ROACH LAKE AND

HUMMINGBIRD BOG:

A COMPARISON

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INTRODUCTION

The University of Notre Dame Environmental Research Center is a 2833 ha. tract of land lying mainly in the southern portion of Gogebic County (Michigan) with its southern border extending into the northern part of Vilas County (Wisconsin).

As a result of the most recent glaciation period, which ended about 12,000 years ago, the Notre Dame property reflects the glaciers unique landscaping ability. On the Notre Dame property alone, 27 lakes were left behind as the glacier receded, all of which are kettle lakes. Although all of the lakes lie in the same general proximity, the glacial topography causes enough relief that one can see a tremendous amount of variation among the lakes and their surrounding vegetation.

Roach Lake and Hummingbird Bog are two lakes contained on the property. The two lakes lie only about two miles apart, but because of glacial topography, Roach and Hummingbird show a fair amount of variation in lake morphology in terms of surface area, depth, and drainage patterns to name a few. Because of these differences, the two lakes show somewhat of a difference in their chemical,physical and biological parameters.

Physical and chemical data were collected on each of the two lakes in the latter part of July 1982. Also, plankton tows were taken in order to determine the relative number and kinds of plankton in the lakes. In this paper, an attempt will be made to compare the chemistry and biology of Roach Lake and Hummingbird Bog.

ROACH LAKE

Roach Lake is one of the larger lakes on the property, having a surface area of 38.4 ha. Birch appears to be the dominant tree around the edge with the western bank containing numerous sugar maples. Conifers were found to be very sparse in the surrounding area. Roach Lake contains crystal clear waters which makes it an excellent lake for recreational purposes. The lake is over ten meters deep with a bottom composed of soft sediments supporting small macrophytes. Roach Lake does not have any significant drainage and is considered a seepage lake.

As mentioned earlier, Roach Lake has very clear waters and as a result, had a high secchi disk reading of 5 m.

Roach Lake showed a peculiar oxygen-temperature curve (Fig. 1). The temperature curve appears to be typical. The first five meters had a constant temperature around 23 degrees Celsius. This strata was the epilimnion. During the next two meters, the thermocline, the temperature dropped 4.7 and 4.6 degrees Celsius for each meter of depth. Below 7m., in the hypolimnion, the temperature gradually dropped off to 8.6 degrees Celsius. Readings were taken up to 10 meters, but it is hypothesized that the last two meters were made up of fine suspended particles.

The oxygen curve from Roach Lake was a little more unusual. A positive heterograde oxygen curve was obtained. The epilimnetic waters produced consistant oxygen readings in the range of 7.5 to 7.7 ppm. The oxygen readings then jumped to 12.0 and 12.9 ppm at 6 and7 meters respectively. Below this depth the oxygen concentration dropped off to practically nothing.

Lake samples for chemical analysis were taken with a Kemmerer bottle at three different depths. The first sample was taken from the epilimnion at 2 meters. A second sample was taken from the metalimnion at 7 m. in an attempt to explain the oxygen bulge and a third sample was taken from the hypolimnion at 8 m., just above the suspended particles. The chemical data is listed on Table 1.

The results of the plankton tow showed that the copepod Osphranticum was the dominant zooplankter in Roach Lake. Keratella, Bosmina and Nauplius larvae were also present. Also, a few Cyclops were found.

The dinoflagellate Peridinium clearly dominated the phytoplankton. Anacystis was the second most abundant of the phytoplankton. Other organisms found to a lesser extent in Roach Lake were Gymnodinium, Asterionella, Desmidium, Micrasterias, Dinobryon, and Fragilaria. Relative quantities of the planktonic organisms are given in Table 2.

The phytoplanlton data shows that, like Roach Lake, Hummingbird Bog contained Peridinium as its dominant phytoplankton. Others found in the tow were Chrysosphaerella, Dinobryon, Microcystis, Asterionella, Desmidium, Micrasterias, Fraqilaria, Spiroqyra, and Micratinium. The reative numbers these plankton are

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DISCUSSION

In comparing the chemistry of Roach Lake and Hummingbird Bog, it is essential to point out that both bodies of water appear to have similar underlying parent material which is granite. Both of their soils are very poor in calcium which has a great deal of impact on the development of lakes.

As mentioned earlier, Roach and Hummingbird lie only two miles apart and are similar in many respects. However, they differ in other areas due to their size, depth and surrounding vegetation.

