is part of the Hudson River National Estuarine Research Reserve.

Samples of plants and their associated insects were collected from two stations within the high marsh. These stations were designated as A and B (Fig. 1). Each station was characterized by stands of L. salicaria, T. angustifolia, and P. australis adjacent to each other. Sampling was conducted in spring (26 March through 5 May) and in summer (17 June through 28 June), 1996. Collections were made on five different days during each time period. On each day, stems of the three plant species along with their associated insects were collected from 0.25 m^2 quadrats. Quadrats were located randomly within communities of the three plant species using a grid system and a table of random numbers.

No samples were collected within 1 m of a stand margin. One quadrat per plant species was sampled on each day from each station. Therefore, during the two time periods, three plant communities at two stations were sampled five times yielding a total of sixty samples of plants and insects.

Quadrats were laid out using a 0.5 x 0.5 m frame that could be opened and positioned at ground level with minimal disturbance to the plants and insects. All stems within the quadrat were cut approximately 2 cm above the ground, identified, counted, and sealed in the same plastic bag. Inflorescences (flowers) and infructescences (fruits) were also counted and included in the samples. Each sample contained at least 70% (by stem count) of the dominant plant species in that community. Secondary species were T. angusifolia in the L. salicaria and P. australis communities and Scirpus fluviatilis in the T. angustifolia community.

Samples of plants and insects were kept cool in outdoor bins at the Bard College Field Station during the spring sampling period. During the summer sampling period, samples were refrigerated at 1.6° C in a walk-in cooler on the Bard College Campus.

Insects were dissected from all plant parts by hand over a white enamel pan. The insects were separated to the lowest recognizable taxon and individuals within each taxon were counted, weighed, and dried to a constant weight at 60° C. Insect specimens were then preserved in 70% isopropanol and representatives were sent to systematic entomologists for further identification. Voucher specimens were deposited at the Bard College Field Station.

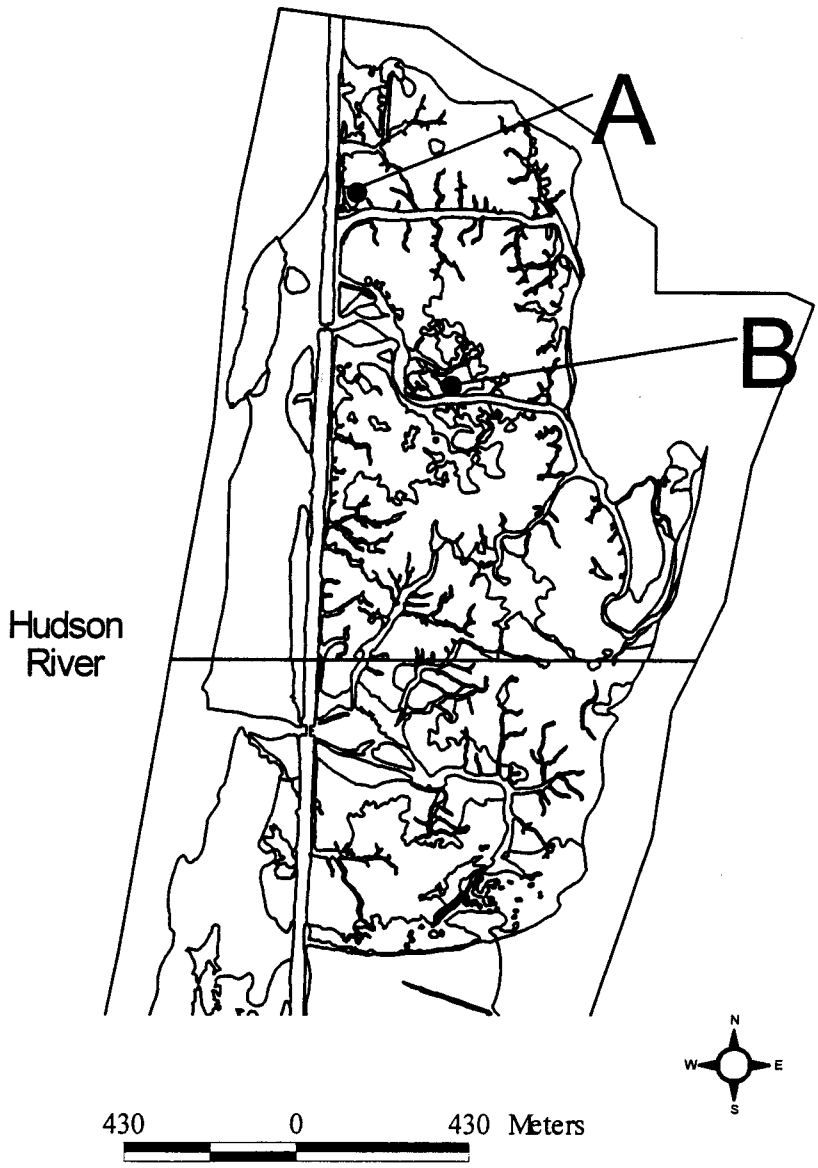

Figure 1. Location of Tivoli North Bay and stations A and B.

After dissection, plant materials were placed in paper bags and air dried at 20° C during the spring season. Plant materials from both spring and summer seasons were oven dried to a constant weight at 80° C at the Institute for Ecosystem Studies in Millbrook, New York.

Plant and insect data were analyzed using a least squares linear regression and correlation and a nested analysis of variance (ANOVA) where station was nested within season and season was nested within plant community (Ambrose and Ambrose 1995). All effects were considered fixed. Prior to statistical analysis, all data ($n = 60$) were compared to computer-generated normal distributions using histograms and Chi-square and Lilliefors tests (Statsoft 1995). To reduce skewness, kurtosis, and outliers, all values were transformed by $\log_{10}(x+1)$ (Krebs 1989, Tabachnick 1989). Some data were still non-normal (i.e. Lilliefors $p < 0.05$) after transformation, although skewness and kurtosis were substantially lower. Samples were treated as community units for analysis, regardless of secondary plant species.

Results

Lythrum salicaria and P. australis had higher total biomass than T. angustifolia in the spring at both stations (Fig. 2). Seasonal differences in total biomass among the three plant communities were significant (Table 1). Phragmites australis had higher biomass than the other two plant communities in station B (Fig. 2).

Total stem densities differed between stations in the spring. Phragmites australis and T. angustifolia had higher densities than L. salicaria at station A, but L. salicaria and T. angustifolia had higher densities than P. australis at station B (Fig. 2). In the summer total stem density was similar at both stations. Differences in total stem density among plant communities, season, and station were not significant (Table 1). Total stem density of L. salicaria and T. angustifolia increased with total biomass (Fig. 3).

Lythrum salicaria and P. australis had higher biomass per stem than T. angustifolia in the spring at both stations (Fig. 4). In the summer P. australis had higher biomass per stem than L. salicaria at station A. It also had higher biomass than L. salicaria and T. angustifolia at station B. Station differences in biomass per stem were significant (Table 1). Total biomass per stem increased with total biomass of P. australis (Fig. 5).

