A STUDY OF PLANKTON DILUTION IN

SOURCE STREAMS COMPARED WITH THAT OF LAKE DALLAS PROPER

APPROVED:

J. K. G. Silvey

Major Professor

J. B. McBryde

Minor Professor

B. B. Harris

Director of the Department of Biology

L. A. Sharp

Chairman of the Graduate Council

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THESIS

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A. A. Evans, B. S.

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INTRODUCTION

History

Some knowledge concerning marine and fresh water life goes back to earliest times. Limnology as a distinct field of science has existed for two generations, at least since the time of F. A. Forel (1892-1904). In Europe Thieneman (1926) and Wesenberg-Lund (1900, 1910) were outstanding pioneers in the field of limnology and in work on various plankton investigations.

In America much of the credit in developing fresh water biology must go to E. A. Birge and C. Juday (1922) for research on many inland lakes, and to C. A. Kofoid (1903) whose work on the Illinois river is authoritative. Plankton studies have been made on Lake Michigan by S. Eddy (1927), in North Carolina by R. E. Coker (1926), in Northern New York by P. R. Burkholder (1932), and in certain other regions of the United States and Canada by R. Woltereck (1932). A. H. Wiebe (1928) made a biological survey of the upper Mississippi river, and W. Furneaux (1906) studied life in ponds and streams, to cite a few of the many able biologists who have devoted considerable time to the study of fresh water organisms.

However, little if any work of the above nature has been undertaken in the Southwestern states. The writer has been unable to find in the available literature, or in any of the college libraries examined here in North Texas, but one reference to any Plankton studies to date having been made in this state. The Annual Report of the Texas Game, Fish and Oyster Commission states, regarding lakes not producing fish in the quantity expected, "As a rule any lake trouble is almost certainly the result of deficiency of oxygen, or excess of carbon dioxide or both aggravated by high temperature of the water."

The writer does not fully agree with the quoted statement. The dissolved gases are no doubt contributing factors, but the absence of plankton is the most essential factor in reduced productivity. (Dr. Wiebe (1935) mentions certain plankton forms as fish food.)

Fig. 1 Lake Dallas

Dr. Wiebe, in the same report regarding scarcity of fish in Fern Lake, Nacogdoches, says, "An earlier visit and examination of the water had disclosed a scarcity of plankton and the need of a chemical analysis."

Aim and Purpose

The purpose of this study in ecology is, as indicated in the title, a comparative one. However it is not an attempt to integrate the aquatic life of lentic and lotic series. It is rather the outgrowth of normal scientific curiosity in the study of distribution and sources of those organisms near the bottom of the food cycle of Biota in Lakes and Streams.

The problem is confined chiefly to the plankton group in the strictly scientific connotation, that is, to that heterogenuous mixture of bioseston which, as organisms in water, are free floating, generally microscopic, and normally with little power of locomotion. Very little direct reference will be made here to the neuston, pleuston, nekton, and benthos, although their importance and relation to the plankton group is neither overlooked nor ignored. It is merely beyond the scope of this paper.

