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An Ecological Analysis of Silver Lake Fen I. The Aquatic Metazoan Fauna

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An Ecological Analysis of Silver Lake Fen I. The Aquatic Metazoan Fauna[1]

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Abstract. The aquatic metazoan fauna and physico-chemical features of the Silver Lake Fen, Dickinson County, Iowa, were investigated. The pools displayed high values of alkalinity, calcium and total hardness, sulfate and dissolved solids; neutral to alkaline conditions; and extreme diurnal variability in dissolved gasses, pH and temperature. Fifty metazoan species have been collected from this unique and rigorous habitat, with nine species being most abundant and widespread. Possible causal factors dealing with population dispersion are discussed.

INTRODUCTION

The Silver Lake Fen, located in Section 32, Dickinson County, Iowa (R-38-W, T-100-N), has received considerable study. Shimek (1915) referred to the floral components of the fens. Carter (1939) studied certain of the fen's physico-chemical features and Anderson (1943), Conard (1952), Dodd (1955), and Gashwiler and Dodd (1961), have investigated the fen flora. Research on the protozoa of the fen pools has been done by Hempstead (1938), Hempstead and Jahn (1939), and Johnston (1948). Most recently, Durkee and Hager have initiated studies of the pollen profile of the peat sediments (Personal communication).

This report is concerned with an unexplored aspect of this habitat—the metazoan fauna of the fen pools. A future publication will deal with the geological aspects.

PHYSIOGRAPHY

Silver Lake, with the fen situated on its southwest border, occupies a large pothole in the Bemis moraine of the Cary drift. The fen has developed above glacial drift and clay; situated within the area of the fen are five mounds of peat "fen mats", generally characterized by the presence of small, shallow pools (Figure 1.) The largest of these fen mats (Number 1) was selected for this study.

This fen mat encompasses an area of 3696 m^2 (0.9 acre) and ranges from a mound of peat six meters above the level of the lake to an expanded area within one meter of lake level (Figure

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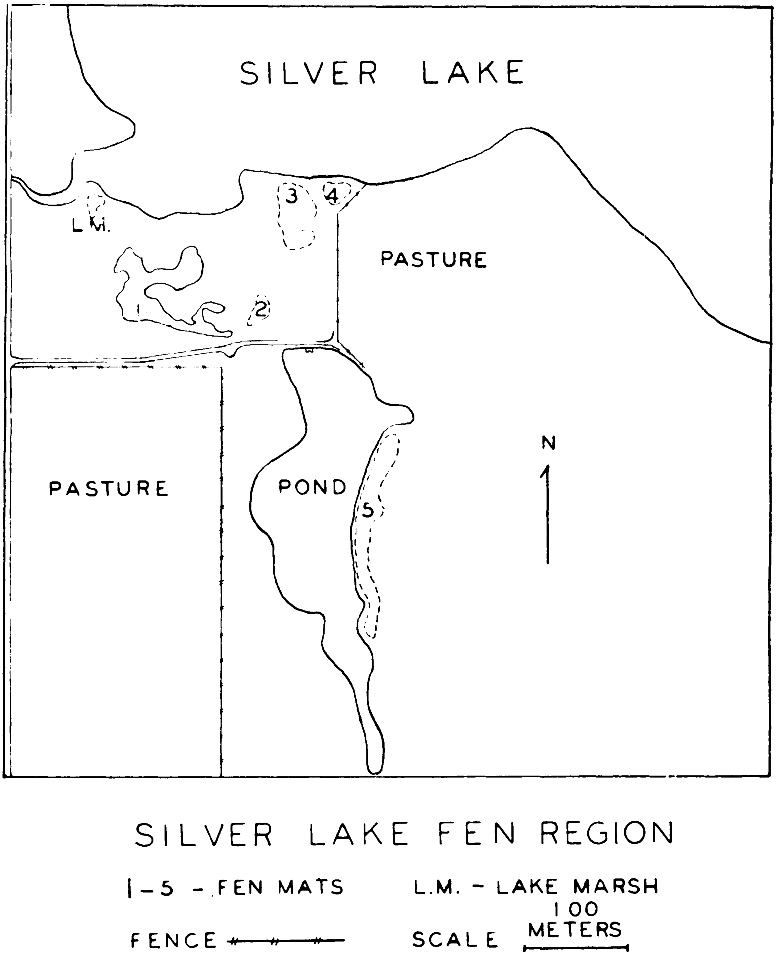