A total of eight insect orders was found in the plants during both seasons (Table 2). One thysanopteran was found at station A in the summer and one collembolan was found at station B in the summer. Due to C. phragmitidis, homopterans had highest density and biomass on P. australis in the spring (Table 2, Fig. 6).

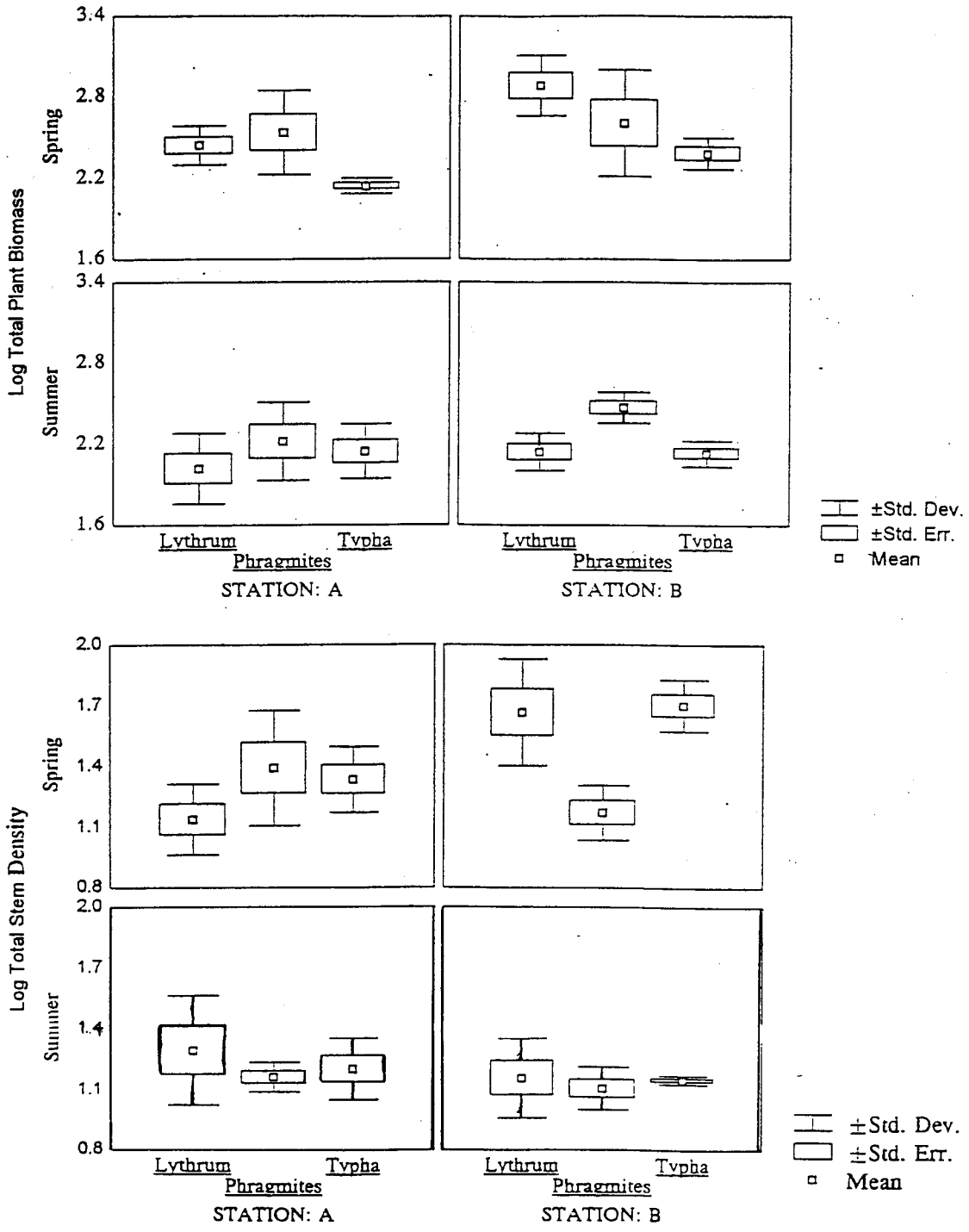

Figure 2. Total plant biomass and total stem density by season, station, and plant community.

Table 1. **ANOVA results for log-transformed variables.**

		df	MS	F	p
Plant Biomass	community	2	0.35	0.52	>0.1
	season	3	0.67	4.78	0.05*
	station	6	0.14	0.29	>0.1
	error	48	0.48		
Stem Density	community	2	0.11	0.36	>0.1
	season	3	0.29	1.42	>0.1
	station	6	0.20	0.61	>0.1
	error	48	0.33		
Plant Biomass/ Stem	community	2	0.71	2.37	>0.1
	season	3	0.30	2.93	>0.1
	station	6	0.10	2.62	<0.05*
	error	48	0.04		
Insect Biomass	community	2	<0.01	0.71	>0.1
	season	3	<0.01	7.00	<0.025*
	station	6	<0.01	5.00	<0.005**
	error	48	<0.01		
Insect Density	community	2	5.32	13.30	<0.05*
	season	3	0.40	1.87	>0.1
	station	6	0.21	1.89	>0.1
	error	48	0.11		
L. phragmitella Biomass	season	3	<0.01	3.30	0.1000
	station	6	<0.01	1.50	>0.1
	error	48	<0.01		
L. phragmitella Density	season	3	0.86	13.17	<0.005**
	station	6	0.07	1.48	>0.1
	error	48	0.04		

