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Association of Aquatic Insects to Macrophytes in an Agricultural Drainage Ditch

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ABSTRACT—The aquatic insects associated with five species of aquatic macrophytes were collected and identified from a drainage ditch in Le Suer County. A total of 21,160 specimens from eight orders were recovered with Diptera being the dominant. Tests of association using the Coefficient of Community and Percent Similarity revealed a unique community associated with *Potamogeton nodosus.* Further, the authors found that the same information generated from the study could have been accomplished without the detailed taxonomy.

The purpose of this study was to investigate the association of aquatic insects to aquatic macrophytes in a South Central Minnesota agricultural drainage ditch. If strong association to specific plants was found than the use of macro-invertebrates as indicators of water quality would come under question in that the plants rather than water quality would be the distribution factor. This study also examined the value of taking aquatic insects down taxonomically for use in plant association studies which utilize the Percent Similarity and Coefficient of Community analyses.

Plant association collections were made on 7/29 and 8/5 during the summer of 1976 in Le Sueur County Ditch 59. Five species of plants including *Potamogeton nodosus, Ceratophyllum demersum, Potamogeton pectinatus, Elodea canadensis,* and *Potamogeton crispis* were collected at the first date with the latter absent at the second date. Collections were made by using an inverted five liter plastic bag which captures both those macro-invertebrates attached to and in close association with the plant (Quade, 1969(.

Bagged samples were washed over a number 25 USGS sieve screen (707 micron opening) in the laboratory and the associated insects were preserved in alcohol. The plants from the collections were oven dried at 80 degrees centigrade until no further weight loss was observed and weighed. The preserved collections were sorted under a dissecting microscope and identified. More minute taxa were identified under a 100x microscope.

The keys used for identification and taxonomy were: *"Aquatic Insects of Wisconsin,"* Hilsenhoff, W.L.; *"Larvae of the North American Caddis Fly Genera (Tricopters),* Wiggins, G.B.; *"Aquatic Insects of North America,"* Merritt/ Cummins ed.; and *"The May Flies or Ephemeroptera of Illinois,"* Burks, B.

Question of Association or Assemblage

The question as to the association or assemblage of macro-invertebrates to aquatic angiosperms has a long history of

	Potamogeton nodosus	Ceratophyllum demersum	Potamogeton pectinatus	Elodea canadensis	Potamogeton crispis
Potamogeton nodosus		97 (88)	63 (75)	63 (75)	46 (63)
Ceratophyllum demersum			73 (86)	73 (86)	48 (71)
Potamogeton pectinatus				91 (100)	48 (83)
Elodea canadensis					48 (83)
Potamogeton crispis 7/29					

investigation (Shelford, 1918; Needham, 1928; Brown, 1933; Krecker, 1939; Wilson, 1939; Juday, 1943; Andrew & Hasler, 1943; Edmundson, 1944; McGaha, 1952; Rosine, 1955; Gerking, 1957).

Much of the early research dealt with the size and shape of the aquatic angiosperms and their influence as substrate on the macro-invertebrates. Shelford (1918) proposed that one could probably remove all the larger aquatic plants and substitute glass structures of the same form and texture without greatly affecting the immediate food relations. Plants which have a greater leaf dissection were found to harbor a greater animal population (Andrew & Hasler, 1943; Rosine, 1955; Gerking, 1957). Submergent vegetation generally had a greater leaf dissection and harbors a denser population. Emergent vegetation is non-leafy and hard-surfaced and was found to be not as densely populated (Krecker, 1939; Mcgaha, 1952).

While the size and shape of a plant determines the "cover" or "substrate" the plant furnishes to the invertebrates, the plant was also proposed to be a source of food (Wilson, 1939). Juday (1943) stated that by far the greater part of the material that is utilized by the aquatic animal is manufactured by the aquatic plants. Manufacturing was loosely

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Table I. Insect orders potentially associated with aquatic macrophytes, expressed as percent and number of combined plant collections of each plant.