Figure 1. Silver Lake Fen Region

Table 1. Areas of Fen Mat and Included Contours and Zones*

Total Fen Mat—3696	
Contours of Fen Mat	Fen Zones
0-1m—160	East— 570
1-2m—1710	South— 610
2-3m—772	West—1170
3-4m—223	North—1346
4-5m—218	
5-6m—592	
Above 6m—21	

* All numbers in m^2.

2 and Table 1). The zone enclosed within the 1- to 2-meter contour accounts for almost one-half the area.

The major floral zones are included in Figure 3. A dense stand of *Phragmites communis* occupies the fen hillock which partially divides the fen mat. The mat generally has a very low vegetative cover with *Rhyncospora capillacea* and *Lobelia kalmi* especially prevalent. Much of the margin of the mat is fringed by *Parnassia glauca. Chara hypnoides* was commonly found in the pools, and emergent growths of *Scirpus* and *Triclochin* occurred in the shallow pool margins.

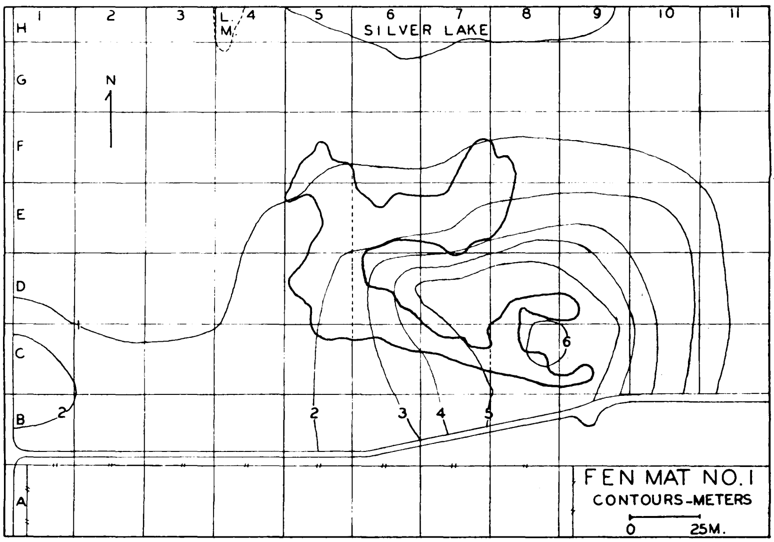

Figure 2. Fen Mat No. 1

Chemistry

Analyses for alkalinity, chloride, calcium and total hardness, iron, nitrate, nitrite, pH, ortho-phosphate, silica and sulfate were performed with a Hach Portable Water Laboratory (Model DR-E1). Volker (1962) has discussed these procedures. Dissolved oxygen was determined by means of the Rideal-Stewart modification of the Winkler method and carbon dioxide was analyzed by titration with phenolphthalein and sodium hydroxide (A.P.H.A. Standard Methods, 1960). Dissolved solids were determined by evaporating 100 ml of filtered water to dryness, drying in a deccator and weighing the sediment.

Table 2 lists the chemical data obtained for water from the pond and lake marsh and a range of values for various fen pools. The high values of alkalinity, calcium and total hardness, sulfate and dissolved solids may be noted, together with the neutral to alkaline nature of the water. Previous investigators have established that hydrogen sulfide commonly occurs in the pools (Hempstead and Jahn, 1939; Johnston, 1948).