It is considered that plankters are an essential

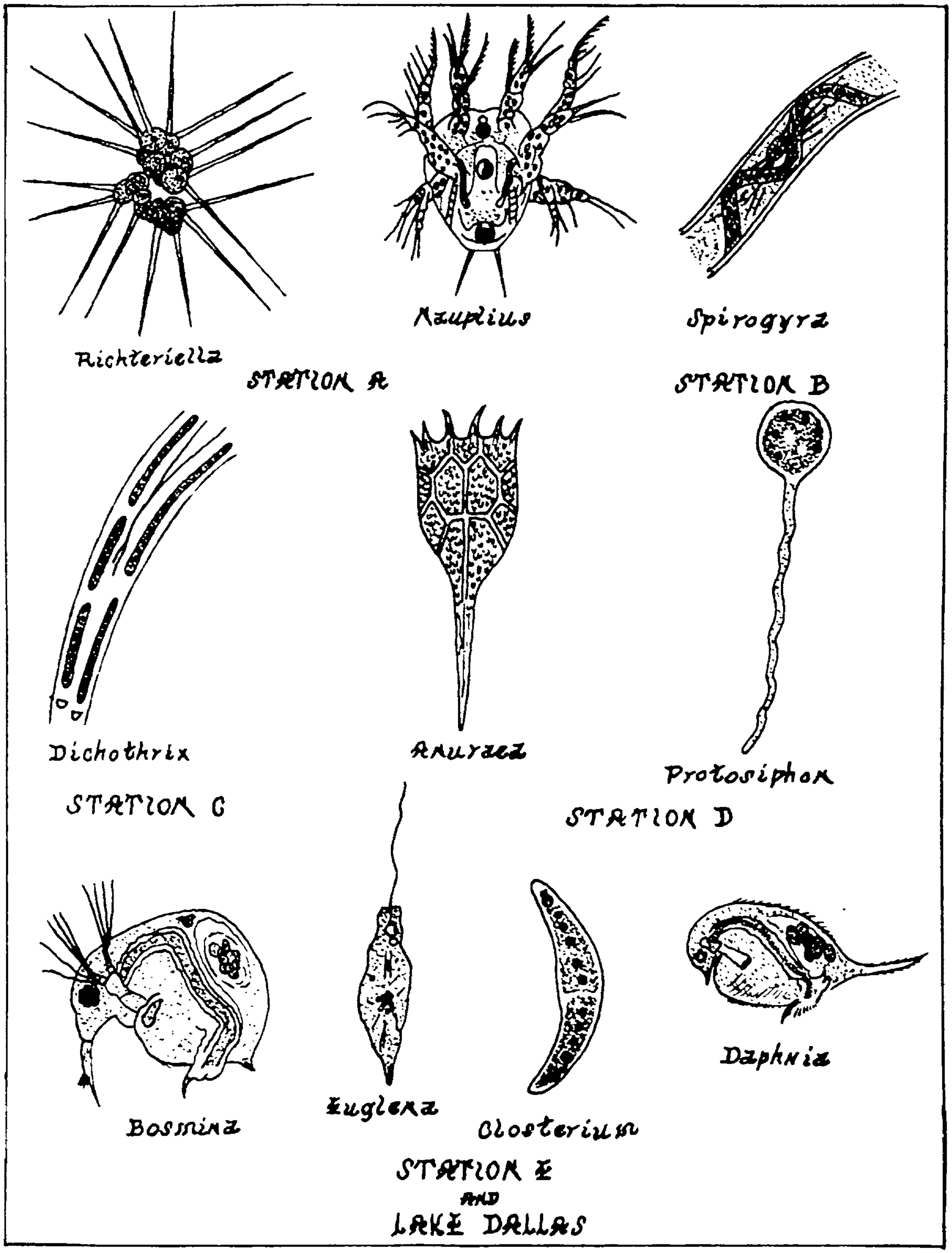


Fig. 2. Water Plankters

NOTE: TAKEN FROM WARD AND WHIPPLE

link in the food cycle of organisms living in water. Frequently lakes and streams are artificially stocked with fish, which are the highest organisms in this food cycle. Complete absence of plankters in these lakes and streams for any material period of time would break the cycle and inevitably result in a biological desert, yet the lakes and streams are seldom artificially stocked with plankters in order that the food cycle may be completed. Where it is complete and other ecological factors are favorable, the productivity is said to be high and the potentialities exist for a fisherman's paradise. Thus economically as well as scientifically the presence or absence of plankters is of importance to mankind, and this problem is essayed with the hope that it may develop at least some few of the many facts which necessarily must be known before a complete knowledge can be gained of the life habits of the members of the plankton group.

Methods and Equipment

Although this was primarily a comparison of quantitative and qualitative plankton in several different localities, some general characteristics of the connected environments were also studied. Standard Methods of Water Analysis were used in obtaining the Physio-Chemical data.

Obviously there was needed an automobile to reach the lake, and a boat (both motorboat and rowboat were used at times) as transportation on the lake.

For determining the chemical and physical characteristics two especially constructed sample cases were designed by Dr. J. K. G. Silvey for portability and use in the field. Both boxes were equipped with handles, the larger about 1 x 2 x 4 feet was partitioned for sample bottles to which glass stoppers were tied (to prevent loss when submerging bottles in the water). The other box, slightly smaller,

Fig. 3 Chemical Analysis

was constructed in like fashion with partitions for holding sample bottles but with a double lid for carriage of pipettes. Tests for carbon dioxide content, and the first part of the oxygen test, were completed in the field, as was also the pH determination. Completion of other chemical tests were done immediately on return to the laboratory. The methods in detail were those given by Dr. Silvey to his class in Animal Ecology and the instructions follow closely the procedure given by Eldridge and Theroux, (1935).

A reversing thermometer of the Negretti-Zambra type was used in taking temperature readings at various depths in the lake.

The catch method was used to collect the organisms to be studied and the equipment consisted of a Juday Sampler and a plankton-net of # 20 bolting cloth.

