THESIS PROPOSAL

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PALEOLIMNOLOGY OF SUNFISH LAKE

Introduction

Paleolimnological studies utilizing restricted numbers of markers are making it increasingly clear that an integrated effort is necessary using a variety of markers of both biological and non biological origin to gain a clearer understanding of the history of lakes. Various sedimentary fossils (cladocera, [redacted], molluscs, ostracods, plant macrofossils, pollen, diatoms) and chemistry of the sediments are some examples of approaches used in previous attempts to reconstruct the sedimentary record. Sedimentary chlorophyll degradation products (SCDP) have been studied in Little Round Lake (Brown, et al. 1977). It was found that these pigments were little altered after their deposition in this meromictic situation but that the factors affecting their relative proportions beforehand were very complex. It has been shown that SCDP will also reflect the onset of meromixis, also the relative proportions of the chlorophyll a phorbins and b phorbins may give an indication of the relative proportions of algae not containing chlorophyll b (e.g. cyanophyta) to those containing both chlorophylls if the differential diagenic rate is taken into account (Daley, et al. 1977). It has been shown as well that there are carotenoids in the sediments of specific biological origin. Oscillaxanthin from two known species of Oscillatoria, O. rubescens and O. agardhii is an indicator of eutrophy (Brown, 1963). Photosynthetic bacterial xanthophyllic carotenoids, spheroidenone, spheroidene and 2-ketospirilloxanthin from Rhodopseudomonas spheroides are markers of the onset of meromixis as this species is an anaerobe yet is intolerant of H_2S which developes high concentrations later on in meromixis

(Brown, 1968). Sanger and Gorham (1972) use pigments in a more generalized fashion to interpret lake histories. They compare quantities of SCDP and carotenoids in the lake to those found in surrounding forest litter and suggest that the ratio of SCDP to carotenoids increases with increased allochthonous inputs to lake sediments as the carotenoids are broken down more readily. High allochthonous inputs they suggest also will give high epiphasic to hypophasic carotenoid ratios and low SCDP to epiphasic plus hyphophasic carotenoid ratios. Generally oligothrophic situations are noted to give lower total pigment preservation but understanding diversity of pigments is complicated by the number of pigments put into the system overlaid by the number created or destroyed by diagenesis (Sanger and Gorham, 1972). The aliphatic hydrocarbons and the fatty acids have proven to be useful biological markers as well. Changes in absolute amounts and distribution of carbon chain length has proven interesting. It has been suggested that the relative amounts of short chain fatty acids (algal origin) and long chain fatty acids (terrigenous) indicate changes from oligotrophic (high percent autochthonous input) situations to eutrophic (high percent allochthonous input) situations (Meyers, 1978) also the ratio of alkanes, carbon chain length twenty-nine (terrigenous) to chain length seventeen (algal) has been related to the above situations.

It is proposed therefore to use plant pigments (chlorophylls and carotenoids and their breakdown products) and other biological markers available (diatoms, pollen and hydrocarbons) as well as available chemical data and physical data which may be gleaned from the stratigraphy. This accumulated data will then be subjected to cluster analysis "Infaie" (Orloci, 1969), to objectively group the data and allow further interpretation and investigation of possible discrepancies. This it is proposed will give a clearer understanding of the lake's history.

Study Site

Sunfish Lake is located about 8 km west of Waterloo, Ontario (altitude 365 m) in a small depression surrounded by sandy kames, over bedrock of shale, salt and gypsum. The watershed is small (2.25 km^2) and consists of farmland and mixed deciduous forest. The lake is one of a series of kettles and this is reflected in its general characteristics, area 8.3 Na, maximum depth 20 m, maximum length 577 m, maximum width 189 m, mean depth 20 m, volume development ratio 1.56, relative depth 6.15%. The lake is also meromictic with chemocline in mid summer at about 13 m and thermocline at 8 m. The inlets are intermitent and there are reports of subsurface springs. It is not known whether or not these springs contain disolved salts and thus cause the meromixis. (The above information was gleaned from papers by Duthie and Carter 1970 and Adams and Duthie 1976).

It should also be noted that the lake is quite heavily cottaged.

Choice of Site

Firstly the meromixis of the lake was an important factor. The sediments below the chemocline are undisturbed due to the density barier to overturn. They are also highly reduced and this prevents any disruption by benthic organisms as they cannot exist under these conditions. This highly reduced state is excellent for the preservation of carotenoids, chlorophylls and hydrocarbons. Thus these sediments, which are probably varved (contain annual layers) are an excellent record of the lake's past.

Secondly this lake occurs in the area of Ontario referred to as "Ontario Island", first exposed after the waters of the Great Lakes started to recede towards their present levels and thus the lake could have its origin as early as 14,000 B.C.

Thirdly the lake has been previously studied (Adams and Duthie 1976 and Sreenivasa and Duthie 1973) and diatom pollen and chemical data are available for the complete sediment depth.

Methodology

Field: Three cores will be taken with complimentry frigid fingers for a good water-mud interface. One core will be taken in the deepest section, another at above chemocline depth and the third above the chemocline. This should give an idea of the degree to which the chemoline has fluctuated.