Data obtained for a 24-hour analysis reveal great variability

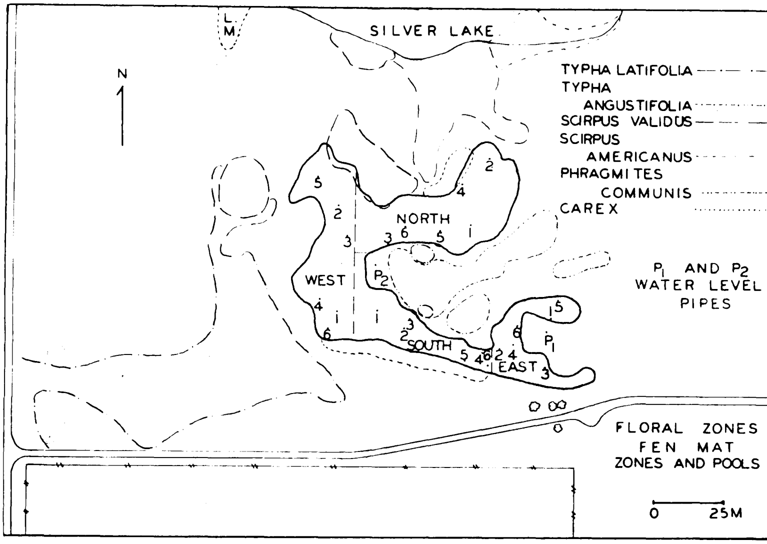

Figure 3. Floral Zones, Fen Zones and Pools

Table 2. Chemical Data*

Test	Pond	Fen Pools	Lake Marsh
Alkalinity, total	440	240-400	340
Chloride	25	25-50	50
Hardness, calcium	480	820-1200	400
Hardness total	660	1240-1550	550
Iron	0.15	0.12-4.0	0.63
Nitrate	0.55	0.1-0.50	0.75
Nitrate	<0.01	0.01-0.035	0.016
pH	7.35	6.8 -8.2	7.45
Ortho-Phosphate	0.47	0.03-0.45	0.48
Silica	12	33-300	50
Sulfate	280	840-1520	550
Dissolved solids	1030	2353-3107	1445

* All readings except pH in p.p.m.

(Table 3). Four pools, chosen to represent varied types of microhabitats were studied: E-3, a medium-sized pool; S-1, a deep pool; N-3, an extremely shallow seepage pool; and W-5, a very large pool.

Pool E-3 showed extreme fluctuations in oxygen, carbon dioxide, pH and temperature. Although anoxic conditions also developed in S-1, this pool was somewhat more stable. Situated in a seepage zone where water would be continuously replenished, pool N-3 demonstrated rather uniform conditions during a diurnal period. Finally, although W-5 did show considerable variability, the fact that anoxic conditions did not develop may be of special importance to certain aquatic species.

These results give some indication of the unique chemical nature and variability of the fen pools. Within such small bodies

Table 3. 24-Hour Analyses August 26-27, 1963.

	Pool			
	E-3	S-1	N-3	W-5
Oxygen (p.p.m.)				
0800	0.0	1.3	1.7	2.4
1200	12.85	4.7	0.95	9.2
1600	13.5	5.4	1.45	11.4
2000	8.4	1.1	2.6	6.7
2400	0.0	0.0	2.2	4.1
0400	0.0	0.0	0.9	1.8
% Oxygen Saturation				
0800	0	14	17	26
1200	150	60	10	120
1600	170	68	15	147
2000	98	12	25	77
2400	0	0	21	43
0400	0	0	8	18
Carbon Dioxide (p.p.m.)				
0800	62	50	55	27
1200	28	44	54	14
1600	8	32	48	8
2000	27	50	57	15
2400	50	50	44	12
0400	68	52	52	22
pH				
0800	7.0	7.0	7.25	7.4
1200	7.85	7.2	7.0	7.7
1600	7.7	7.05	7.15	7.7
2000	7.4	7.0	7.1	7.5
2400	7.0	6.9	7.1	7.3
0400	6.9	6.85	7.05	7.1
Temperature (C°)				
0800	18	20	17	20
1200	30	29	20	30
1600	30	28	19	29
2000	24	22	15	23
2400	18	19	15	18
0400	1500	16	14	17

of water, several factors may play a role in this variability: the ratio of aquatic vegetation to volume, overall volume, renewal of water, evaporation rates and volume fluctuations. The physical and chemical nature of the fen pools restricts the acquatic fauna in a rigorous fashion.