One major difference between Hummingbird Bog and Roach Lake is that Roach Lake is believed to have turned over last spring and Hummingbird did not. Hummingbird is a very small body of water protected by a dense stand of conifers. The wind action on the surface is seldom sufficient to get the underlying waters to mix. This has a tremendous effect on the kinds of organisms that will be able to exist in that bog. A turnover recycles nutrients that have accumulated on the bottom back to the entire lake. Also, the hypolimnion receives a fresh supply of oxygen. The oxygen-temperature profile of Hummingberd Bog shows that the oxygen supply was nearly depleted below 1 m. and the temperature got very cold. The hydrogen sulfide test was positive indicating the absense of oxygen.

On the other hand, Roach Lake is a much larger lake and is less sheltered from the wind. It appears that Roach turned over last spring. Much of the water still contained sufficient oxygen, although ten meters was found to be depleted. The hydrogen sulfide test was taken at eight meters instead of ten to avoid the bottom sediments. At this depth the test was negative. However, it is believed that if a sample was tested at ten meters, it would have been positive.

The sulfate, nitrate, and phosphate levels in Hummingbird Bog were all somewhat lower than what was found in Roach Lake. This difference can possibly be attributed to the fact that Roach's nutients were recycled last spring and Hummingbird's were not. Very little sulfate, nitrate or phosphates were present in Hummingbird's epilimnion.

The decomposition process is very slow in Hummingbird Bog. Therefore, when the sulfates are used in protein synthesis in organisms, they are slowly returned back to the waters, thus making the sulfate levels very low.[1] Roach Lake does not have the peaty bottom like that of Hummingbird, suggesting that its decomposition process is faster. This might explain the greater abundance of sulfates in Roach Lake.

Nitrates are present in aquatic environments as the result of nitrogen fixing bacteria and blue green algae. These nitrates are then assimilared by organisms into amino acids. Low levels of nitrates can be attributed to denitrification by microbes and also sedimentation.[2] Once again it appears that the nitrates in Hummingbird have not been recycled.

In determining the phosphate content of Roach and Hummingbird, two tests were run. One measured the free phosphates (ortho phosphates) and the other measured total phosphates including sestonic and dissolved phosphates. According to Gerald A. Cole, the phosphate cycle is very rapid and the total phosphate test gives the best indication of phosphorus levels in a lake.[3]

Rocks of the earth's crust supply the lakes with phosphorus in addition to the phosphorus recycled from the sediments. Phosphorus is often the limiting factor for primary production and on sunny days is in high demand. Roach Lake was found to have more ortho phosphates and total phosphates than Hummingbird Bog. Apparently more phosphates were recycled in Roach. Roach had a higher total phosphate content indicating there were more phosphates wrapped up in the organisms.

Hummingbird Bog is a good example of a bog. It is not very well drained, it is well protected, a Sphagnum mat surrounds it, the water is a dark tea color and its waters are acidic.

In contrast, Roach Lake is considered a lake even though it is showing some signs of becoming a bog. Roach has very clear water with a high secchi disk reading. It is large and not too well protected. However, its water's are acidic and a small amount of Sphagnum has been found. The presence of Sphagnum in a lake is very instrumental in determining the future of a lake. The Sphagnum acts as an ion exchanger adsorbing the calcium and releasing hydrogen ions. This causes the water to become acidic and also reduces the calcium supply which is necessary for bacteria to breakdown organic matter.[4] The process is self accelerating.

If Roach Lake is on its way to becoming a bog, it is not far along the way. Its color is very clear compared to the humic stained color or Hummingbird. The apparent color is a measure of the materials in solution and the particulate matter.[5] The true color is the color of the water with all of the particulate matter filtered out. Roach Lake had a very low true color reading with a slightly higher apparent color indicating the presence of particulate matter. Hummingbird Bog had color readings of about ten times higher. This can be attributed to the high amounts of dissolved organic materials. In the hypolimnion of Hummingbird, the true and apparent color were identical suggesting the absence of living and non-living particulate in this strata.

The acidity of a lake is the measure of its ability to donate hydrogen ions. Hummingbird Bog had a higher acidity than Roach. Apparently Hummingbird's Sphagnum mat acts as a good source of hydrogen ions.

pH is a measure of hydrogen ion concentration. Hummingbird Bog had a lower pH than Roach Lake possibly because Hummingbird's Sphagnum mat and edaphic effects of the conifers put more hydrogen ions into the water.