df = degrees of freedom MS = mean square * = significant ** = highly significant

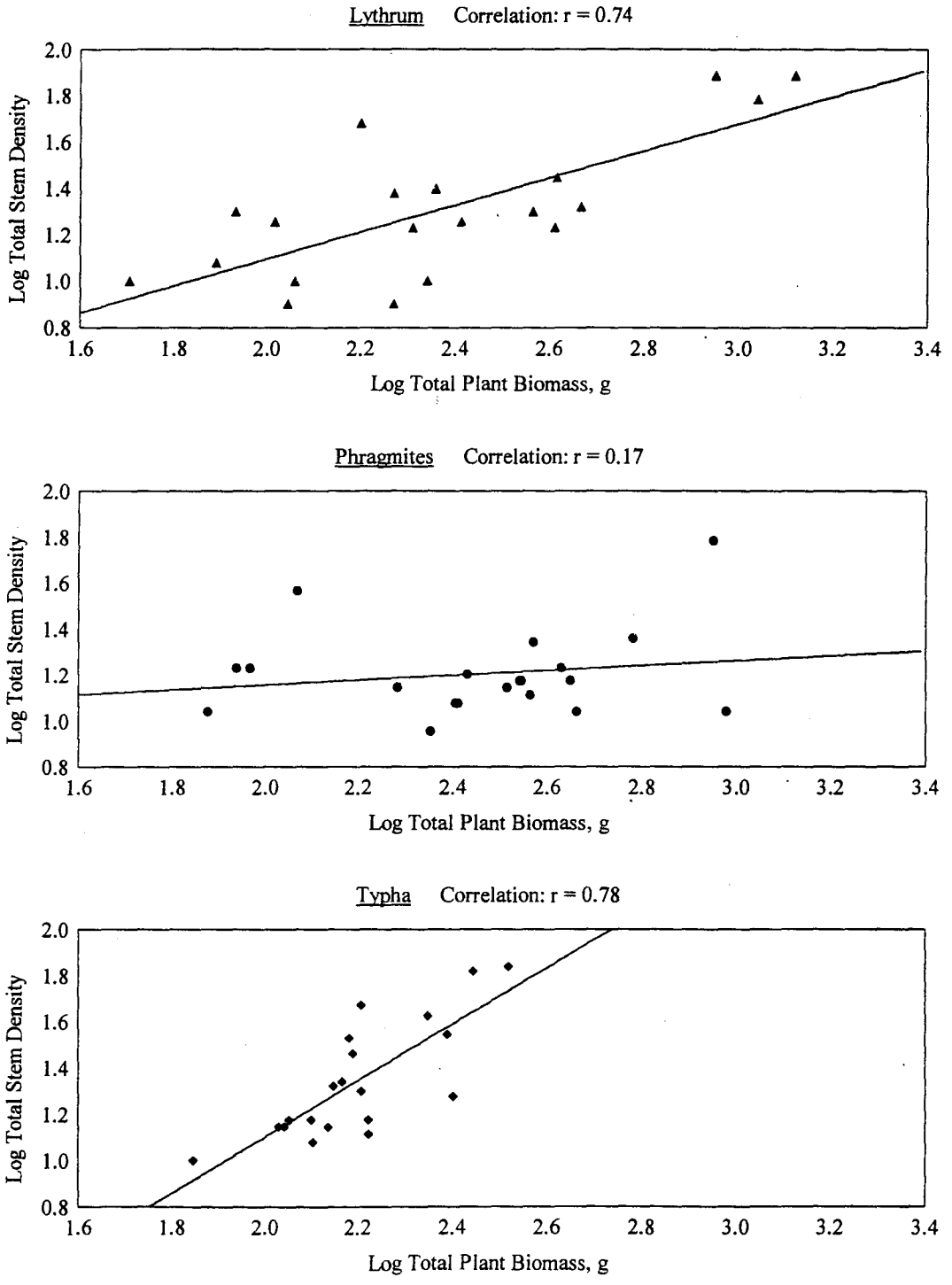

Figure 3. Log total stem density versus log total plant biomass for the three plant communities.

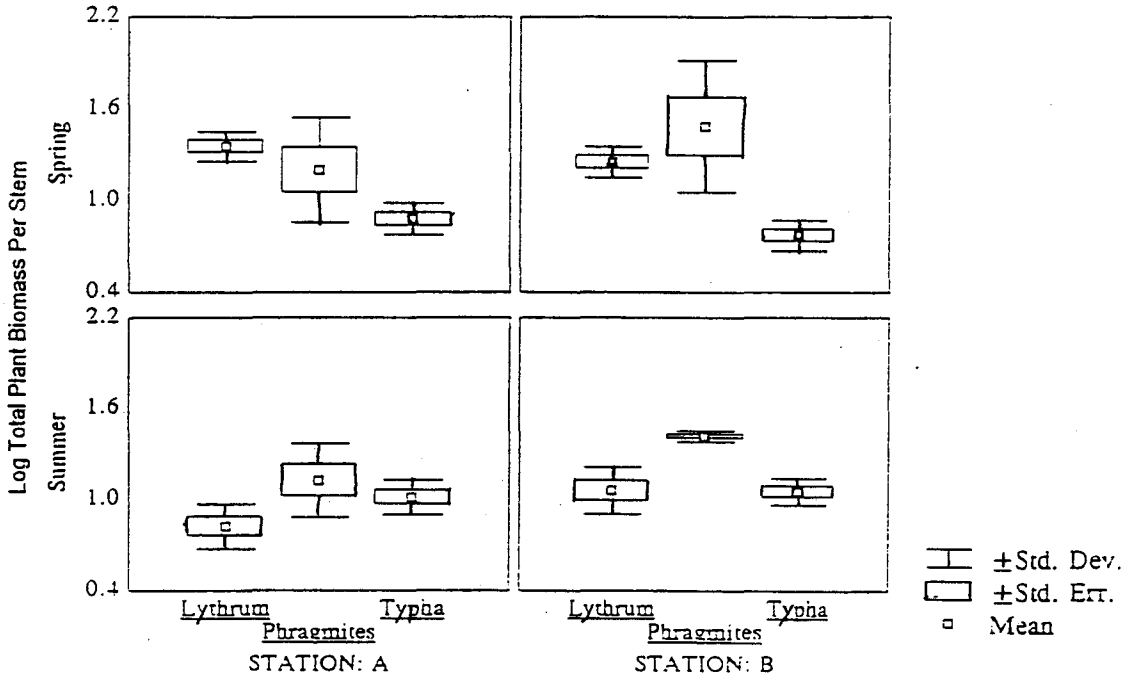

Figure 4. Total plant biomass per stem by season, station, and plant community.