		Potamogeton nodosus	Elodea canadensis	Potamogeton pectinatus	Ceratophyllum demersum	Potamogeton crispis	No. Specimens	Percent Total	Arith. Average Plant Percent
Diptera	%	26.8	90.4	90.7	59.5	98.8		65.7	73.24
	#	1881	4152	3867	1863	2155	13918		
Hemiptera		62.7	1.4	3.0	25.1	0.6		25.5	18.56
		4400	66	130	777	12	5385		
Ephemeroptera		3.8	3.0	2.6	6.1	0.4		3.4	14.00
		266	141	110	189	9	715		
Odonata		4.1	2.0	1.3	4.4	---		2.7	2.36
		292	92	57	137	---	578		
Coleoptera		1.0	3.0	2.1	4.2	0.1		2.1	2.08
		74	136	91	133	3	437		
Lepidoptera		1.3	<.1	<.1	.6	<.1		.6	0.40
		91	4	5	20	2	122		
Megaloptera		.02	---	---	---	---		<.1	<.01
		2	---	---	---	---	2		
Tricoptera		.02	---	---	<.1	---		<.1	<.10
		2	---	---	1	---	3		
No. specimens		7008	4591	4260	3120	2181	21160		
No. specimens/ gr. dry wt. plant		26.7	16.9	37.3	25.5	78.7			
No. of Collections		9	8	9	9	2	37		

interpreted to include the layer of periphyton found on the submerged plant surfaces. The greater number of aquatic invertebrates utilize the periphyton (aufuchs) consisting of bacteria, protozoa, and algae, instead of the actual plant tissue (Rosine, 1955).

The plant surfaces introduce new ecological conditions which are reflected by an adjustment on the part of the fauna (Rosine, 1955). Brown (1933) noted that Bryozoans avoided the plant Chara because of the odorous, sulfur-containing compound it secreted. The individual chemistry of other types of plants could have a similar effect on other macro-invertebrates. Even the changing plant chemistry as it ages and dies affects the abundance of animals present (Krecker, 1939).

Water quality, however, cannot be ignored. The chemistry of the water is of prime importance to the plant and those smaller plants and animals which depend on it for support, protection, and food (Wilson, 1939). The character of the periphyton must be varied in different types of water, so far as the presence or absence of sensitive species are concerned (Edmundson, 1944). In the same way that plants affected the invertebrates directly and indirectly as a food source, so too, the water chemistry has a direct and indirect effect.

McGaha (1952) discussed factors external to the plants which tend to reduce the invertebrate populations. Silt tends to settle in stems, petioles, and leaves, both submergent and floating, making it difficult for invertebrates to cling to plant surfaces. It clogs pores, mines, and burrows of the animals and inhibits the growth of a periphyton layer. Secondly, pollution, in terms of oil and gasoline residues left by recreational vehicles, interferes with insects living on submerged structures. Finally, water turbulence inhibits plant growth and tends to wash off those invertebrates which are not optimum clingers.

A total of 21,160 aquatic insects from 37 samples within a single plant bed were collected, identified, and tabulated in our study (Table I). Approximately one-third were collected on *Potamogeton nodosus* the only floating leaved aquatic

	Potamogeton nodosus 7/29	Potamogeton nodosus 8/5	Ceratophyllum demersum 8/5	Ceratophyllum demersum 7/29	Potamogeton pectinatus 8/5	Potamogeton pectinatus 7/29	Elodea canadensis 7/29	Elodea canadensis 8/5	Potamogeton crispis 7/29
Potamogeton nodosus 7/29		72 (75)	74 (100)	58 (100)	55 (83)	69 (100)	58 (100)	71 (100)	59 (83)
Potamogeton nodosus 8/5			71 (75)	47 (88)	41 (63)	67 (75)	57 (75)	62 (75)	32 (63)
Ceratophyllum demersum 8/5				59 (86)	41 (83)	81 (100)	63 (100)	76 (100)	46 (83)
Ceratophyllum demersum 7/29					61 (71)	65 (86)	67 (86)	59 (86)	61 (71)
Potamogeton pectinatus 8/5						52 (83)	60 (83)	60 (83)	53 (66)
Potamogeton pectinatus 7/29							71 (83)	86 (100)	46 (83)
Elodea canadensis 7/29								73 (100)	52 (83)
Elodea canadensis 8/5									45 (83)
Potamogeton crispis 7/29									

	Potamogeton nodosus	Ceratophyllum demersum	Potamogeton pectinatus	Elodea canadensis	Potamogeton crispis
Potamogeton nodosus		53 (62)	31 (35)	34 (34)	28 (28)
Ceratophyllum demersum			69 (69)	68 (69)	50 (61)
Potamogeton pectinatus				69 (98)	52 (92)
Elodea canadensis					81 (92)
Potamogeton crispis 7/29					