In collecting with the Juday Sampler, (Fig. 16) which has a two-liter capacity, varying numbers of samples were taken ranging from 10 in most cases on Lake Dallas to 22 in one of the streams. The largest number was taken in an attempt to obtain more specimens where the aquatic organisms were sparse.

In taking samples along the streams some additional equipment was used as means had to be devised for the writer, when working alone, to take samples and hold the net simultaneously. A tripod was used from which the

Fig. 4 Pecan Creek, "Station F"

plankton net was suspended. (Fig. 4). Hip-boots were needed for wading in the streams. Collecting bottles were labeled and carried along to hold the samples.

A small amount usually five cubic centimeters, was put in each bottle as a preservative. (Formaldehyde)

Having collected the desired number of samples 10-22--through the net, the collecting-bucket was removed and its contents emptied into a graduate cylinder so that the amount could be measured. The bucket was then rinsed with an amount of washing water which was also measured and emptied into the sample bottle which was then ready to be taken to the laboratory. In order to obtain the specimens which are so small that they pass through the meshes of # 20 bolting cloth, a centrifuge was used. A five-gallon bucket was employed to bring the samples from lake and stream to the laboratory. In running the centrifuge sample for separating out the nannoplankton the volume of water was measured prior to entering and checked as it emptied from the centrifuge into a graduate. The speed of passage was adjusted so that one liter of fluid was centrifuged in five minutes. The centrifuge is electrically operated, manufactured by Forest Specialties Company of Chicago, and runs at a high rate of speed.

In that the source streams were quite shallow usually less than two meters, a sample of only one depth was taken at each location, but on the lake, samples were taken from several consecutive depths, which permitted a determination of vertical distribution. The method followed to obtain this, as was done on May 12, was essentially as follows: In a deep place in the lake located by soundings, the anchor of the motorboat was dropped overboard, and samples taken. The cord of the Juday Sampler had been marked to permit lowering to known depths for each specific sample. Ten surface samples were passed through the net, the catch was measured and put in a bottle with a label marked "surface." Measured amounts of washing water and preservative were also put in. The process was repeated until a sample bottle was gathered from each meter of depth. (The Juday Sampler is so constructed that it may be closed to collect samples at specific depths by the use of a target which is dropped and releases a trigger allowing the instrument to close.) Anchor was then pulled and a new location chosen where the process was repeated. The surface sample was placed in the same bottle with the first surface sample, and the other depths into their respective bottles. The process was again repeated in a third locality thus making the third corner of a fairly large triangle.

Having collected a plankton sample the next method of procedure was to make a qualitative and quantitative count and an analysis of the data. In order to determine the exact area of the field of observation of a particular microscope it was calibrated as follows: An ocular micrometer graduated 0-5, and with each division subdivided into tenths was put in the eyepiece. A stage micrometer was observed, and the scale in the eyepiece of the microscope compared with the calibrated standard. Results indicated--

Microscope # 16/N. 7.5 ocular # 130330.

Objective	Ocular micrometer	Stage micrometer millimeters	Line space mm	Area Square mm
16 mm	0	.16		
			.17	.0289
	1	.33		
			.17	
	2	.30		
			.17	
	3	.67		
			.17	
	4	.64		
			.17	
	5	1.01		
			.85	.7225
4 mm	0	.14		
			.04	.0016
	1	.18		
			.04	
	2	.22		
			.04	
	3	.26		
			.04	
	4	.30		
			.04	
	5	.34		
			.20	.04

Having obtained the subtended area in the field the volume of water examined was secured in two alternate ways. In one a plunger was used which delivers exactly one cubic centimeter, in the other the volume was obtained of the counting cell which was a glass slide having a brass frame sealed on to it. The area within the frame was measured and its thickness obtained by several micrometer readings. Net thickness of water samples held on slide # 1 under cover-slip and within the frame was 1.033 millimeters. Therefore the volume of water subtended by the scale 0-5 rotated through 90° to give an area of .7225 square millimeters and multiplied by the thickness 1.033 millimeters of film of water on the counting cell, gave a volume for each observational count of .7463 cubic millimeters or .75 as the constant for this microscope and slide. (The other scope used #25/N was calibrated and the constant 1.274 obtained.)

The constant is applied in the formula for number of organisms per liter = O/U x 1000 x (c + w + p) ÷ L, where:

O = average count per organisms per 100

U = unit used (.75 with scope # 16/N).

1000 = cubic millimeter per cubic centimeter

C = concentrate
W = washing water
P = preservative

} S = total volume of sample in cubic centimeters

L = vol. of water in liters taken for sample.