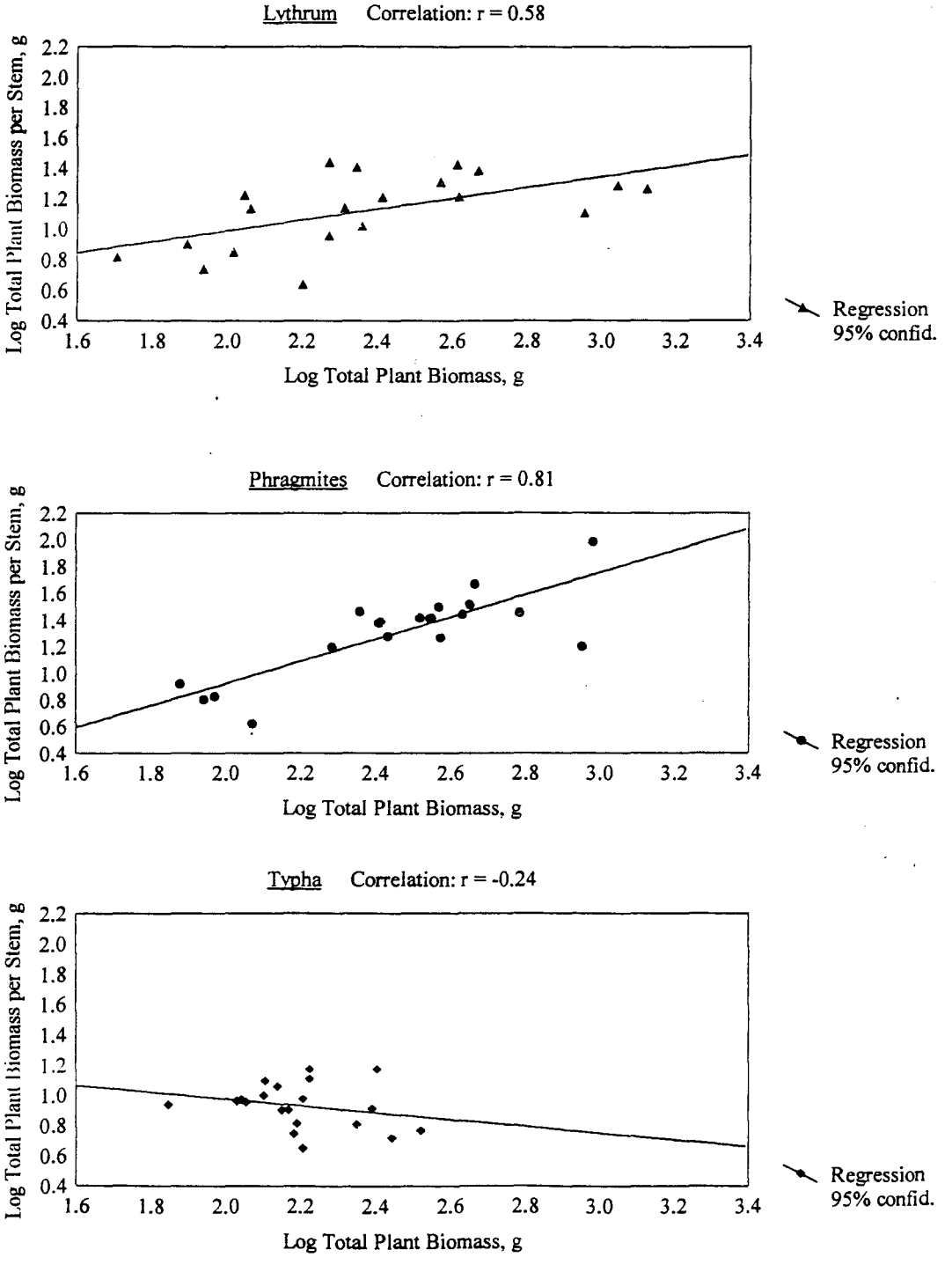

Figure 5. Log total plant biomass per stem versus log total plant biomass for the three plant communities.

Table 2. Insect taxa and numbers per 1.25 m^2 (i.e., 5 samples) found in Lythrum salicaria, Phragmites australis, and Typha angustifolia

	L. salicaria				P. australis				T. angustifolia			
	SPR		SUM		SPR		SUM		SPR		SUM	
	A	B	A	B	A	B	A	B	A	B	A	B
Coleoptera:				20			2	1			3	
Cantharidae:												
Cantharis sp.		2								1		
Carabidae:												
Clivina americana		1										
Stenolophus fuliginosus		1										
Coccinellidae:												
Scymnus (Pullus)					1							
Collembola:												
Arthropleona:												
Poduridae				16				1				
Diptera:	1	2		1		481		1		29		
Cecidomyiidae					32							
Chironomidae												1
or Culicidae			1									
Muscidae											1	
Unidentified pupae			1		6							
Hemiptera:												1
Anthocoridae			1									
Homoptera:												
Aphididae:												
Hyalopterus pruni							44	6				
Cercopidae				2								
Cicadellidae:			2	1								
Graphocephala coccinea								1				
Coccoidea:				3			184					6
Chaetococcus phragmitidis					287	393		909				
Unidentified nymph				1								

Table 2. continued

	L. salicaria				P. australis				T. angustifolia			
	SPR		SUM		SPR		SUM		SPR		SUM	
	A	B	A	B	A	B	A	B	A	B	A	B
Hymenoptera:												
Braconidae								1				
Pelecinaidea or Proctrupoidea								1				
Platygasteridae						90						
Pteromalidae								2				
Lepidoptera:			6									
Momphidae	106	34			3							
Tineidae:												
Lymnaecia phragmitella		20							67	41	17	17
Thysanoptera			1									
Unidentified Order		2	5	3	1							

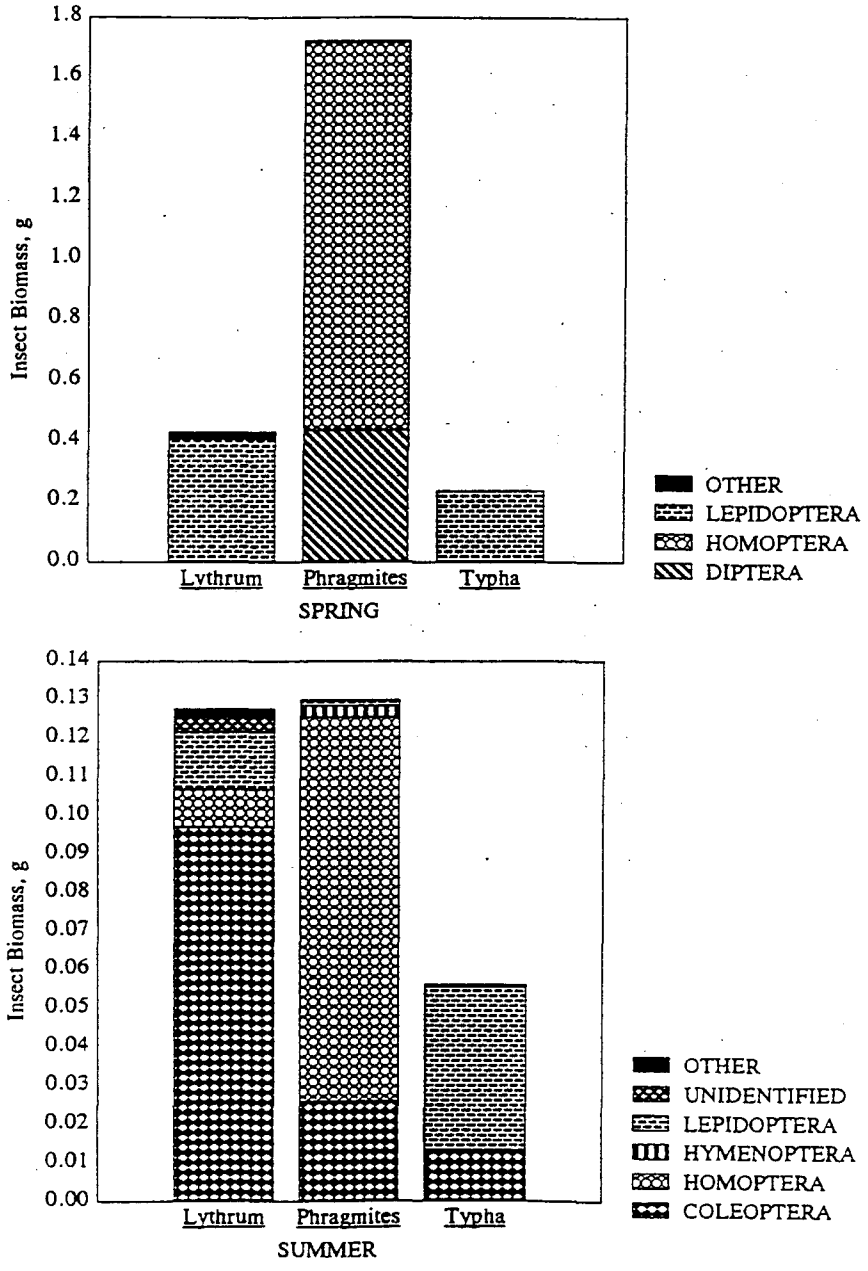

Figure 6. Spring and summer insect biomass in each order for the three plant communities. In the spring, the category other includes Coleoptera, Hymenoptera, and insects that were not identified to order. In the summer, the category other includes Collembola, Diptera, Hemiptera, and Thysanoptera.

