

Limnological Problem

Douglas Lake,
Cheboygan Co., Mich.

T. Harold Glover
Summer of 1929

The purpose of the summer's work was to compare the qualitative and quantitative distribution of plancton in two distinct depressions in Douglas Lake with special reference to temperature. The depressions selected were Camp Davis and Grape Vine (see map), whose physical aspects in relation to size, depth, and isolation are similar. Temperature, then, was the chief physical difference taken into consideration.

Douglas Lake is singularly characteristic by its presence of seven deeps or depressions in its bed ranging from fifty to ninety feet deep. The two selected have had wide differences in the past years in thermal characteristics. Camp Davis depression is protected from the prevailing northwest and west winds and forms a well defined thermocline. This occurs early in the season and a low bottom temperature is also maintained. The depth varies from twenty to twenty four meters. Its protected position made it a good working base when the weather prohibited work on other parts of the lake. The vertical temperatures recorded showed a moving down of the thermocline. (see charts) Grape Vine depression acted contrary to its usual behavior so work on it had to be abandoned after the first four weeks. Due to its exposure to the prevailing winds it usually does not stratify. Its bottom temperature is usually high in comparison to stratifying depressions. But it began to stratify early, sending down several distinct thermal belts and finally stratified definitely with a strong and permanent thermocline.

Stony Point depression was next selected as a working base. Several features made it quite objectionable for the work in hand. Its isolation occurs at forty rather than thirty feet as the other depressions. It is not as deep as Camp Davis depression, ranging from fifteen to seventeen meters.

Outline of work

As the plan was two-fold, to secure both qualitative and quantitative distribution, several plans of securing these were attempted. The only qualitative method was to identify the organisms and to compare their appearance at the various levels in the different depressions. At first it was attempted to get all specimens to species. This was too time consuming so only a few were so traced. Charts appear in a later part of this paper showing an attempt at qualitative comparison. Under quantitative work there were several ways of computing contrasting amounts. Under this, was live weight comparison, dry weight comparison, and quantitative counts. Due to the lack of time the latter was not attempted. Charts also appear giving some quantitative comparison.

Methods

The methods of procedure varied from time to time. However the Juday sampler was used throughout in securing water samples. Temperatures were taken in vertical series using a Tycos Maximum-Minimum thermometer, registering in degrees Fahrenheit. These readings were transposed into the metric system. Depths were taken in meters.

As the work was to include all plancton it was impossible to use

a Birge net. This net permits the nanoplankton to go through the mesh. In its place was used a high grade of uniformly hard pressed filter paper. This serves very well to strain out organisms. As a check on this method the filtrate was again filtered and the paper examined. No organisms were seen on the filter paper, all being removed in the first filtering. The method has several disadvantages. Filtering was a slow process. It was impossible to get a large amount of water thru the filter paper because of the time element. The filtering through of the last funnelful was very slow. The paper tended to dry at the edges causing the organisms to desiccate before the concentrate was reduced to a workable amount.

Qualitative Determination

A high speed centrifuge was used to remove the plankton for qualitative determination, at first. This method was accurate, and rapid. However it was impossible to get whole microcrustacea and other zooplankton in the concentrate. Colonial forms, as well, were not easily recognised as such. However the centrifuge was used in quantitative determination that will be mentioned later.

Another method resorted to to obtain samples of plankton at various depths for qualitative determination may be termed the rope method. This gave a fairly visible evidence of effect of thermal stratification on plankton growth. It served also as a crude representation of the types of plankton at the various levels. The procedure was as follows. A rope was weighted, lowered into the depression and supported in more or less of a vertical level by means of a surface float. This rope was permitted to remain in position for four weeks and then removed. In removing, the collected plankton gave the rope a green color and also a slimy feeling to the touch. This was true in the epilimnion only. As the thermocline levels were reached a distinct dropping off in the colorization was noted. As the lowest levels were reached the rope appeared clean. At the same time of removing this rope a sounding lead, that had been previously lowered, was removed, giving the exact levels. Samples of the collected plankton were removed from the rope at various levels by doubling the rope at the level desired and washing the doubled rope in plankton-free water in a wide mouthed bottle. In this way about two inches of the rope on either side of the meter level was washed. The criticism of this as a qualitative collection is the failure of some organisms to adhere to the rope, the distinct negative ~~reaction~~ reaction of some zooplankton to the upward moving of the rope, and the washing off of some forms in the upward course of the rope. Some forms may be brought up from the adjacent waters. However the sampler-filterpaper method was used more.

The following chart shows a determination of some forms found at critical levels in the depressions.