Laboratory: Efforts will be made to maintain samples in the conditions in which they were found (cool, dark and reduced). A comparison of frozen and unfrozen samples will be made as the frigid finger samples differ from the core samples in that respect.

Methodology with respect to extraction and thin layer chromotography (T.C.L.) will be much the same as that described in Daley (1974) with modifications to extraction, sonication apparatus and handling of the T.C.L. plates. These modifications were made in order to streamline the procedure to allow handling of the large number of samples.

Firstly extraction will take place in a closed container under nitrogen. (Two stopcocks allow the flushing of the sample with nitrogen and extrusion of it after sonication.) Sonication will be with a cup sonicator cooled to 4-7^{o}C.

Direct reading of T.C.L. plates with an alternate set of filters in the fluorimeter will be attempted. A certain amount of experimentation will be needed to improve the technique.

Computing

The proposed program is "INFAIE". An aglomerative clustering program which will give objective groupings of data into periods of lake history. More recent periods may be compared to historical information dealing with settlement patterns and dates of cottage and road construction.

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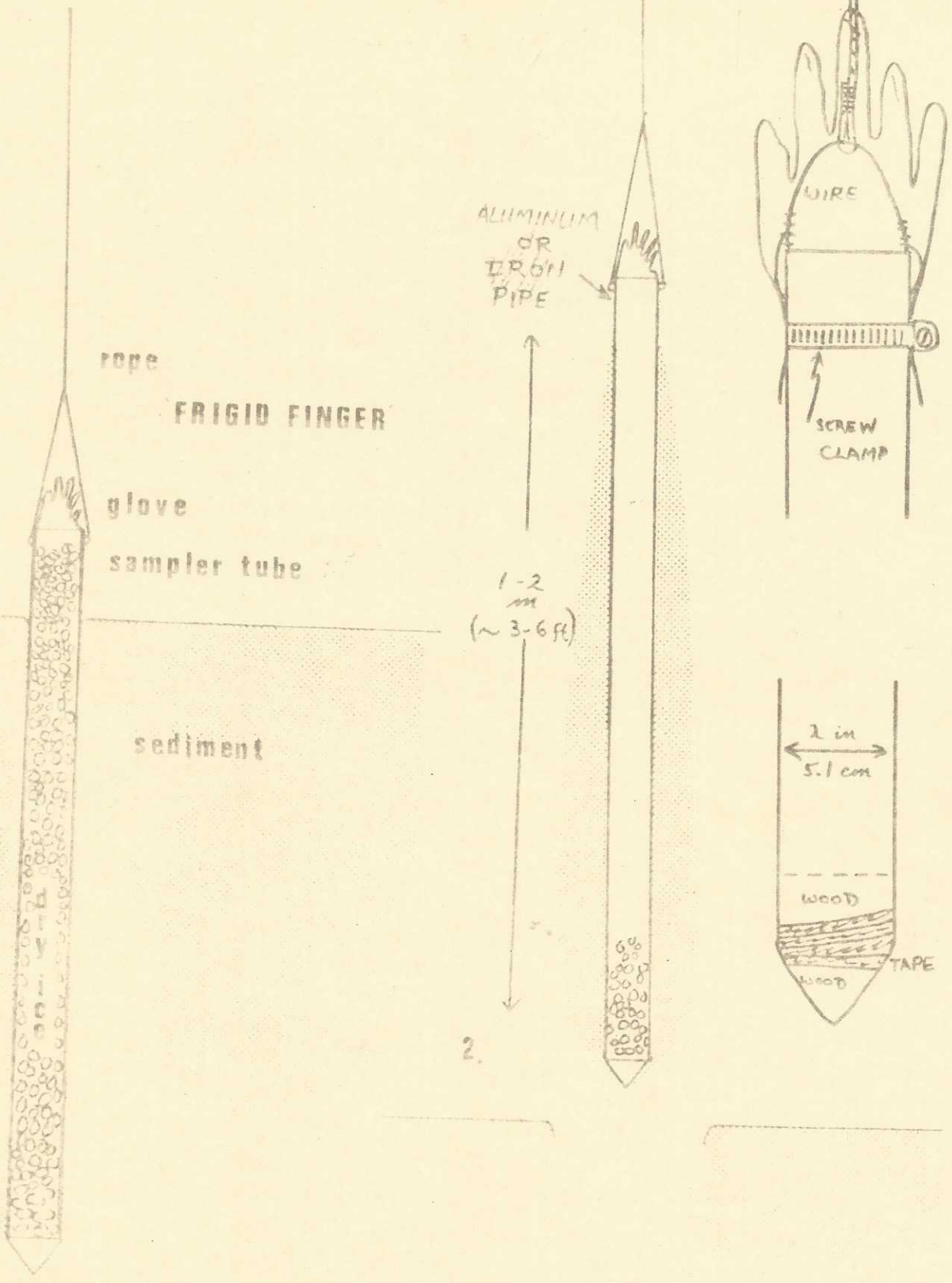
rope
FRIGID FINGER
glove
1.
sampler tube
sediment
ALUMINUM OR IRON PIPE
1-2 m (~ 3-6 ft)
2.
WIRE
SCREW CLAMP
2 in
5.1 cm
WOOD
TAPE
WOOD

FIG. 11