Dipterans accounted for the remainder of insect density and biomass on P. australis (Table 2, Fig. 6). Insect density and biomass on L. salicaria and T. angustifolia were dominated by the order Lepidoptera in the spring (Fig. 6).

In the summer, nymphal scale insects and adult aphids (Homoptera) made up the majority of insect density and biomass on P. australis (Table 2, Fig. 6). Adult and larval coleopterans were present on all three species and accounted for the highest density and biomass on L. salicaria (Table 2, Fig. 6). Lepidopterans dominated the insect fauna on T. angustifolia and were still well represented on L. salicaria (Table2, Fig. 6). The most insect taxa were present in the summer and on L. salicaria (Fig. 6).

Phragmites australis had higher total insect biomass than L. salicaria and T. angustifolia in the spring (Fig. 7). The three plant communities had similar total insect biomass in the summer. Seasonal and station differences in total insect biomass were significant (Table 1).

Total insect biomass did not vary with total plant biomass (Fig. 8) or with total plant density (Fig. 9). Differences in total insect density among the three plant communities paralleled differences in insect biomass in the spring (Fig. 7). These differences in total insect density were also apparent during the summer. In both seasons P. australis had higher total insect density than the other two plant communities (Fig. 7). Community differences in total insect density were significant (Table 1). The majority of insect biomass and density on P. australis consisted of C. phragmitidis, a homopteran specific to the plant. Total insect density did not vary with total plant biomass (Fig. 10) or with total plant density (Fig. 11).

The lepidopteran L.phragmitella was found on T. angustifolia at both stations in both seasons (Fig. 12). It was also found on L. salicaria at station B in the spring. Total density on T. angustifolia at station B in the spring was significantly higher than on L. salicaria (Fig. 8 and Table 1).

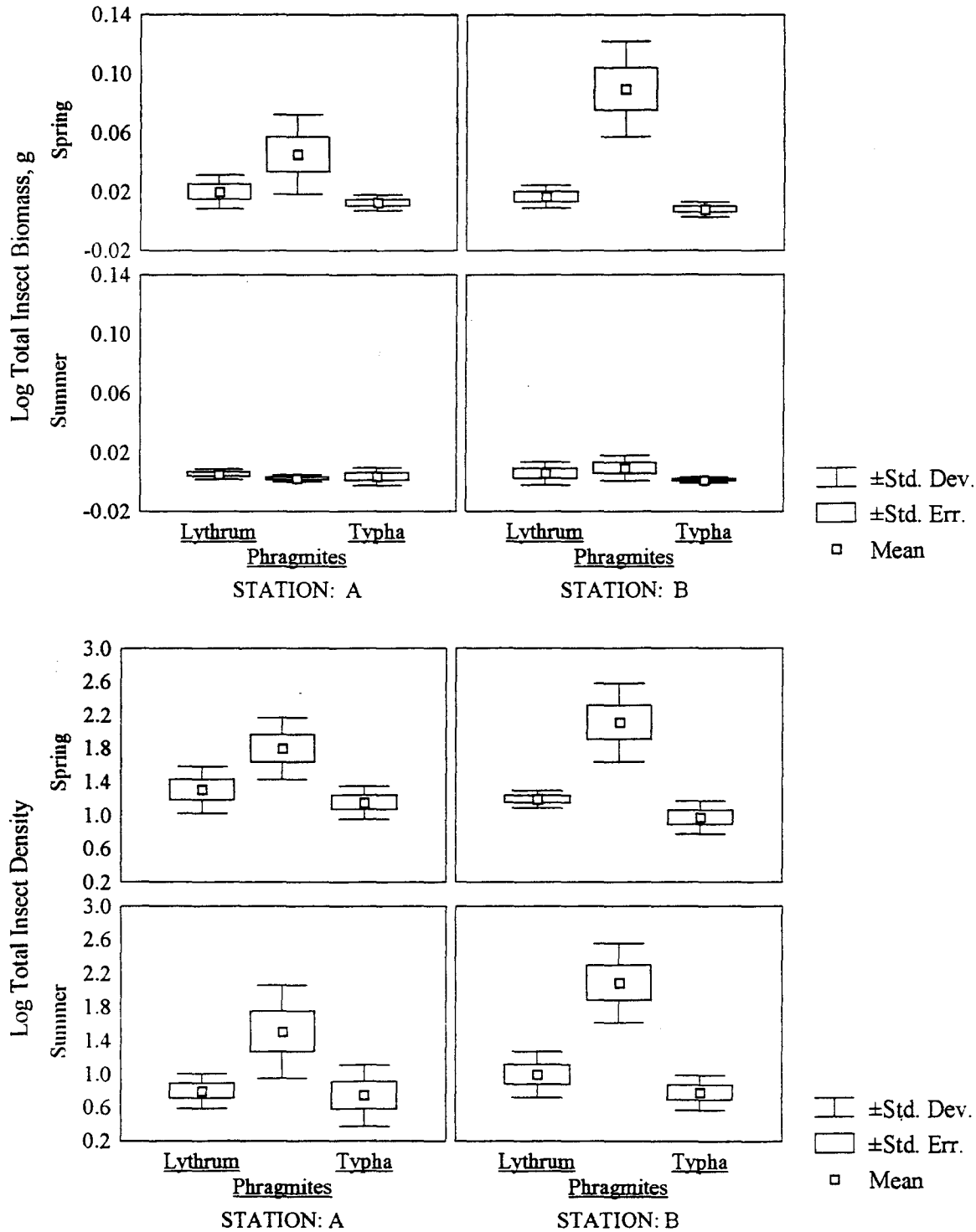

Figure 7. Total insect biomass and density by season, station, and plant community.