Camp Davis Depression		
<u>10 meter level</u> , the isolation level of the depression		
Orthosira	Ceratium	Dictiosphaerium pulchellum
Melosira crenulata	Mallomonas	Aquatic annelid
Asterionella formosa	Polyarthra	
Fragilaria	Staurastrum	
Synedra	Crucigenia quadrata	
Tabellaria fenestrata	Pediastrum	
Stephanodiscus	Scenedesmus quadricauda	
Navicula	Botryococcus	
Merismopedia punctata		

12 meter level, lowest limits of epilimnion.

Orthosira	Crucigenia
Cyclotella	Pediastrum
Dictiosphaerium	Synedra
Clathrocystis	
Diffugia	
Navicula	
Gleocapsa	
Aquatic annelid	
Eudorina	
Polyarthra	
Chroococcus	

14-15 meter levels, middle of thermocline

Aquatic annelid
Coelosphaerium
Cyclotella
Pediastrum
Eudorina
Diffugia
Scenedesmus
Tabellaria

18-19-20 meter levels, in the hypolimnion

Pediastrum
Cyclotella / all very few
Stephanodiscus /
Many skeletal forms

Grape Vine depression

Attention was paid to the lower limits particularly before it stratified. An examination of the plancton content at what was termed the hypolimnion at Camp Davis depression, yielded the following forms in quite numerous amounts.

18-19-20 meter levels

Coelosphaerium	Pediastrum
Clathrocystis	Fragillaria
Melosira	Orthosira
Dictiosphaerium	Botryococcus
Staurastrum	Synedra
Cyclotella	Diffugia
Stephanodiscus	Navicula
Ceratium	Anabaena
Lyngbya	Ulothrix
Asterionella	

Results of Qualitative Comparison

While it was not possible to make a careful study of all the levels of Grape Vine depression before it stratified, fortunately the most important level was examined. This lower level did not show the desert region visible in Camp Davis depression. It will be noticed that many forms prevalent only in the upper levels in this last named depression are seen in the lowest levels of Grape Vine Depression. The green color on the rope was visible to the bottom. The forms were also more numerous. This seemed to imply that thermal stratification does effect plancton production at various levels and also that depressions vary

in productivity.

Some time was spent in attempts to do specific determination of these forms. However it was so time consuming it was thought best to stop with generic determination. Many small forms were present also that were unable to be determined because of the power available.

Quantitative Determination

A method of approaching a quantitative account was tried with the filter paper method of collection and counts. This however did not give an accurate determination. This inaccuracy was due to the lack of a method to ascertain the amount of water in the filter paper and the other criticisms noted above. In filtering, a great number of small organisms must furnish food for others while in the process of reducing the concentrate to a workable amount. Another method will have to be resorted to to gain quantitative counts of nanoplankton.

The centrifuge was used in getting at what will be termed live weight. This was well under way when the breakdown in the centrifuge caused work on it to cease. Known amounts of water from the different levels were run through the centrifuge. The amount remaining in the cup was measured and weighed. A similar amount of plankton free water at the same temperature was weighed and the difference was attributed to the weight of the organisms. In this way the weight of various levels in the contrasting depressions could be determined.

When this failed an attempt was made to get at dry weight of the plankton. This was done by filtering a known sample of water (one liter) and thoroughly desiccating the remains on the paper. The paper was weighed before using. Extreme care had to be taken to thoroughly bake the paper to remove the moisture before this initial weight was made. The drying was done in the sun on extremely hot days, the filter paper being placed in shallow pans and covered with a glass plate. At intervals the glass plate was reversed to permit the condensed moisture to evaporate into the atmosphere. After about six hours in the sun the paper is again weighed and the difference in weight is attributed to plankton weight, dry.

This method has its limitations. Slowly settling sand and skeletal forms attribute some weight, especially in the lower levels. Stony Point depression was used in this method because Grape Vine had stratified.

Dry weight - Camp Davis Depression

Depth	Initial Weight	Second Weight	Plankton Weight
10 meters	3.5461	3.5884	.0423
12 "	3.5400	3.5590	.0190
14 "	3.4866	3.5145	.0279
15 "	3.5047	3.5745	.0698
18 "	3.5626	3.6794	.1168

Dry weight - Stony Point Depression

10 "	3.4740	3.4908	.0162
12 "	3.4673	3.5128	.0455
14 "	3.5705	3.6341	.0636
15 "	3.4673	3.5128	.0455

5.

No lower level was possible in this depression.