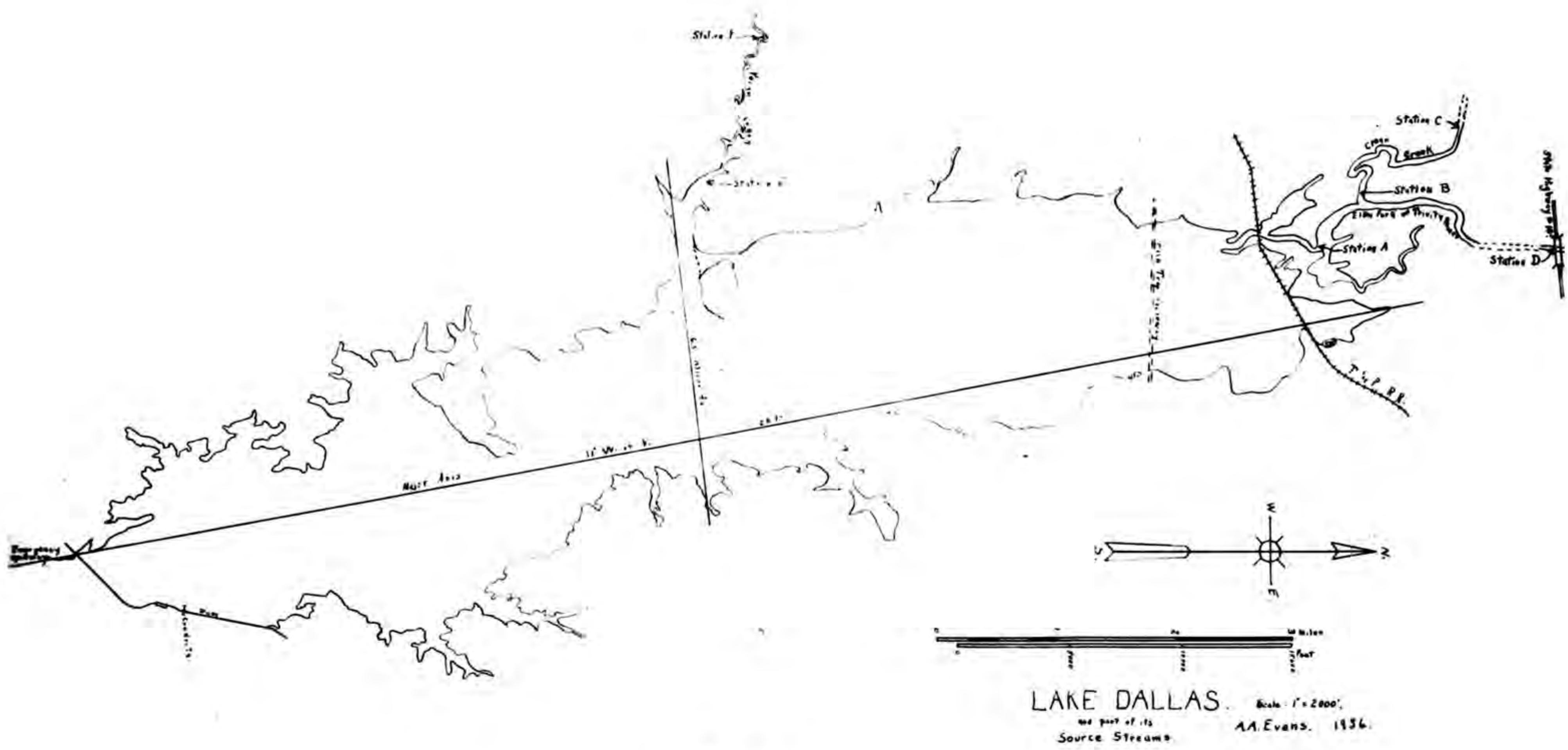
An average of at least 10 counts was always taken and specimens were examined and identified for qualitative analysis (Ward and Whipple, 1918) and counted for quantitative results.

Other general methods and equipment such as is used by an engineer and draftsman were also necessary. A drawing board was used to make the maps, a polar planimeter to obtain the area, and a map-measurer in determining the length of shore line. The chemical balance was also used as a check method in getting the area of the lake at the 525 foot contour.

Physiography and Morphometry

In order to get an idea of the physiography of the terrain, a general exploratory trip was made by motor-boat up and down the lake, and by foot and automobile for a number of miles along the banks of the source streams. For more detailed morphometry, a map of the lake was traced from a copy of the official contour and ownership map of the City of Dallas, originally prepared under the direction

Fig. 5 Lake Dallas



Station C
Creek
Station B
Elm Fork of Trinity
Station A
Station D
State Highway
T & P. RR.
Main Axis
LAKE DALLAS
and part of its
Source Streams
Scale: 1" = 2000'
A.A. Evans. 1936.