Fauna

For the purposes of studying the distribution and abundance of the fen pools, the fen mat area was divided into four zones: an east zone of relatively small pools, a south zone sloping from five meters to two meters in elevation, a west zone containing several large pools, and a north zone proceeding from the seepage zone along the hillock toward the lake.

Within each zone six pools were randomly selected for sampling purposes. To study the smaller animals, samples 1/400 m^2 in area were collected from the bottom deposits of the pools by means of a sheet metal tube (5x5x30 cm). Samples were re-

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turned to the laboratory where they were washed through a series of graded screens into a #25 silk bolting cloth. The flocculent material remaining in the bolting cloth was transferred to a wide-mouth bottle and diluted to 500 ml. From this solution, 5-10 ml aliquots were bottled, each bottle was inverted 50 times, then contents were counted by use of a dissecting microscope. Thus, counts represent 1/10 of the original sample.

The distribution of larger species was studied through the use of another sampling tube (20x20x30 cm) enclosing an area of 1/25 m^2. These samples were analysed at the fen.

Based upon these collections, as well as other cursory collections, a species list, together with a list of pools where the specimens were collected, has been compiled (Table 4). The total quantitative sampling data appear in Table 5. In table 6 the pools are arranged in descending order for area, mean depth, volume, species/pool and species m/3.

Discussion

Qualitative collections from the nearby pond and lake marsh have revealed an abundant and varied faunal assemblage. This is in sharp contrast to the restricted fauna of the fen. Fifty species have been recorded from the fen pools and at least one-half of these species have been found in five or fewer pools. The quantitative data reveal the following nine taxa to be most prevalent: Nematoda, *Alona sp., Potamocypris smaragdina, Physocypria sp., Enorchrus hamiltoni, Laccobius sp.*, Chironomidae, *Dasyhelea sp.*, and *Stagnicola elodes*. These same representatives are rather widespread throughout the pools.

When one considers the variability and rigorous physico-chemical conditions of this habitat, these findings are not especially surprising. A paucity of species may be expected under these conditions, but the species which are able to survive here may, and do, occur in large numbers. This is in harmony with results obtained from many diverse habitats where the number of species is severely restricted, but the number of organisms per species is very large (Hesse, et al., 1951, pp. 37-39).

Using the data from Table 6, pools of the four zones of the fen mat were compared statistically to ascertain whether zonal differences in the distribution of species existed. The tests for "analysis of variance" and "least significant difference" were used (Adler and Roessler, 1962, pp. 238-239).

The pools of the west zone were found to contain a significantly greater number of species than pools of the other three zones. However, no significant difference was found to exist between the four zones in area, mean depth, volume, or species/m^3.

Alone, therefore, the physical parameters of the pools may not be used to explain the greater abundance of species in the west zone.

One may note, however, that the pools of the west zone are on the average much larger than the pools in area and volume. This would undoubtedly increase the number of niches available. In addition, the results of the 24-hour analysis suggest that anoxic conditions may not be as likely to develop in the larger pools; such anoxic conditions may be limiting to certain species. The relative proximity to the lake and the lake marsh might also play a role in the number of immigrants to this area. These factors, as well as other undetected elements, may partially explain these observed distributional differences within the fen.

The physiological adaptations employed by the animals for existence under these unique conditions pose a challenging series of future problems.