	Potamogeton nodosus 7/29	Potamogeton nodosus 8/5	Ceratophyllum demersum 8/5	Ceratophyllum demersum 7/29	Potamogeton pectinatus 8/5	Potamogeton pectinatus 7/29	Elodea canadensis 7/29	Elodea canadensis 8/5	Potamogeton crispis 7/29
Potamogeton nodosus 7/29		72 (77)	45 (58)	32 (34)	26 (27)	24 (26)	25 (26)	24 (25)	21 (22)
Potamogeton nodosus 8/5			62 (79)	46 (51)	40 (45)	39 (42)	41 (44)	39 (41)	34 (36)
Ceratophyllum demersum 8/5				59 (70)	62 (63)	59 (60)	61 (62)	43 (60)	41 (53)
Ceratophyllum demersum 7/29					62 (91)	71 (90)	83 (92)	79 (90)	72 (84)
Potamogeton pectinatus 8/5						84 (95)	64 (97)	49 (95)	44 (90)
Potamogeton pectinatus 7/29							76 (97)	64 (99)	58 (93)
Elodea canadensis 7/29								79 (94)	76 (91)
Elodea canadensis 8/5									86 (93)
Potamogeton crispis 7/29									

macrophyte. Diptera were found to be dominant on all plant species except *Potamogeton nodosus.* Hemiptera were dominant on *P. nodosus* and second in rank on all others except *Elodea canadensis.* These observations further held true when the lumped plant collections were divided into dates of collection.

In all summed plant collections, Table I, the 80 percent level was reached by adding Diptera and Hemiptera. The unique plants, as regards insect association, were *Potamogeton nodosus* and *Ceratophyllum demersum.* A strong association of Hemiptera to these plants was observed. Megaloptera were found associated with only *Potamogeton nodosus* and Tricoptera only with *P. nodosus* and *C. demersum.*

Measurements of Community Type

Since we were sampling a flowing water environment in a single macrophyte bed we could assume little water chemistry or sediment difference. We then applied two measurements of community type. First the Jaccard coefficient of community was calculated. This statistic measures relative similarity of species composition; it overemphasizes minor species compared to large differences in dominant and major species. We were not able to get good segregation of community-types with the coefficient of community.

Much better results were obtained by computing the percent similarity:

$PS_C = 100 - 0.5 \quad a\text{-}b \quad = \min(a,b)$

in which a and b are the percentages of a species in samples A and B. The percent similarity measures relative proportions of species in collections and provides a numerical index for comparing communities. The weakness of the measurement is that it tends to overvalue shared dominant species and undervalue compositional differences.

Coefficient of Community analysis based on summed plant -insect data shows that *Ceratophyllum demersum* and Potamogeton nodosus *share similar species as well as Elodea canadensis* and *Potamogeton pectinatus* (Figure 1). The arrangement of plants in a matrix (order based on an attempt to force the highest percentages to the diagonal) remains the same order whether one uses 29 taxa or 8 orders. The mean in going to fewer taxa (orders) for the determination of the coefficient increases from 65 to 81 and the range decreases from 97-46 to 100-63. Figure 2 shows the impact of breaking down the plants collections to sums for each of the dates sampled and then generating a matrix. The best matrix order as shown places similar plant taxa next to each other and results in the same order as in Figure 1. It is seen that similar plant taxa at different dates show both high Coefficient of Community *(Elodea canadensis)* and low *(Potemogeton pectinatus).* The means of these coefficients are remarkably similar to Figure 1 for the 29 taxa versus 8 orders (60.3 to 84.8) with the range decreasing 86-32 to 100-63. *Potamogeton nodosus* and *Ceratophyllum demersum* do not separate out in our Coefficient of Community analysis.

Percent similarity community analysis in Figure 3 results in a best fit matrix with the same order as the Coefficient or Community generated. However, *Potamogeton nodosus separates out as being unique with low values to the others.* separates out as being unique with low values to the others. *Ceratophyllum demersum,* to a lesser degree, also has lower values. In comparing the results obtained from 29 taxa to 8 orders the mean increases from 53.5 to 64.0 and the range increases 28-81 to 28-98.