The alkalinity, calcium, and magnesium are all interrelated compounds in the water. Alkalinity is a measure of the lakes buffer capacity and measures the bicarbonates in the water. In order for alot of bicarbonates to be present in the water, the water must contain alkaline earth metals, such as calcium or magnesium. These metals combine into insoluble carbonate forms and soluble bicarbonate forms. However, Hummingbird Bog and Roach Lake are low in calcium and magnesium and therefore have low alkalinity. The alkalinity in Hummingbird is slightly higher than in Roach. This is in agreement with the fact that Hummingbird contains more calcium and magnesium.

Iron is an element necessary in electron transfer in plants during photosynthesis.Ferric compounds are not soluble and will precipitate, but under reducing conditions, like low oxygen and low pH, ferric compounds are converted to soluble ferrous compounds. Hummingbird Bog contained a good deal more soluble iron than did Roach Lake, because of its anoxic conditions.

Plankton were collected in Roach Lake and Hummingbird Bog using a Wisconsin net. The net was towed from behind a boat for a two minute interval. This method of collection enables one to determine the different kinds of plankton and their relative numbers in a body of water. However, this method of collection does have its limitations. For example, equal amounts of water do not pass through the tow nets during each sample due to uncontrollable factors such as boat speed and length of each tow. It is impossible to run equal amounts of water from each lake through the nets and therefore the amounts of each organism present in the tow can not be compared between the two bodies of water with too much accuracy. In addition, the plankton net only collects from a narrow layer on the surface of the lake, omitting many organisms from lower depths. However, for our purposes, the two minute tows gave a good indication of plankton populations in Roach Lake and Hummingbird Bog.

In both Roach Lake and Hummingbird Bog, the dominant phytoplankyon at the time was the dinoflagellate Peridnium. Different species of Peridinium require different conditions. Certain species are adapted to acid, calcium deficient waters which typify both Hummingbird and Roach.[6]

The green algae, Chrysosphaerella was found to be the second most abundant phytoplankton in Hummingbird although it was not found in Roach. Species of Chrysosphaerella require one of the vitamins thiamin or B_{12} or both.[7] The absense of this genus in Roach Lake might be that the lake lacks one of Chrysosphaerella's nutrient or vitamin requirements.

Anacystis was found to be fairly plentiful in Roach Lake and to a lesser extent in Hummingbird. Blue green algae are usually signs of eutrophication, conditions which Roach and Hummingbird clearly do not have. Ironically, such blooms usually develop when combined nitrogen in solution is low and inorganic phosphates are undetectible.[8] Both Hummingbird and and Roach met these conditions which probably explains the presence of Anacystis in each of these bodies of water.

Dinobryon is a golden-brown algae that was fairly abundant in Hummingbird Bog and also present in Roach. Dinobryon is characteristic of nutrient poor oligotrophic lakes.[9] They usually develop in lakes in late August after the decline of more numerous species.[10] Dinobryon requires low levels of phosphorus and also thiamin, B_{12} and sometimes biotin. Hummingbird appeared to have more Dinobryon than Roach possibly because of its lower nutrient levels.

The diatom *Asterionella* is one of the most important fresh water phytoplankton.[11] Some species become abundant when nutrient levels in oligotrophic waters decline.[12] Both Hummingbird and Roach had a fair amount of *Asterionella* in their water.

Roach Lake was found to contain the dinoflagellate *Gymnodinium* to some extent. *Gymnodinium* requires calcium deficient water and also the vitamins B_{12}, thiamin and biotin. This ~~genera~~ genus was not found in Hummingbird Bog possibly because of a vitamin deficiency.

Small amounts of other phytoplankton were found. *Micrasterias*, *Desmidium*, *Spirogyra*, and *Micratinium* are all green algae that were found in either one or both of the bodies of water. Green algae are correlated with low calcium concentrations.

Analysis of the zooplankton data shows that the rotifer *Keratella* was the most abundant zooplankton in Hummingbird Bog. It was also found in Roach Lake, but to a much lesser extent. *Keratella* ~~are~~ is capable of entering a wide variety of habitats.[13] They feed by sedimenting fine particles as a result of beating of their cilia. The reason why Hummingbird contained so many more *Keratella* than Roach might be explained in terms of the fish populations in the lakes. Hummingbird Bog contains a stunted yellow perch population whereas, Roach Lake supports a larger community of fish including yellow perch, largemouth bass, pumpkinseed and muskellunge. The *Keratella* in Roach Lake are probably much heavier preyed upon and therefore occur in fewer numbers.