Table 4. Species List and Pools Occupied

Fauna	Pools Occupied
Nematoda	
Genus & species?	All pools
Tardigrada	
Genus & species?	Not recorded
Annelida	
Oligochaeta	
Lumbricidae	Not recorded
Hirudinea	
Haemopsis kingi	Not recorded
H. marmorata	Not recorded
Arthropoda	
Crustacea	
Cladocera	
Alona sp.	E-1,3,4,5,6;S-2,4,5,6; W-1,2,3,4,5,6;N-1,2
Copepoda	
Genus & species?	E-2,3,4,5,6;S-2,3; W-5;N-3,5,6
Ostracoda	
Potamocypris smaragdina	E-1,2,3,4,5,6;S-1,2,4; W-1,2,3,4,5,6;N-3,4,5,6
Physocypria sp.	E-1,2,3,6;S-2,6; W-1,2,3,4,5,6;N-1,2
Genus & species?	E-2;S-1,6;W-6
Amphipoda	
Hyalella azteca	W-5
Hydracarina	
Hydrachna sp.	E-1;S-1
Insecta	
Collembola	
Isotomurus sp.	E-1;S-3;W-2,3;N-1,6
Odonata (Nymphs)	
Sympetrum obtrussum?	W-3,4,5;N-6
Liebllulid-Genus & species?	W-2,3,4,6;N-4,6
Anax junius	W-5
Chromagrion sp?	S-1,3;W-4,5

Hemiptera	
Limnogonus sp.	E-1;S-1,2;W-1,3,5,6
Gerris sp.	S-1;W-5,6;N-4,5
Belostoma sp.	
Corixid-Genus & species?	S-1;W-5;N-2
Coleoptera	
Thermonectus ornaticollis	S-1
Hydroporus tenebrosus	
Laccophilus maculosus	S-1
L. proximus	
Hygrotus impressopunctatus	E-2,5;W-4;N-5
Hydroporus niger	S-2;N-3,5
Copelatus chevrolati renovatus	
Dineutus horni	
Enochrus hamiltoni	E-1,3,4,5,6;S-1,2,3,4,5; W-1,2,3,4,5,6;N-1,2,3,5
Tropisternus lateralis nimbatus	S-1;W-3
Laccobius sp. (Probably new)	E-1,2,3,4,5;S-3,4,5,6; W-2,4,6;N-4,5,6
Berosus sp. (Larvae)	W-2,5
Cyphon sp. (Larvae)	W-6
Diptera (Larvae)	
Psychoptera sp.	E-6
Culex tarsalis	S-5;W-1
Culiseta inornata	S-2,3,6;W-1,3,6
Procladius sp.	N-2,5,6
Chironomid-Genus & species?	E-3;S-2,6;W-1,2,3,4,5,6;N-3,4,5,6
Dasyhelea sp.	E-1,3,4,6;S-1,2,3,4,5,6; W-1,2,3,4,5,6;N-2,3,4,5,6
Bezzia sp.	E-2;W-1;N-2,3
Stratiomys sp. (1)	E-1,2,4,6;S-4,5;W-2,3,6;N-4,5,6
Stratiomys sp. (2)	E-1;S-2,5;W-1,4,5;N-2,4,5
Tabanus sp. (1)	E-1
Tabanus sp. (2)	S-3;W-5
Eristalis sp.	
Mollusca	
Gastropoda	
Stagnicola elodes?	E-1,3,4,6;S-1,2,6; W-1,2,3,4,5,6; N-1,2,3,4,5,6
Physa gyrina	
Gyralus parvus	W-1,4;N-5
Oxyloma sp. (Semi-aquatic)	

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Table 5. Total Quantiative Sampling Data of the Metazoan Species

1/400 m² Samples		1/25 m² Samples	
Nematoda	300	*Hydrachna* sp.	1
Alona sp.	230	*Sympterum obtrussum*	5
Copepoda	230	Libellulid	7
Potamocypris smaragdina	260	*Chromagrion* sp.	4
Physocypria sp.	190	*Limnogonus* sp.	15
Unidentified Ostracod	25	*Gerris* sp.	7
Hydrachna sp.	6	Corixid	3
Isotomurus sp.	7	*Thermonectus ornaticollis*	2
Libellulid	3	*Laccophilus maculosus*	1
Chromagrion sp.	1	*Hydroporus niger*	6
Enochrus hamiltoni	1	*Enochrus hamiltoni*	83
Laccobius sp.	4	*Tropisternus lateralis nimbatius*	2
Ptychoptera sp.	1	*Laccobius* sp.	56
Culex tarsalis	4	*Berosus* sp.	13
Culiseta inornata	2	*Cyphon* sp.	2
Chironomid	153	*Culiseta inornata*	14
Dasyhelea sp.	437	*Stratiomys* sp. (1)	14
Bezzia sp.	8	*Stratiomys* sp. (2)	21
Stratiomys sp. (1)	22	*Stagnicola elodes*	182
Stratiomys sp. (2)	5	*Gyralus parvus*	3
Tabanus sp. (1)	1		
Tabanus sp. (2)	1		
Stagnicola elodes	9		
Gyralus parvus	1		
Total of 62 samples		Total of 43 samples	