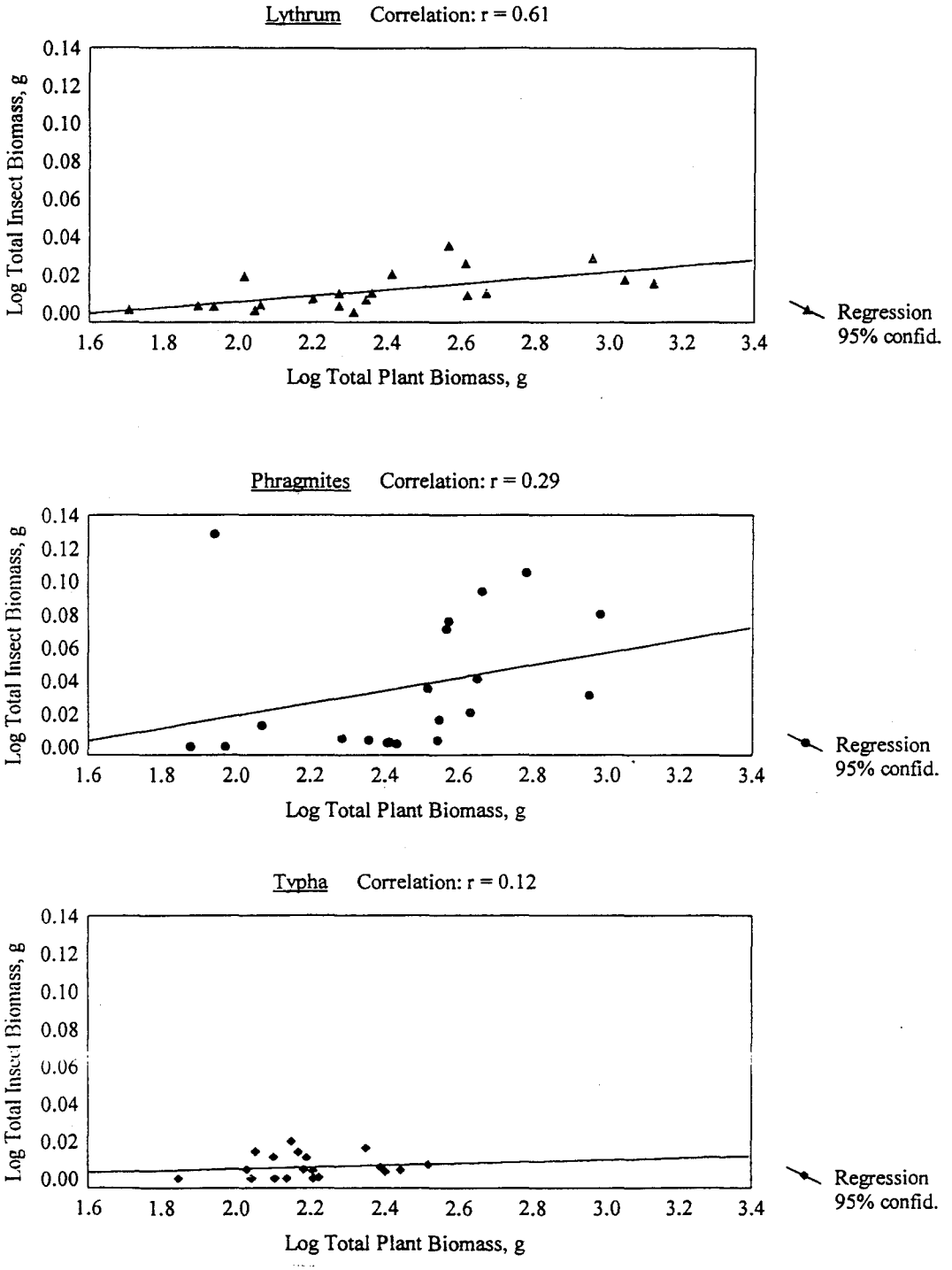

Figure 8. Log total insect biomass versus log total plant biomass for the three plant communities.

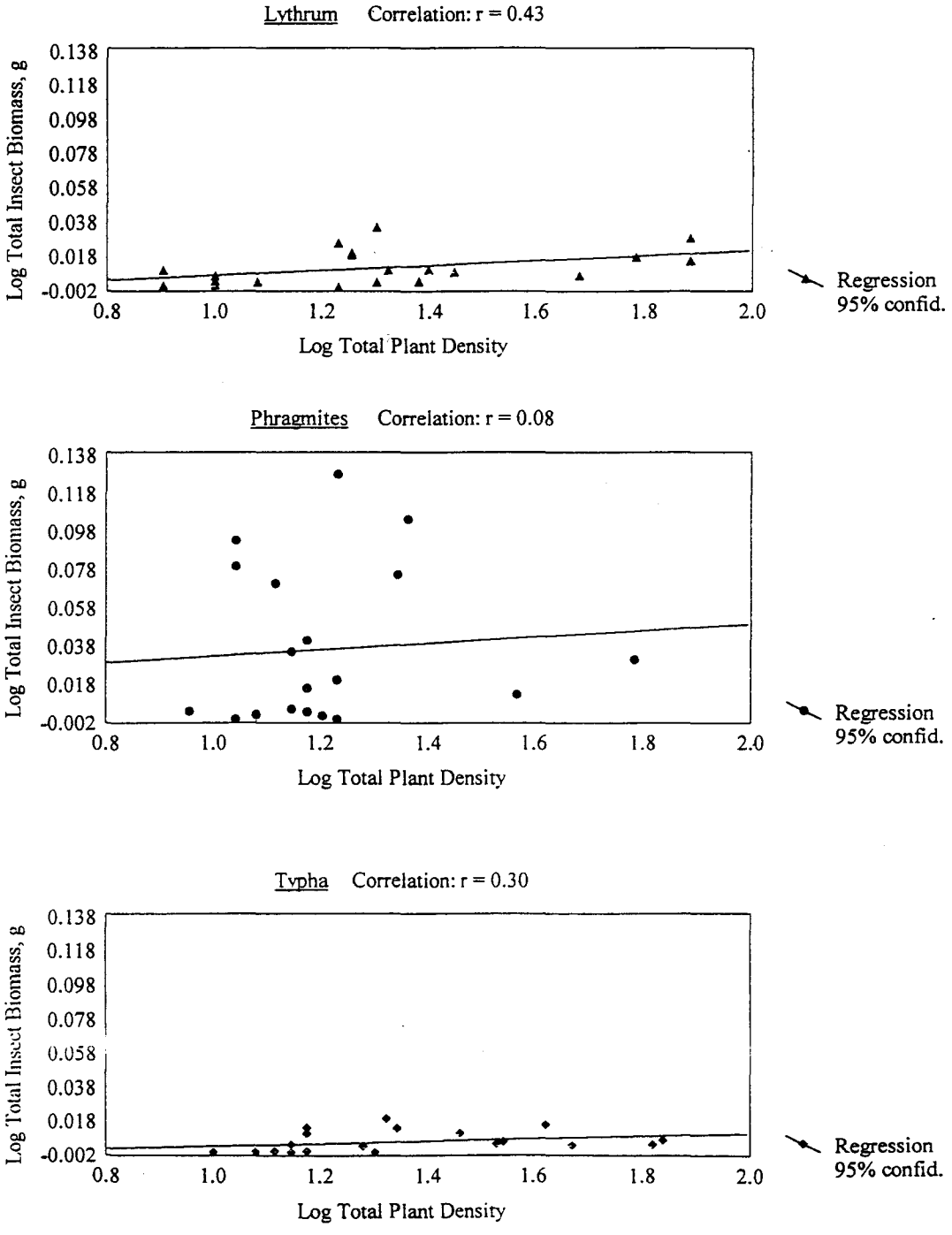

Figure 9. Log total insect biomass versus log total plant density for the three plant communities.