The most dominant zooplankter in Roach Lake was the copepod Osphanticum. No material could be obtained concerning the chemical or nutritional requirements of this ~~genera~~ genus. None were found in Hummingbird Bog.

The copepod Cyclops was found in fair numbers in Hummingbird Bog, but not so much in Roach Lake. Cyclops are carniverous organisms and are intolerant of high temperatures. The abundance of Cyclops in Hummingbird and their absence in Roach might be explained as follows: Hummingbird had a very thin strata at its surface were oxygen was present. In this strata all the plankton were concentrated and the Cyclops had alot of prey available. Roach had a good supply of oxygen down to 8 m. and therefore, its organisms were more distributed. As a result, the Cyclops probably were not all concentrated near the surface. Also, Cyclops are not tolerant of high temperatures and it is possible that more Cyclops could have been present in the deeper, cooler waters.

Fair amounts of Daphnia were found in Hummingbird Bog. These cladocerans are herbivorous filter-feeders. They have been extensively studied in the areas of specific gravity, vertical migration and cyclomorphosis. The absence of Daphnia in Roach Lake and their presence in Hummingbird Bog cannot be readily explained. Possibly Hummingbird contained a certain type of algae or had conditions that were more favorable for Daphnia.

A few Bosmina were found in both Roach Lake and Hummingbird

Bog. These cladocerans are not easily correlated with seasonal cycles of temperature.[14] Another cladoceran found in Hummingbird was Holopedium. This organism isusually confined to soft waters.

No data was collected revealing the kinds and numbers of fish and other plankton predators in Roach Lake and Hummingbird Bog. Therefore it is hard to determine their impact on the number and kinds of plankton present. However, as previously mentioned, Roach Lake is believed to contain a much larger fish population which undoubterly effects the plankton populations.

Overall, Roach Lake and Hummingbird Bog were very similar in species composition of both phytoplankton and zooplankton. This is understandable when looking at the chemistry results. Both bodies of water contained similar nutrient levels of sulfates, nitrates and phosphates. Both were found to have low levels of calcium, magnesium and had low alkalinities. The only major differences found between the two were pH and the water color. These conditions provided a similar environment for for organisms and as a result, the species composition of Roach and Hummingbird were very similar. Species present in one lake and not the other or even different relative numbers of species found in the lakes occur because species require certain nutients and have different tolerances like pH ranges or oxygen concentrations. Hummingbird Bog and Roach Lake do differ somewhat in pH and oxygen concentrations as well as nutrient levels, thus helping to explain the differences in the plankton populations found.

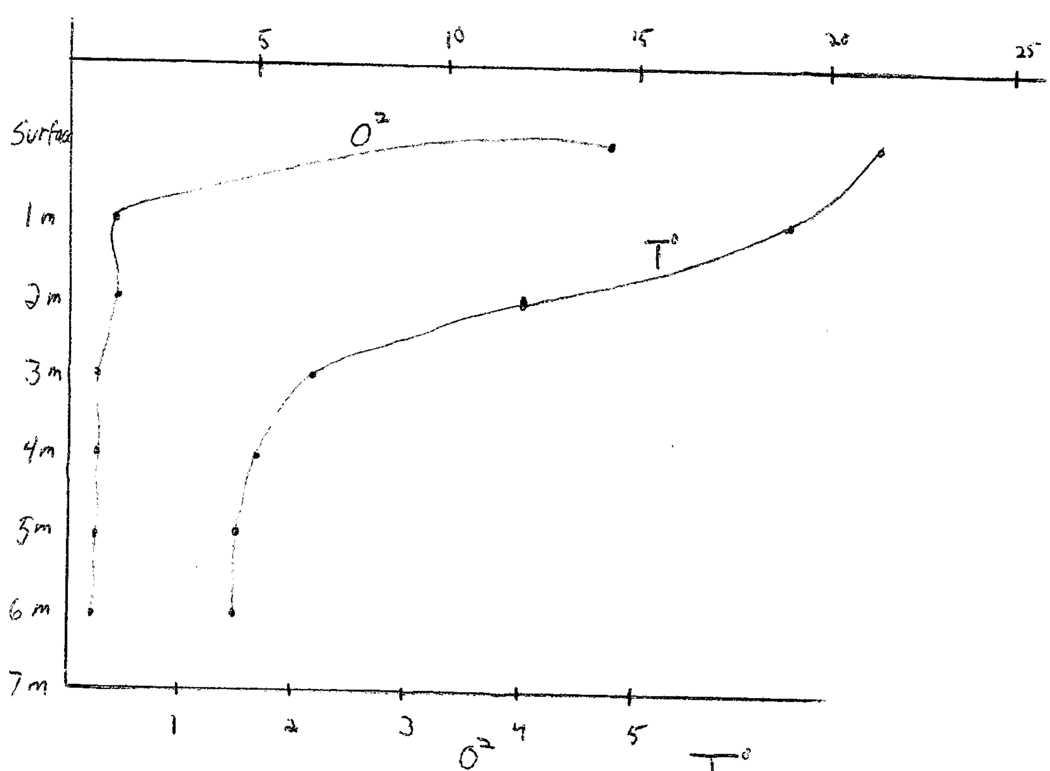
In conclusion, it was found that Roach Lake and Hummingbird

