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Introduction

The purposes of this paper are to introduce some of the physical characteristics and to summarize the geological and recent history of a northern Iowa Sphagnum bog.

The marshy portion of Dead Man's Lake, Pilot Knob State Park, was referred to as a bog by L. H. Pammel (1928) and described as a sphagnum mat by Grant and Thorne (1954). The park is located on the Hancock side of the Hancock-Winnebago county border in sections three and four of Ellington township. It is four miles east of Forest City.

In surveying the immediate park area on foot, other marshy areas ranging in area from .1 to .8 hectares were found but none of these had any of the sphagnum mosses, although the habitats appear very similar. Other marshy areas in Hancock and Winnebago counties within 15 miles were investigated and these revealed no evidence of sphagnum. This site appears, then, to be unique in the immediate area and according to Grant and Thorne (1955), the only one reported for the state. What we have here is evidently an isolated sphagnum mat of 1 hectare (2.5 acres) in area. This isolation poses many problems. A particularly interesting feature of the site is the fact that this acid bog (pH 4.5 to 6.0) is contiguous with a neutral pool of 1.1 hectares (2.7 acres) with a periphery of typical marsh plants.

Physiographically, the Pilot Knob area is 100 meters above the basal plain and Dead Man's Lake is 30 meters below the summit of the Knob itself. There is no surface drainage of Dead Man's Lake as the surrounding hills rise steeply from the water boundary to heights ranging from 3 to 15 meters (Figure 1).

This area is near the southern terminus of the Altamount moraine, Mankato lobe of the Wisconsin glaciation. The mounds are pebbly drift with gravel veins of Wisconsin origin underlain with the blue clay of the Kansan drift. (MacBride, 1902)

The name "Dead Man's Lake," according to the best information available, was coined by an early explorer upon finding on the shores of the lake an Indian who had been banished from his tribe to spend his last days there.

The area was established as a state park in 1924. Originally the area was called Pilot Mound, but two newspaper editors decided to refer to it in their publications as Pilot Knob to distinguish it from a small town of the former name. A citizen's committee of seven took the first steps to establish this area as a state park in 1920 and in the course of a year had secured enough money to purchase the original tract of 235 acres. This tract, which was donated to the state, with an additional 50 acres comprises the present park site.

Recommendations were made in 1926 to remove part of the bog, but whether this had been done or not cannot be verified.

Physical and Chemical Features

Morphology of the Basin

The entire drainage area of the basin does not exceed 10 hectares (25 acres) (Figure 1). The sharply sloping sides of the basin are covered by timber and dense underbrush. The picnic areas are maintained by the park authority and have a heavy grass cover which prevents erosion. The only evidence of solid materials being brought in by affluent waters is at the southeast corner of the lake where a graveled path has yielded and formed an alluvial fan extending into the lake about two meters.

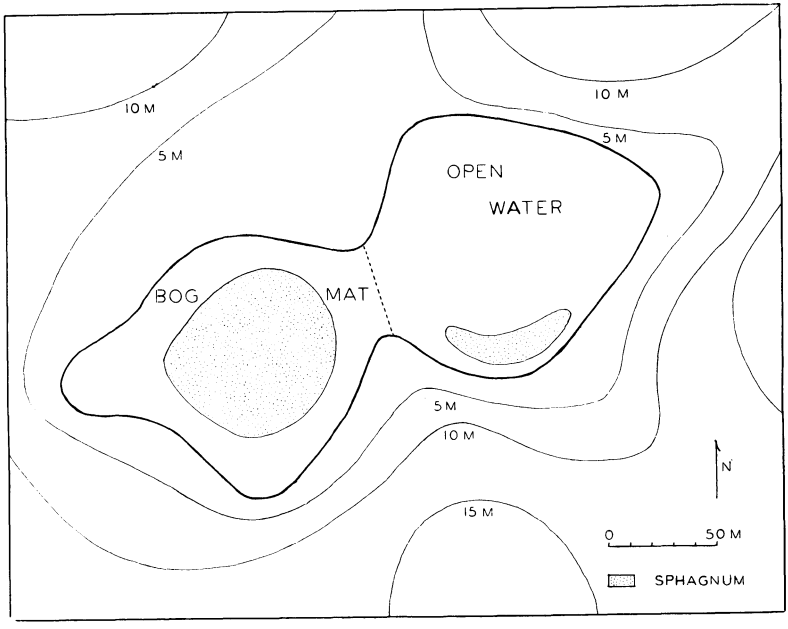

Figure 1. Bog and Dead Man's Lake with contours at five meter intervals for the drainage basin.

The extent to which the basin has been filled can only be determined by penetration to the gravelly drift through the muck at the bottom of Dead Man's Lake. Attempts to do this were unsuccessful. However, measurements were made to a standard of resistance at the apparent bottom. Soundings were made in the open water area with a two pound lead weight with a bottom area of 26 cm^2. The maximum depth recorded by this method was 2.8 m. Under the sphagnum mat the technique had to be changed. The soundings were done with an inch water pipe with a bracket at the bottom with the area of 45 cm^2. It was pushed forcibly into the substrate until the resistance of the accumulated sphagnum detritus stopped it. The maximum depth under the floating sphagnum mat was 2.3 m.