Table 6. Comparison of Pool Size With Species Number
Ratio—Largest/Smallest

Area — m²		Mean Depth—cm		Volume—m³		Species		Species/m³	
E-5	0.109	N-3	1.0	E-2	0.0058	N-1	6	W-5	9.05
E-2	0.290	E-2	2.0	E-5	0.0063	E-5	7	W-4	29.8
S-4	0.321	S-3	2.09	S-5	0.0116	S-4	7	W-2	30.7
S-5	0.375	N-5	2.36	N-1	0.0169	S-5	8	N-4	36.3
N-1	0.434	W-3	3.0	S-3	0.0212	E-4	9	S-1	60.9
E-6	0.566	S-5	3.14	E-1	0.0236	E-2	9	N-2	78.8
E-4	0.647	E-1	3.18	S-4	0.0238	S-6	9	S-6	102
E-1	0.739	W-1	3.22	W-3	0.0262	S-3	9	E-3	123
W-3	0.872	N-6	3.41	E-4	0.0284	E-6	9	W-6	181
S-6	0.993	S-2	3.5	N-5	0.0284	E-3	10	S-2	182
S-3	1.01	W-4	3.57	N-3	0.029	N-3	10	E-6	269
N-6	1.13	N-1	3.86	E-6	0.0334	N-2	10	W-1	289
N-5	1.18	W-6	4.25	N-6	0.0384	N-4	11	S-4	294
W-1	1.51	E-4	4.36	W-1	0.0484	N-6	12	E-4	316
E-3	1.51	N-4	4.66	S-2	0.0715	S-2	13	N-6	313
W-6	1.93	E-3	5.43	E-3	0.0815	W-2	13	N-3	345
N-2	1.98	E-5	5.8	W-6	0.0831	E-1	14	N-1	355
S-2	2.04	E-6	5.92	S-6	0.0883	S-1	14	S-3	424
S-1	2.11	W-2	5.95	N-2	0.127	W-1	14	N-5	564
N-3	2.90	N-2	6.54	S-1	0.230	W-3	15	W-3	573
N-4	6.46	S-4	7.43	N-4	0.303	W-6	15	E-1	593
W-2	7.12	W-5	7.50	W-2	0.423	W-4	15	S-5	689
W-4	14.00	S-6	8.94	W-4	0.504	N-5	16	E-5	1108
W-5	28.00	S-1	10.86	W-5	2.10	W-5	19	E-2	1550
257		10.86		362		3.17		172	

Ratio Largest/Smallest

APPENDIX

Statistical Analyses

Analysis of Variance and Least Significant Difference

1. Species/Pool

	E*	S	W	N
Mean	9.7	10	15.2	10.8

F – 5.52, F.99 – 4.94

L.S.D. — 4.53

Thus, Zone W is significantly different that Zones E, S and N at the 1% level.

2. Area of Pools (m^2)

	E	S	W	N
Mean	0.644	1.162	8.905	2.347

F – 2.907, F0.95 – 3.10

Thus, no significant difference at 5% level.

3. Mean Depth of Pools (cm)

	E	S	W	N
Mean	4.45	5.98	4.58	3.64

F — 1.08, F.95 — 3.10

Thus, no significant difference at 5% level.

4. Pool Volume (m^3)

	E	S	W	N
Mean	0.04265	0.0744	0.5308	0.09045

F – 1.92, F0.95 – 3.10

Thus, no significant difference at 5% level.

5. Species/m^3

	E	S	W	N
Mean	3959	1755.9	1112.55	1692.10

F – 2.28, F0.95 – 3.10

Thus, no significant difference at 5% level.

* E,S,W and N refer to the pools of the East, South, West and North Zones respectively.

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