Results of Quantitative Comparison

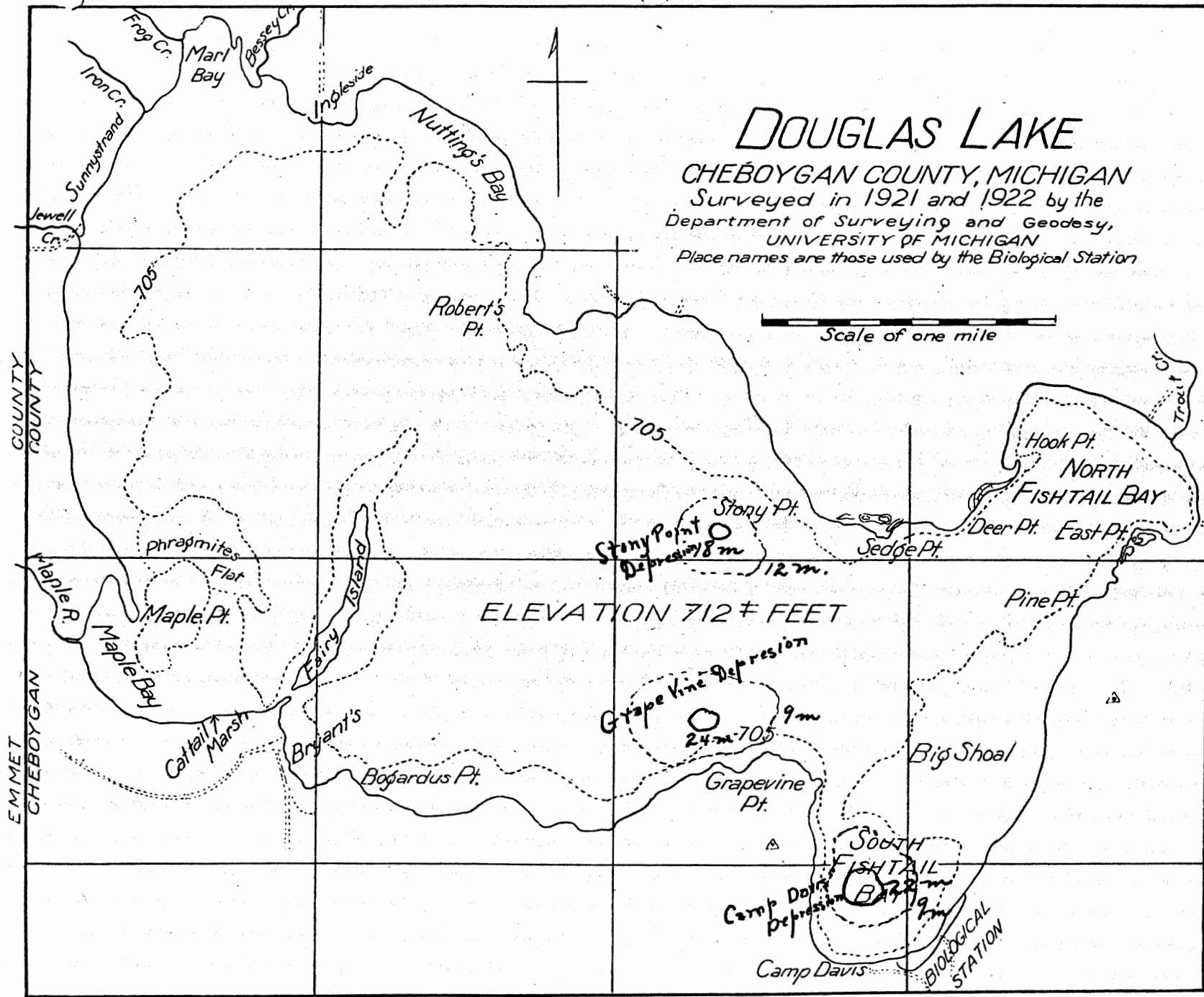
The results are limited because of the lack of counts and failure of the centrifuge. Conclusions drawn from the dry weight are interesting but perhaps too hurried. It would be more desirable to have at least a few more experiments. However it seems that the sudden falling off of the weight in the thermocline level (that is as the thermocline is approached) can be attributed to the rapid decline in temperature. Such is not true in the Stony Point study. The increasing weights undoubtedly can be attributed to the skeletal forms and the sand in suspension.

H. Harold Glover
Summer 1929

DOUGLAS LAKE

CHEBOYGAN COUNTY, MICHIGAN

Surveyed in 1921 and 1922 by the
Department of Surveying and Geodesy,
UNIVERSITY OF MICHIGAN
Place names are those used by the Biological Station



TEMPERATURE RECORD

LOCALITY Grape Vine Depression SKY Clear to Clouded

RECORDS BY T. Harold Glover

DATE 6-27-29

WIND Breeze S

APPARATUS Max-Min#21

TIME 9:30-12:00 a.m.