Fig. 6

of Nagle and Thompson, consulting Engineers. Tracings from United States Department of Agriculture map were added to lake proper showing the source streams and the location of stations for the collection of sample data.

Lake Dallas is a lake of the third order, with a storage capacity, when first built, of 63.2 billion gallons of water when filled to the 525 foot contour. It has already silted and filled to such an extent as to diminish this amount appreciably. The greatest depth obtained by soundings which were taken during several exploratory cruises of the Limnology class in the spring of 1936 was thirty-four feet. The area covered at the 525' contour is approximately eleven thousand acres, or to be exact 470,784,850 square feet as obtained by the writer which represents an average by planimeter reading and weighing methods. The maximum length is 59,500 feet or about twelve miles, maximum width 13,600 feet, and length of shore line, due to numerous bays and promontories, as computed with a map measurer was 300,000 feet. The major axis is 11° west of a North-South line. (Fig. 6).

The creeks studied, which are the principal source streams of Lake Dallas, are the Elm fork of the Trinity River, and Clear Creek. The confluence of these two is about two and one-half miles above the mouth of

Elm Fork. It was desired to obtain specimens out of each fork as well as from the common stream for a qualitative comparison.

At this dry season of the year the rate of flow of these streams is practically negligible and the volume emptied into the lake is not large; however,there is constant flowage and no stagnation except in isolated deeper holes. The accompanying photographs were taken by the writer to convey an idea as to the relative general size and appearance of the various streams at the different locations.

Samples were also taken from Pecan Creek; first, at a station about one-half mile above where it empties into the lake,and second,approximately two miles above its mouth and three miles below the Denton sewage disposal plant. Specimens from this stream were studied, not because of the volume of flow as a source stream, but because Pecan Creek carries the outflow from the sewage plant and the writer expected in consequence a higher degree of productivity here than in the other source streams.

All three source streams worked have well-defined and comparatively deep channels and are subject to seasonal floods and overflows. At this time they become swift running, carry large volumes of water, overflow their banks and mix with much backwater from the lake.

Fig. 7 Confluence of Elm Fork and Clear Creek, "Station B"

It was found that both Clear Creek and Elm Fork have silted up in places to such an extent as to make wading extremely hazardous if not practically impossible. The fine soils from the fertile fields of the cultivated and as yet largely unterraced watershed have been eroded and transported by floods and deposited in the channels much in the nature of quicksand. Where this condition prevailed the writer quickly mired down in hip-boots and had to resort to the use of logs and stumps for a more firm foothold from which to lower the Juday Sampler.

Acknowledgments

The author wishes to express his indebtedness and gratitude to Dr. J. K. G. Silvey for his constructive criticism in the capacity of Major Professor and for his many valuable suggestions. The author desires to express his appreciation particularly to Miss LaVerne Scott for her able assistance in taking chemical and physical data, and he is also grateful to several members of the Faculty and to a number of his associates and classmates for their assistance in the compiling of data and in various ways during the preparation of this thesis.

Fig. 8 Clear Creek, "Station C"

RESULTS

Data from Lake Dallas

Plankton samples were taken from the lake April 23, 1936, with four depths in the series (Table 1), again on May 12, with five depths from the three corners of a large triangle for vertical distribution (Table II). Again on July 19, five samplings were taken but the eight meter depth was so full of debris that analysis was impracticable. (Table III). Data for Temperature record (Table IV) and for Dissolved gases (Table VII) were taken on April 23, a chemical analysis was also made on August 2. (Table VII).

Data from Source Streams

Plankton sample # 1 (Table IV) was taken June 10, from "Station A" on Elm Fork of the Trinity River about two miles above where it empties into Lake Dallas (Fig. 16) and one-half mile below the mouth of Clear Creek.

Sample # 2 (Table IV) was taken June 18 from Clear Creek, "Station B," located about 100 yards above the confluence of the two streams.

Sample # 3 (Table IV) was taken the same afternoon from "Station C" on Clear Creek about one mile above its mouth into Elm.

Sample # 4 (Table IV) was taken July 8, from

Fig. 9 Elm Fork, "Station D"

"Station D," on Elm Fork where State Highway # 10 bridge crosses over the stream, being about three miles above the mouth of Clear Creek.

Sample # 5 (Table IV) was taken July 17 from "Station D" also.