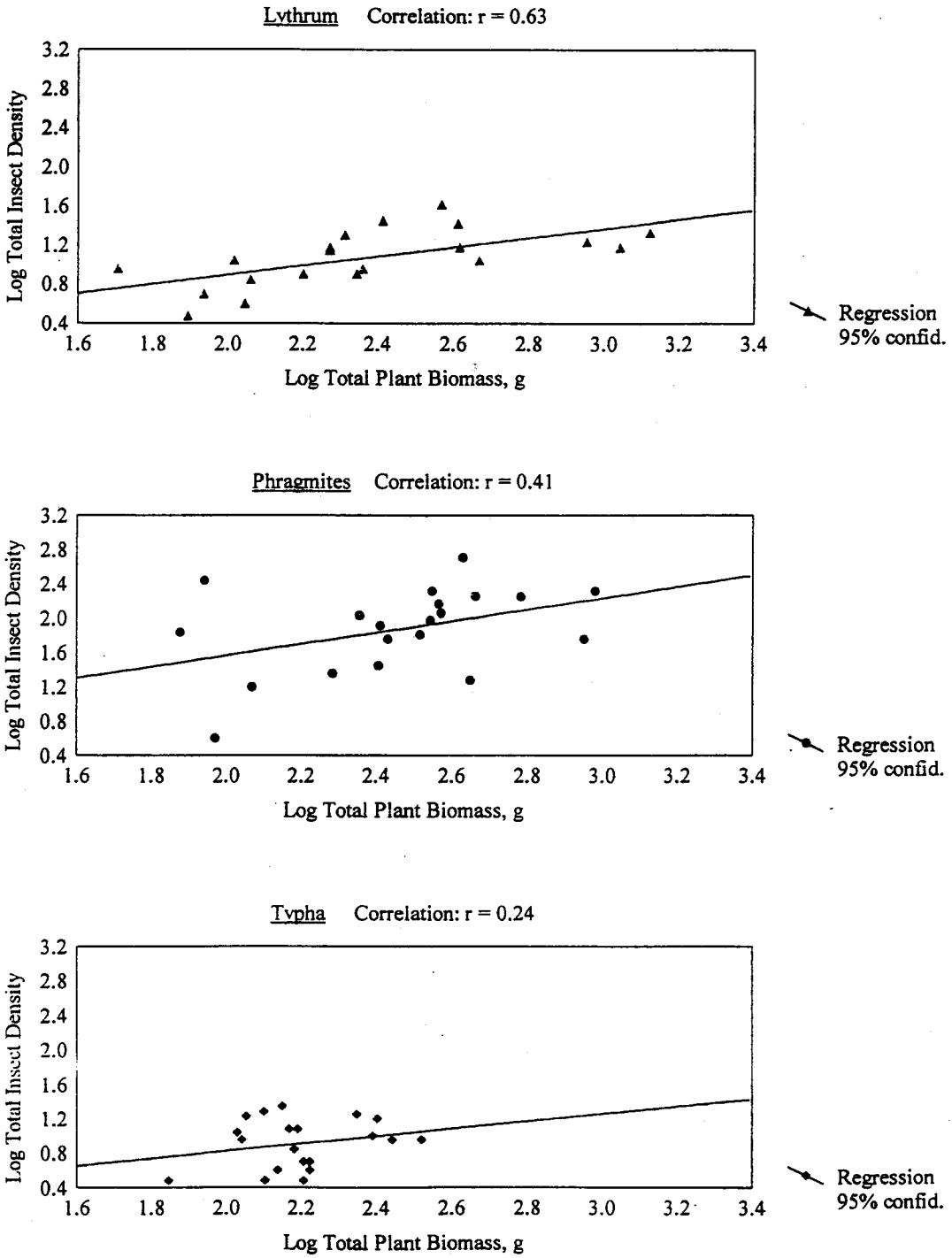

Figure 10. Log total insect density versus log total plant biomass for the three plant communities.

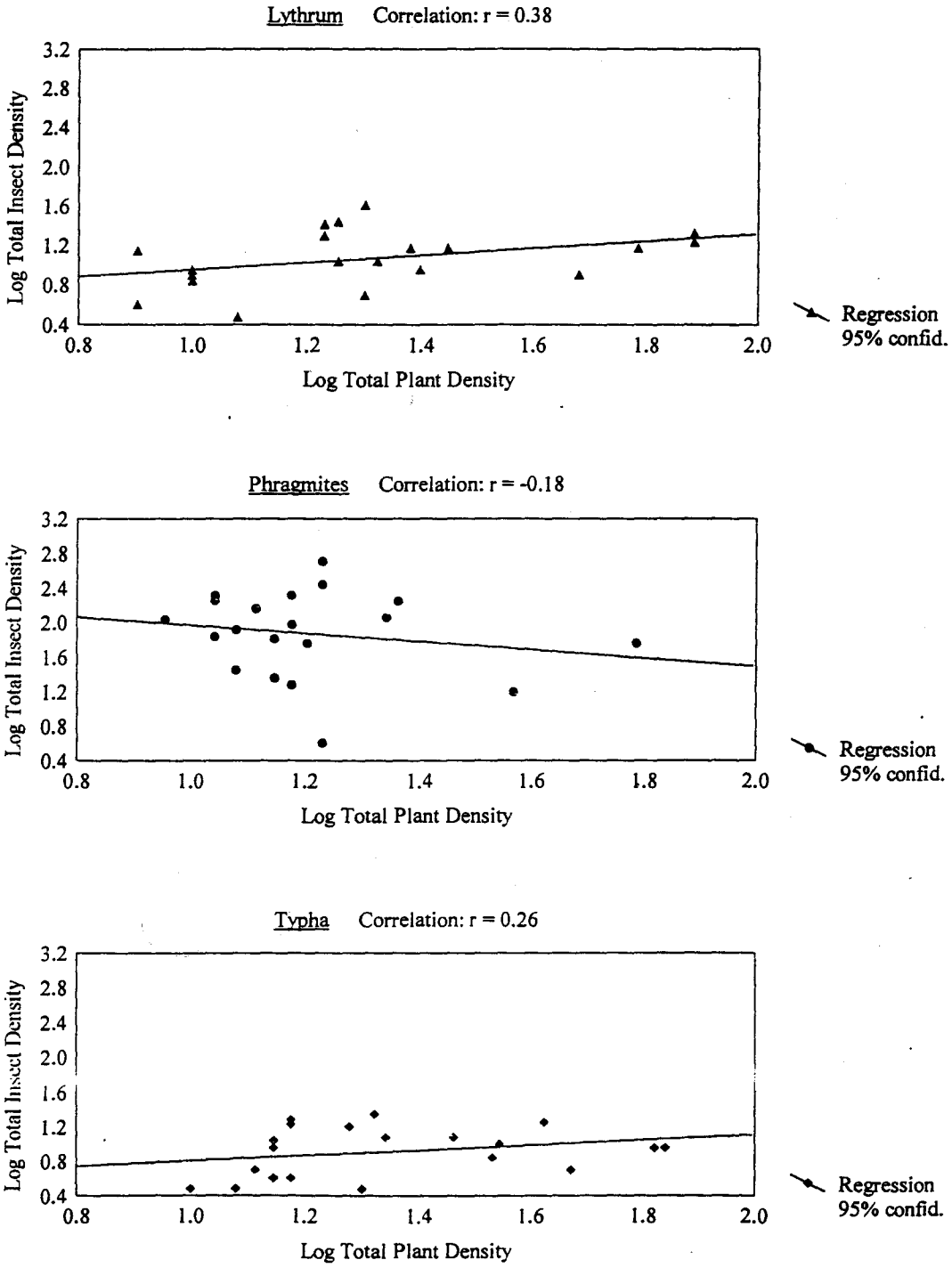

Figure 11. Log total insect density versus log total plant density for the three plant communities.