Depression Record # 1

Thermometer	Depth		Temperatures				Remarks
	Meters	Feet	Fahr.	Corrections	Centigrade	Corrections	
# 21	0		68		20		Surface Stratification seen
	1		65.5		18.9		
	2		65		18.3		
	3		65		18.3		
	4		65		18.3		
	5		65.5		18.6		
	6		65		18.3		
	7		64		17.7		
	8		61		16.1		Slight stratification see here
	9		60		15.5		
	10		60		15.5		
	11		59.5		15.3		
	12		58.5		14.7		
	13		58		14.4		
	14		58		14.4		
	15		57.5		14.1		
	16		57.5		14.4		
	17		56		13.3		
	18		56		13.3		
	19		56		13.3		
	20		54		12.2		Thermocline visible here
	21		54.5		12.5		
	22		54	54	12.2		
	23		54		12.2		
	24		54		12.2		
In Mud	24½		54		12.2		

TEMPERATURE RECORD

LOCALITY Grape Vine Depression SKY Clear to Slight Clouded RECORDS BY T. Harold Glover

DATE 6-29-29

WIND Wind Brisk W APPARATUS Max-Min #21

TIME 8;30 - 10;00 a m.

Depression Record # 2

Thermometer	Depth		Temperatures				Remarks
	Meters	Feet	Fahr.	Corrections	Centigrade	Corrections	
# 21	0		64		17.7		This temperature chart followed 24 hours of violent water agitation. Surface is much colder than record # 1
	1		63		17.2		
	2		63		17.2		
	3		63		17.2		
	4		63		17.2		
	5		63		17.2		
	6		62.5		16.9		
	7		62.5		16.9		
	8		62.5		16.9		
	9		62		16.6		
	10		62		16.6	Slight thermo- cline is moved downward.	
	11		60		15.5		
	12		59.5		15.3		
	13		59.5		15.3		
	14		59		15		
	15		58.5		14.7		
	16		57		13.9		
	17		56.5		13.6		
	18		56		13.3		
	19		55		12.7	No thermocline visible in this region as in chart #1	
	20		55.5		13.		
	21		55		12.7		
	22		54.5		12.5		
	23		54.5		12.5		
	24		54.5		12.5		
In mud	24 1/2		54.5		12.5		

TEMPERATURE RECORD

LOCALITY Grape Vine Depression SKY Clouded

RECORDS BY T. Harold Glover

DATE 7-6-29

WIND Breeze
S W

APPARATUS Max-Min #21

TIME 1:30-3:00 p.m

Depression Record #3

Thermometer	Depth		Temperatures				Remarks
	Meters	Feet	Fahr.	Corrections	Centigrade	Corrections	
# 21	0		69		20.5		Records taken after four days of windy weather in which the water was well stirred up
	1		68		20		
	2		68		20		
	3		67		19.4		
	4		66		18.8		
	5		65		18.3		
	6		65		18.3		
	7		64.5		18		
	8		64.5		18		
	9		64.5		17.7		
	10		64		17.7		
	11		64		17.7		
	12		64		17.7		Thermocline begins extends to here.
	13		62		16.6		
	14		60		15.5		
	15		58		14.4		
	16		57.5		14.1		
	17		56		13.3		
	18		55.5		13		
	19		55		12.7		
	20		55		12.7		
	21		55		12.7		
	22		55		12.7		
	23		54.5		12.5		
In mud	24		54.5		12.5		

TEMPERATURE RECORD

LOCALITY Grape Vine Depression SKY Clear RECORDS BY T. Harold Glover

DATE 7-8-29

WIND Breeze E APPARATUS Max-Min #21

TIME 1:30-3:00 p.m.

Depression Record #4

Thermometer	Depth		Temperatures				Remarks
	Meters	Feet	Fahr.	Corrections	Centigrade	Corrections	
#21	0		70.		21.1		Stratification on surface level.
	1		68		20		
	2		67		19.4		
	3		66		18.8		
	4		66		18.8		
	5		66		18.8		
	6		66		18.8		
	7		66		18.8		
	8		65.5		18.6		
	9		65.5		18.6		
	10		65		18.3		
	11		65		18.3		
	12		64.5		18		
	13		64		17.7		
	14		63.5		17.5		Thermocline starts here. Has moved down and differences are greater
	15		60		15.5		
	16		57		13.9		
	17		56		13.3		
	18		55.5		13.		
	19		--				
	20		55.5		13		
	21		--				
	22		55.0		12.7		
	23		--				
24		--					
In Mud	24½		54.5		12.5		

TEMPERATURE RECORD

LOCALITY Grape Vine Depression SKY Clouded RECORDS BY T. Harold Glover

DATE 7-23-29

WIND Brisk N N APPARATUS Max-Min

TIME 9-11 a.m.