Bog differ in many ways. Roach is larger, surrounded by deciduous rather coniferous trees, is much clearer and turns over more than Hummingbird. However, both bodies of water are low in calcium and magnesium which makes them poorly buffered. Both are fairly acidic and contain varied amounts of Sphagnum.

These conditions give both Roach Lake and Hummingbird Bog similar water conditions. This is apparent in looking at the similar species compositions of both bodies of water. It appears that the big difference between Roach Lake and Hummingbird Bog is that Hummingbird is farther along in terms of bog sucession. It has similar water conditions to Roach, but it contains a well developed Sphagnum mat around its edge. This increases the acidity and darkens the color of the water. Other than that, the physical, chemical, and biological parameters of Roach Lake and Hummingbird Bog are quite similar.

HUMMINGBIRD BOG

FIG. 2



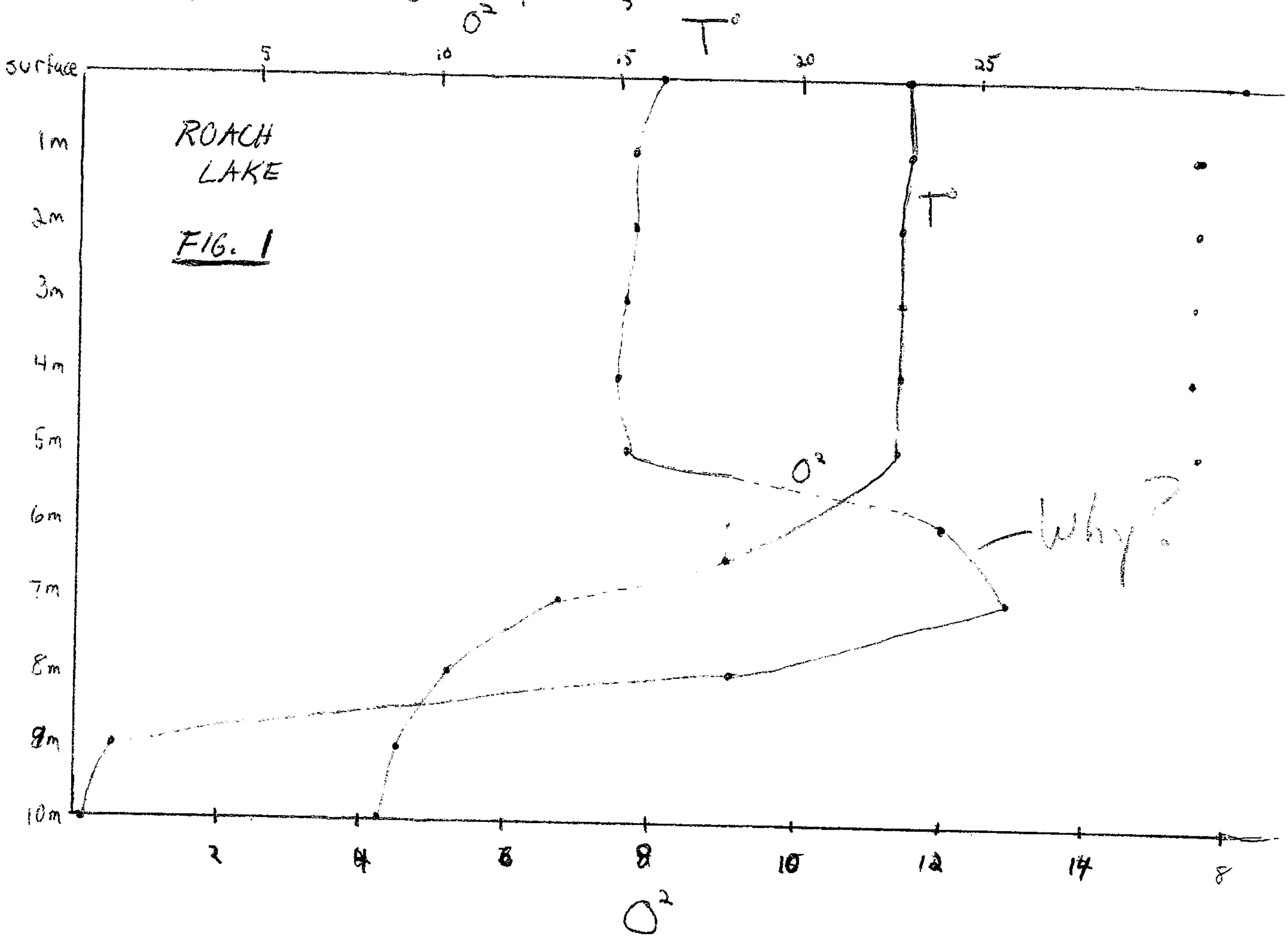


TABLE 1
CHEMICAL DATA

why so long?

	Roach Lake			Hummingbird Bog	
	2m	7m	8m	1m	4m
Secchi Disk	5.0m			0.5m	
Color - Apparent	20	30	20	290	200
Color - True	5	2	10	275	200
Sulfate	2.5	5.5	5.0	0	0
Nitrate	0.65	0.55	0.45	0	0.5
O - Phosphate	0.13	0.11	0.13	0.01	0.07
Total Phosphate	0.23	0.18	0.22	0.10	0.12
Acidity	1.5	1.8	7.5	13.5	18.5
Alkalinity	1.5	2.5	2.5	2.8	5.0