Sample # 6 (Table IV) was taken July 27 from Pecan Creek, "Station E," about one-half mile above its mouth.

Sample # 7 (Table IV) was taken July 27, also from Pecan Creek at "Station F," located in a pasture about two miles above the creek mouth and three miles below the Denton sewage disposal plant.

Chemical data samples were taken August 2, from each of the three source streams, Clear Creek at "Station B," Elm Fork at "Station D," and Pecan Creek at "Station E," (Table IV).

The high count of Lyngbya in Phytoplankton at four meters in Lake Dallas on April 23 is included in the data since it was obtained but it is not consistent with other results, probably it represents a local condition, and should be disregarded.

Fig. 10 Pecan Creek, "Station E"

Horizontal distribution is analyzed and compared in Fig. 12 and Fig. 13. Vertical distribution is shown in Fig. 11, Temperature record in Fig. 14. Comparison of Dissolved gases in Lake Dallas with Source Streams is analyzed in Fig. 15.

TABLE I.

PLANKTON RECORD

Locality-Lake Dallas — L (Correction) 40; U (Unit) .75

Date -April 23, 1936

Time -2-4 p. m.

Depth (Total-10 observations)	Surface	1 meter	2 meters	4 meters
S (C W P)	66	75.5	93.5	98
ZOOPLANKTON				
Difflugia	0	0	1	1
Anuraea	0	2	0	0
Brachionus	0	0	1	0
Bosmina	0	1	1	2
Daphnia	1	1	0	0
Cyclops	1	3	1	0
Nauplii	3	3	0	0
Ostracoda	2	0	1	3
Total	7	10	5	6
PHYTOPLANKTON				
Lyngbya	44	110	55	233
Pediastrum	2	1	0	0
Mugeotia	1	0	0	1
Spirogyra	1	0	0	0
Cladophora	1	0	0	0
Richteriella	1	0	0	0
Closterium	0	0	0	3
Total	50	111	55	237
Grand Total	57	121	60	243
Plankters/liter	12,540	30,451	18,700	77,913

TABLE II.

PLANKTON RECORD

Locality-Lake Dallas

Date -May 12, 1936

Time -1:30-4 p. m.

L (Correction) 20
U (Unit) .75

Depth (Total-10 observations)	Surface	3 feet	9 feet	22 feet	33 feet
S (C W P)	35	47.5	36	29	30
ZOOPLANKTON					
Difflugia	0	0	0	1	0
Anuraea	2	0	4	0	0
Daphnia	0	0	0	0	2
Bosmina	1	6	2	1	1
Copepoda	4	0	0	0	0
Cyclops	4	2	2	2	4
Cyclops eggs	1	2	6	0	0
Nauplii	6	4	3	3	1
Total	18	14	17	7	8
PHYTOPLANKTON					
Lyngbya	4	4	0	1	0
Pediastrum	1	0	1	1	0
TOTAL	5	4	1	2	0
Grand Total	23	18	18	9	8
Plankters/liter	5,366	5,700	4,320	1,740	1,600