When broken down to sampling date the same order of plants persist (Figure 4). The mean increases when going from 29 taxa to 8 orders from 53.9 to 66.4 and the range increases from 21-86 to 22-99. *Potamogeton nodosus* again stands out as having low association values to the other plants and *Certophyllum demersum* is intermediate at one date only.

Biological organisms as water quality or environmental quality indicators

We believe that our data shows that the presence of aquatic insects reflects the presence of aquatic macrophytes and that there does exist some specific associations. The cause of these associations is not known at this time. Further, the information gained in our study could have been derived by stopping with the eight orders rather than taking the specimens down taxonomically to 29 taxa.

If one were to utilize aquatic insects as biological indicators of water quality two questions should be asked. Have all plant species present been sampled? Would there be different species present if other plants were there? Perhaps aquatic insects indicate a broader "environmental quality" rather than "water quality."

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The Demographic Characteristics of 1860 New Ulm, Minnesota, Germans

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ABSTRACT—Demand for an increase in ethnically oriented course materials led to this study of the 1860 New Ulm (Minnesota) German community as an example of ethnic migration and community establishment. The New Ulm German community was defined for the purposes of this study as the 598 German-born adult migrants living in New Ulm and its functionally connected area in 1860. Detailed information concerning the specific places of origin, migratory routes and sequences of intervening stops, and organizational networks of support was collected. A series of maps and graphs represents the migration patterns.

The story of the foundation of the settlement of New Ulm, Minnesota, has been written in at least a half dozen books and articles. (See Tyler and Johnson). There is a fair amount of disagreement in detail between these histories though the rudimentary outline is fairly consistent. What emerges is an account of the establishment of an ethnic community on what were then the frontiers of settlement.

The German settlement of New Ulm arose out of the turbulent atmosphere of contending cultures prevailing in America in the 1850's. On the one hand was the Nativist movement which found its supporters from among the dominant Anglo-Saxon, Protestant population of the nation. Nativism had as its focal issue the violent opposition to further immigration to the United States of either Irish "Papists" or German "Anarchists". On the other hand, there was the "Germanism" or extreme pride in German cultre of many German immigrants. When these two social forces came into contact friction was bound to develop.

It was in response to nativist friction and to the perceived threat to German cultural values that two organizations dedicated to the promotion of German settlement schemes were founded. The Chicago Land Scoiety was founded in 1853 by F. Beinhorn and the Turner Settlement Association was established at Cincinnatti in 1856 by W. Pfaender. The two organizations were to coalesce in the latter half of the 1850's in the settlement of New Ulm. The goal of settlement in Pfaender's words was the protection of the German workingman from the "prejudices and arrogance of the Native Americans which becomes more crass from day to day". The settlement was to provide the German settler with the advantage that the insane, degrading, mortifying attempts of our Anglo-American taskmasters to restrict us could not operate, that we would have the opportunity to enjoy the rights guaranteed to us by the Constitution and to become happy and blessed after our own fashion.

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The concern in this study has been to add some flesh to the bare bones of the story of the foundation of the town of New Ulm. In order to accomplish this end, the authors formulated a set of questions concerning specific characteristics of the founding population and of their migration experience. Archival resources in both the United States and Germany were utilized in the attempt to answer a few primary, factual questions which had not previously been addressed in the literature. Specific querries were concerned with the provisions of information concerning:

1. the demographic characteristics of the population at the time of settlement

2. the specific places of origin of the German born adult founding population

3. the sequence of migrations and routes taken to New Ulm

4. the extent of the influences of land societies in the bringing about of settlement.

Demographic Characteristics and Migration Patterns

One query had to do with the demographic characteristics of the German born adult population of New Ulm Township and adjacent, functionally related areas. In 1860 Brown County in southern Minnesota was on the settlement frontier and had a population of only 2,339. Of this total 1,357 or 58 percent were foreign born. Many among the American born population of the county were children born to freign immigrants in Minnesota or in various states in which the parents had resided prior to migrating to Brown County.

An age-sex pyramid for Brown County in 1860 (Figure 1) shows some interesting features of that group. The pyramid is characteristic of the population of a newly developing area. An interesting feature is the relative balance between males and females, especially in the 20-60 age bracket. The study group shows a similar balance among male and female adults of German origin (338 males to 260 females). The proportions are a peculiarity of the German immigrants of the Nineteenth century in general. For example, during the period from 1846-1860 German immigrant groups averaged