Depression Record # 6

Thermometer	Depth		Temperatures				Remarks
	Meters	Feet	Fahr.	Corrections	Centigrade	Corrections	
# 21	0		72		22.2		
	1		70		21.1		
	2		70		21.1		
	3		-		-		
	4		70		21.1		
	5		-		-		
	6		70		21.1		
	7		-		-		
	8		70		21.1		
	9		-		-		
	10		68		20		
	11		66		18.8		
	12		64.5		18		
	13		63		17.2		
	14		61		16.1		
	15		59.5		15.3		
	16		56.5		13.6		
	17		56		13.3		
	18		55.5		13		
	19		-		-		
	20		55		12.7		
	21		-		-		
	22		54.5		12.5		
	23		-		-		
In Mud	23½		54.5		12.5		

TEMPERATURE RECORD

LOCALITY Camp Davis Depression SKY Clear to Slight Clouded RECORDS BY T. Harold Glover

DATE 6-29-29

WIND Breeze SW APPARATUS Max-Min #21

TIME 1:30- 2:30 p.m

Depression Record #1

Thermometer	Depth		Temperatures				Remarks
	Meters	Feet	Fahr.	Corrections	Centigrade	Corrections	
#21	0		66		18.8		
	1		66		18.8		
	2		65		18.3		
	3		64.5		18.		
	4		64.5		18.7		
	5		64		17.7		
	6		64		17.7		
	7		63.5		17.5		
	8		63.5		17.5		
	9		63		17.2		
	10		63		17.2		Slight signs of thermocline
	11		61		16.1		
	12		60		15.5		
	13		58.5		14.7		
	14		58		14.4		
	15		55.5		13.		Thermocline visible
	16		53.5		11.9		to here
	17		52.5		11.3		
	18		50.5		10.3		
	19		50		10.		
	20		50		10		
	21		49		9.4		
	22		48		8.8		
	23		47		8.3		
In mud	23½		47		8.3		

TEMPERATURE RECORD

LOCALITY **Camp Davis Depression** SKY **Slight Clouded** RECORDS BY **T. Harold Glover**

DATE **7-11-29**

WIND **Breeze S** APPARATUS **Max-Min#21**

TIME **1:30 - 3:00 p.m.**

Depression Record #3

Thermometer	Depth		Temperatures				Remarks
	Meters	Feet	Fahr.	Corrections	Centigrade	Corrections	
#21	0		72		22.2		
	1		71		21.6		
	2		70		21.1		
	3		69		20.5		
	4		68		20.0		
	5		67		19.4		
	6		67		19.4		
	7		67		19.4		
	8		66.5		19.1		
	9		66		18.8		
	10		65.5		18.6		
	11		65		18.3		
	12		64		17.7		
	13		62		16.6		Thermocline begins
	14		58		14.4		
	15		55		12.7		Sample taken at 14.5 m level
	16		52		11.1		End of thermocline
	17		51		10.5		
	18		50		10		
	19		-		-		
	20		49		9.4		
	21		-		-		
	22		48.5		9.1		
	23		-		-		
In mud	24		48		8.8		
							Sample was centri- fuged.

TEMPERATURE RECORD

LOCALITY Camp Davis Depression SKY Clear

RECORDS BY T. Harold Glover

DATE 7-16-29

WIND Breeze S APPARATUS Max.-Min.

TIME 8;30 - 10:00 a.m.

Depression Record # 4

Thermometer	Depth		Temperatures				Remarks
	Meters	Feet	Fahr.	Corrections	Centigrade	Corrections	
# 21	0		73		22.7		
	1		72.5		22.5		
	2		72		22.2		
	3		-		-		
	4		71		21.6		
	5		-		-		
	6		69.5		20.8		
	7		-		-		
	8		67.5		19.7		
	9		-		-		
	10		66		18.8		
	11		-		-		
	12		65		18.3		Sample Taken
	13		62.5		16.9		
	14		60		15.5		
	15		54		12.2		Sample Taken
	16		53		11.6		
	17		51		10.5		
	18		49.5		9.7		
	19		49		9.4		
	20		49		9.4		Sample Taken
	21		-		-		
	22		49.5		9.1		
In Mud	23		48		8.8		
	24						
	25						