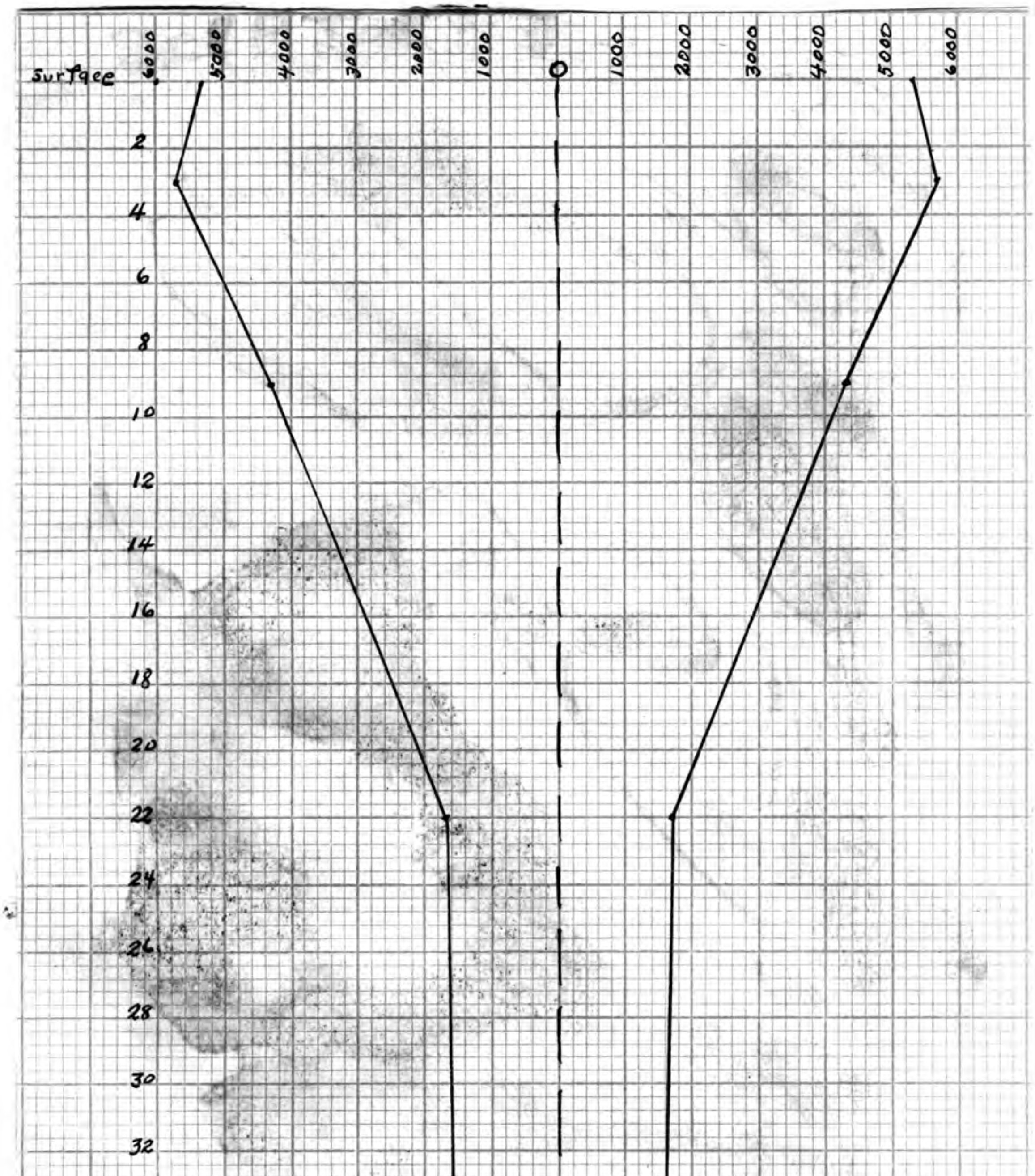


Fig. 11 Vertical Distribution

TABLE III.

PLANKTON RECORD

Locality-Lake Dallas L (Correction) 20

Date -July 19, 1936 U (Unit) 1.274

Time -7-10 A. M.

Depth (Total-10 observations)	Surface	2 meters	4 meters	6 meters	8 meters
S (C W P)	30	30	30	30	30
ZOOPLANKTON					
Anuraea	1	0	0	1	-
Arcella	0	4	0	0	-
Daphnia	0	0	0	1	-
Cyclops	1	0	0	1	-
Nauplii	2	5	3	3	-
Total	4	9	3	6	-
PHYTOPLANKTON					
Lyngbya	33	75	17	29	-
Pediastrum	1	0	0	1	-
Total	34	75	17	30	-
Grand Total	38	84	20	36	-
Plankters/liter	4,474	9,890	2,354	4,239	-

TABLE IV

PLANKTON RECORD

Locality-Source Streams U (Unit) 1.274

Location	Elm Fork	Clear Creek	Clear Creek	Elm Fork	Elm Fork	Pecan Creek	Pecan Creek
Station (Total-10 observations)	A	B	C	D	D	E	F
Date (1936)	6/10	6/18	6/18	7/8	7/17	7/27	7/27
Time (pm)	3-6	2-6	2-6	2-6	2-6	2-6	2-6
L (Juday Samplers x two liters)	20	40	40	30	44	20	20
S (C W P)	60	100	50	55	70	20	40
ZOOPLANKTON							
Anuraea	0	0	0	1	0	0	2
Corethra	0	0	0	0	1	0	0
Nauplii	1	0	0	0	0	4	0
Sida	0	0	0	0	0	2	0
Euglena	0	0	0	0	0	0	3
Total	1	0	0	1	1	6	5

(continued on next page)

TABLE IV (Continued)