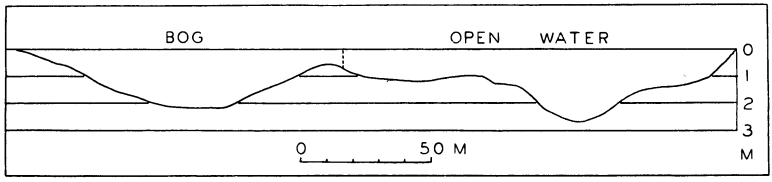

Figure 2. Profile of the East to West, greatest distance of bog and open water.

The contours of the basin were established by 10 transects from the shore of the lake over distinctive terrain up to the extremities of the basin. The rise of the slope was measured by a barometric altimeter accurate to 0.1 m.

Meteorological Data

The data in Table 1 were obtained from the station in Forest City (Lat. 43° 16′, Long. 93° 38′). The distance of this station from the Pilot Knob area, being four miles, would seem to be insignificant for this purpose.

Table 1

Comparison of Precipitation and Temperature Data with 10 Year Average

	Precipitation		Temperature	
	Avg.	1957	Avg.	1957
March	3.8 cm	3.9 cm	– .1° C.	– .1° C.
April	5.5	3.1	7.9	8.8
May	10.5	20.0	14.7	13.9
June	11.5	11.7	19.8	19.4
July	8.4	4.3	22.8	25.1
August	9.7	11.3	21.4	21.6
September	10.2	5.0	16.6	15.4
October	5.7	4.3	10.1	8.8
November	4.3	8.5	1.3	.1
December	2.4	1.1	–6.4	–2.9
January	2.6	1.2 (1958	–9.3	–5.6* (1958)
February	2.6	.5	–7.7	–9.2*
Total	77.2 cm	74.9	Mean 7.6° C.	8.0° C.

*Unofficial Averages

Chemical Data

The contiguous waters of the sub-mat and open water exhibit a wide chemical variance. One would expect these differences to be significant in species distribution.

The dissolved oxygen and pH determinations were made using the Hellige colorimetric technique. For the purpose of a later, more complete survey, this technique will be discarded in favor of the more accurate Rideal-Stewart modification of the Winkler method by titration. The high humic content of the water makes accurate comparison difficult. The total hardness determination was made by using standard soap solution, and the turbidity by a U. S. Geological Survey turbidity rod.[1] The pH samples were fairly constant for both sub-mat water and open water up to about 10 meters from the interface and these varied slightly depending mostly on rainfall. The difference here between pH of 4.5 and 7.0 respectively is undoubtedly important.

Table 2

Comparison of Dissolved Oxygen, pH and Total Hardness Between Sub-mat Water, Interface and Open Water

	Sub-mat Water	Interface	Open Water
Dissolved Oxygen	1 ppm	2.5 ppm	4.0 ppm
pH	4.5	6.0	7.0
Total Hardness (ppm $CaCO_3$)	34.2 ppm	51.3 ppm	68.4 ppm

1. Techniques used are those described in Welch, 1948 and in A.P.H.A. Standard Methods, 1923.

As would be expected, the oxygen content of the open water was much greater than that below the mat. With some slight variability, the dissolved oxygen in the sub-mat samples was one part per million at 17° C. (10% saturated), but in the open water the reading of four p.p.m. at 24° (47%) decreased late in the summer as the temperature rose and the water level lowered eight inches from June to August.

The turbidity measurements in the open water, taken in mid-August, registered 24 p.p.m. (equivalent silica particles) with the platinum needle going out of sight at approximately 35 cm. depth. The sphagnum detritus suspension in the sub-mat water would reduce a sample to near opacity in a 250 ml. sample bottle. A 500 ml. sample of sub-mat water was dried and found to have 1.6 gm/liter dry weight. After incineration, the sample was found to have 1.0 gm/liter organic material.

All total hardness measurements were stable through many tests

at the values given in Table 2, the open water having precisely two times the hardness of the sub-mat water.

Biotic Features

The point of interest in the animal community of the sub-mat waters is a paucity both in terms of number of species and individuals. One of the few forms collected far under the sphagnum mat was an annelid of the oligochaete group found infrequently in the muck and sphagnum detritus at two meters depth. The coleopterans and the amphipod, *Hyalella azteca,* penetrate into the mat in decreasing number out to about 10 meters from the interface where they are found in large numbers. The supra-mat pools are dominated by culicid larvae. Living specimens of the fingernail clam, *Sphaerium sp.,* also penetrate to about four meters under the mat in the mucky substrate.

Contrast this with the wide variety of pond life found in the contiguous open water. Specimens tentatively classified represent seven phyla. To show this representation each phylum will be discussed briefly and very generally with special attention to populations found in abundance. The phyla are: Protoza, Porifera, Rotatoria, Annelida, Arthropoda, Mollusca and Chordata. Pending verification by specialists, all discussion will be limited and tentative.