Calcium	4.0	4.5	5.0	11.2	7.2
Magnesium	6.5	5.0	4.5	4.8	3.3
p^H	6.4	6.4	6.5	5.5	5.4
Specific Cond.	16.4	17.1	16.3	26	22
H_2S	negative			positive	
Iron	0.06	0.08	0.14	0.41	0.38

TABLE 2
PLANKTON DATA

	ROACH LAKE	HUMMINGBIRD BOG
Keratella	45	2050
Bosmina	35	10
Cyclops	5	355
Nauplius	30	25
Daphnia	0	55
Holopedium	0	20
Osphranticum	280	0
Peridinium	1895	1390
Asterionella	45	30
Fragilaria	5	5
Dinobryon	10	170
Micrasterias	10	10
Desmidium	15	30
Spirogyra	0	5
Chrysosphaerella	0	210
Micratinium	0	5
Gymnodinium	60	0
Anacystis	280	75

FOOTNOTES

[1]Cole, Gerald A., Textbook of Limnology (C.V. Mosby Co., 1979, Second Ed.; St. Louis, Missouri) p. 312.

[2]Ibid. p.358.

[3]Ibid. p. 350.

[4]Ibid. p. 278.

[5]Ibid. p. 167.

[6]Hutchinson, G. Evelyn, A Treatise On Limnology: Vol. II Introduction to Lake Biology and The Limnoplankton (John Wiley and Sons, Inc. 1967; New York, New York) p. 345.

[7]Ibid. p. 339.

[8]Ibid. p. 316.

[9]Ibid. p. 381.

[10]Ibid. p. 488.

[11]Ibid. p. 352.

[12]Ibid. p. 381.

[13]Ibid. p. 518.

[14]Ibid. p. 619.

BIBLIOGRAPHY

Cole, Gerald A., Textbook of Limnology (C.V. Mosby Co.,1979, Second Ed.; St. Louis,Missouri).

Hutchinson, G. Evelyn, A Treatise On Limnology:Volume II Introduction to Lake Biology and The Limnoplankton (John Wiley and Sons, Inc.,1967; New York, New York).