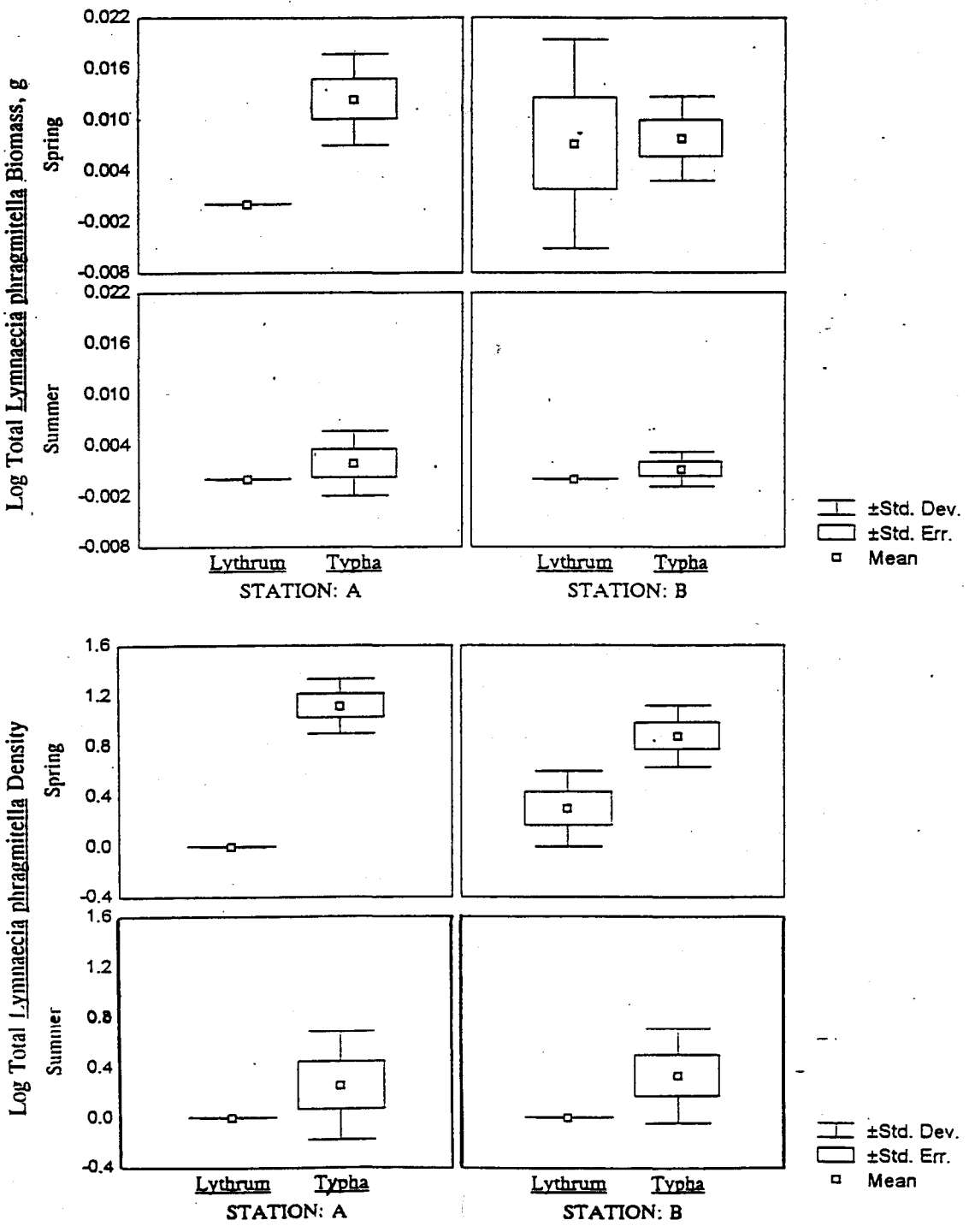

Figure 12. Total biomass and density of Lymnaecia phragmitella by season, station, and plant community.

Discussion

The three plant communities examined in this study differed from each other in biomass, stem density, biomass per stem, and insect taxa. Typha angustifolia , a native species of the marsh, tended to have lower plant biomass and lower biomass per stem than the other two plant communities. The lepidopteran L.phragmitella dominated the insects associated with T. angustifolia. Typha angustifolia supported a lower diversity of insects than the other two plant communities.

Typha angustifolia may eventually be replaced by L. salicaria and/or P. australis which are more aggressive and invasive (Blossey 1993, Marks 1994). If either species replaced T. angustifolia, essential food and cover for muskrats, and many species of waterfowl would be eliminated (Hight 1990). In addition, species composition of the marsh insect fauna would change. Lymnaecia phragmitella would likely decrease along with its host plant. The larvae of L. phragmitella are a food source for downy woodpeckers, red-winged blackbirds, and black-capped chickadees (Sipple 1990). The lepidopteran family Momphidae nearly specific to L. salicaria would likely increase with its host plant.

If P. australis replaced the native T. angustifolia, its taller denser stands would support different insect communities. For example, the homopteran C. phragmitidis which is specific to P. australis would likely increase if its host plant spreads. These insects are preyed upon by ladybird beetles (Coleoptera) which were collected in Tivoli North Bay on P. australis as well (Table 2.).

The terrestrial insects associated with L. salicaria, P. australis, and T. angustifolia represented eight orders. The prominent insect orders associated with T. angustifolia and P. australis are in agreement with earlier research. Claassen (1921) found lepidopterans to be the major insects on T. angustifolia in a non-tidal freshwater marsh in New York State. Imhof (1979) found that the order Homoptera was dominant on P. australis in Europe. Many of the same genera that were represented in Tivoli North Bay have been found in non-tidal and brackish wetlands where insects were sampled using techniques other than harvesting (Bickley and Seek 1975, Simpson 1979). If this study had included aquatic and below-ground insects and incorporated other sampling techniques, it is likely that additional insect orders would have been found (Hight 1990, Sipple 1990). For example, the orders Odonata and Orthoptera may have been found using vacuum or sweep sampling techniques (Bickley and Seek 1975, Hight 1990). The harvest sampling method used in this study did, however, capture some of the faster-moving insects such as adult leafhoppers, wasps, and moths which would usually be captured with a net or vacuum.

To acquire a true knowledge of the insect fauna in a marsh, all of the plant species need to be examined since some insects may be highly selective and host specific (Newman 1991, Halbert and Voegtlin 1994). The insect communities linked with certain plants may vary from season to season (Table 2) therefore, insects need to be sampled throughout the year. For example, sampling in this study took place before L. salicaria flowered, due to an unusually cool summer. It is likely that additional insect taxa would have been found if samples were collected after flowering. In addition, insects are often specific to certain parts of the plant (Claassen 1921). In this study L. phragmitella larvae

were found most often in T. angustifolia spikes and upper stems whereas coleopteran larvae were found in the moist lower stems. Therefore, harvesting of the entire plant would yield a more complete representation of insect communities.

Insects function as herbivores, detritivores, and carnivores (Odum et al.1984, Pedigo 1996). Changes in insect communities have the potential to alter energy flow and decomposition which may affect other marsh inhabitants (Scott 1987, Voegtlin 1995). Studies to further determine insect taxa and the roles they play in wetland ecosystem processes would be valuable for preservation, protection, management, and restoration of wetlands.

Acknowledgments

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