The protozoans include the genera: *Ceratium, Volvox, Euglena* and *Vorticella. Ceratium* was the dominant protozoan studied, with counts averaging 3700/liter in late June and early July. There is evidence of diurnal movement with a negative orientation to light. *Volvox* was present in one sample at about 150/liter. *Euglena* formed a dense scum in a sheltered area in mid-August. A colonial *Vorticella* was in evidence in small quantities in early June with a count of 3/liter.

The one sponge specimen was found on an immersed branch. It had the typical mat-like growth form. Its color suggested an algal commensal within its tissues.

Rotifers were present in most plankton hauls with the quantity averaging about 220/liter. Again there was evidence of diurnal movement, positively oriented to light, with the counts evenly distributed at night.

The annelids of the open water include the aquatic oligochaetes mentioned previously from the bog but in larger numbers. They were found quite concentrated in the muck under ice cover in February. Many leeches were present with quiescent individuals found under the ice in January.

The arthropods were represented by the classes Crustacea, Arachnoidea and Insecta. The small crustaceans of the orders Cladocera, Copepoda and Ostracoda make up the major portion of every plankton haul. The cladocerans exhibited their major population bloom in mid-July, with 80/liter present. Copepods were in bloom in early June, with 30/liter, and under ice cover with 20/liter. The ostracods were not analyzed by population counts.

The larger crustaceans were at all times plentiful, with the amphipod, *Hyalella azteca,* found around all vegetation. Crayfish were seined in large quantities and during a dry period in late July a burrow was seen on the south shore.

A Hydracarina was noted infrequently in these waters.

Insects from five orders were collected. These were: Odonata, Hemiptera, Trichoptera, Coleoptera and Diptera. Odonata nymphs were found at all seasons of the year with adults ovipositing in late July. Four families of Anisoptera were noted, but only one family of Zygoptera. The hemipterans were represented by the gerrids, notonectids, pleids, nepids, belastomatids and the corixids. The corixids were found swimming actively under the ice in mid-February and 36 were found frozen in a collection hole 50 cm. in diameter. One gravid *Belastoma sp.* was collected.

The coleopterans present were the dytiscids, gyrinids and hydrophilids. Both adult and larval forms of Dytiscidae were abundant. The gyrinid beetles were plentiful in mid-August when large groups were seen massed near the center of the open water.

Dipteran families noted were larval and pupal forms of the culicids and larval tendipidids. The culicid larvae were present in the quiet areas but strikingly evident were the distinctive *Chaoborus* larvae, present in quantities averaging 3/liter. These were found active under the ice. The tendipidid larvae were present in the muck in large numbers.

Three pulmonate Gastropods—Physidae, Lymnaeidae and Planorbidae—were collected in small quantities. The sphaeriid clam was plentiful in the shoreward areas and large numbers of them were seen floating, dead, in late July.

Four amphibians were present: *Rana pipiens, Hyla versicolor, Bufo americanus* and *Ambystoma sp. R. pipiens* had completed metamorphosis by late July but the red-tailed tadpoles of *Hyla versicolor* persisted until mid-August.

Small *Chrysemys marginata bellii* were collected in late June.

It becomes evident that the paucity of forms under the bog-mat

is due to the extremely unfavorable habitat presented by the combination of high acidity and low oxygen content.

The mat itself is composed of *Typha latifolia* and the hummock-forming *Sphagnum magellanicum* with three other species of sphagnum mosses present. The edge of the mat at the interface consists of roots of *Leersia aryzoides, Eleocharis palustris, Scirpus cyperinus* and *Lycopus uniflorus*. The dominant shore vegetation of the open water is *Sagittaria latifolia,* the offshore vegetation is mainly *Nuphar advena* and *Nymphea tuberosa* and the submerged aquatics consist mainly of *Potamogeton berchtoldii.*

The island at the southeast corner is a sphagnum mat .08 hectares (.2 acres) in area rather firmly set on the bottom in contrast to the spongy main mat. The water surrounding this islet is completely covered with *Lemna minor.*

An aerial photograph taken in July, 1939 shows one-third of the east half of the lake covered by some sort of vegetation, but this may have only indicated a lower water level.

While these observations on the biota of Pilot Knob Bog are very general and incomplete, it is hoped that they may be of use to future investigators as general orientation. The senior author is continuing the investigation which is revealing more specific and quantitative differences chemically and biotically.

Summary

Dead Man's Lake in Pilot Knob State Park is isolated from drainage between two recessional moraines 65 meters above the basal plain. Its total area is 2.4 hectares (6 acres), 1.3 hectares of which is covered by marsh and mat and 1.1 hectares of open water. The area occupied by sphagnum mosses is one hectare. Though the waters are contiguous, there seems to be little intermixing as evidenced by wide variance in chemical makeup. The relative paucity of the animal life below the mat is the distinctive biotic feature.

Acknowledgments

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