Location	Elm Fork	Clear Creek	Clear Creek	Elm Fork	Elm Fork	Pecan Creek	Pecan Creek
Station (Total-10 observations)	A	B	C	D	D	E	F
PHYTOPLANKTON							
Richteriella	1	0	1	0	0	2	0
Spirogyra	0	1	0	0	0	0	0
Dichothrix	0	0	1	0	0	0	0
Protosiphon	0	0	0	1	0	0	0
Lyngbya	0	0	0	0	0	4	1
Ulothrix	0	0	0	0	0	1	0
Navicula	0	0	0	0	0	0	1
Mastogloia	0	0	0	0	0	0	1
Suriella	0	0	0	0	0	0	1
Closterium	0	0	0	0	0	0	2
Pleurococcus	0	0	0	0	0	0	4
Total	1	1	2	1	0	7	10
Grand Total	2	1	2	3	2	13	15
Plankters/liter	470	196	196	431	249	1,020	2,354

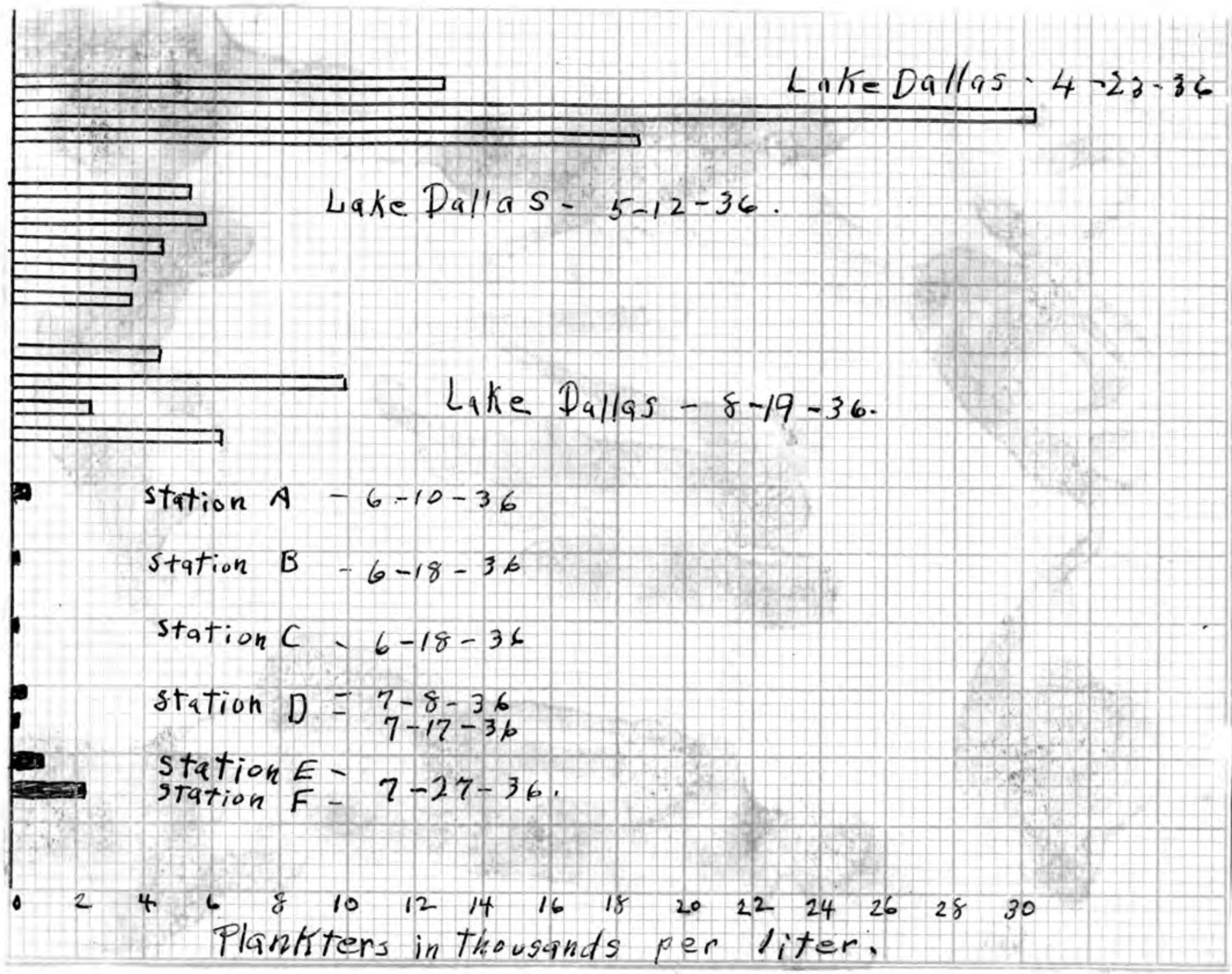


Fig. 12 Horizontal Distribution

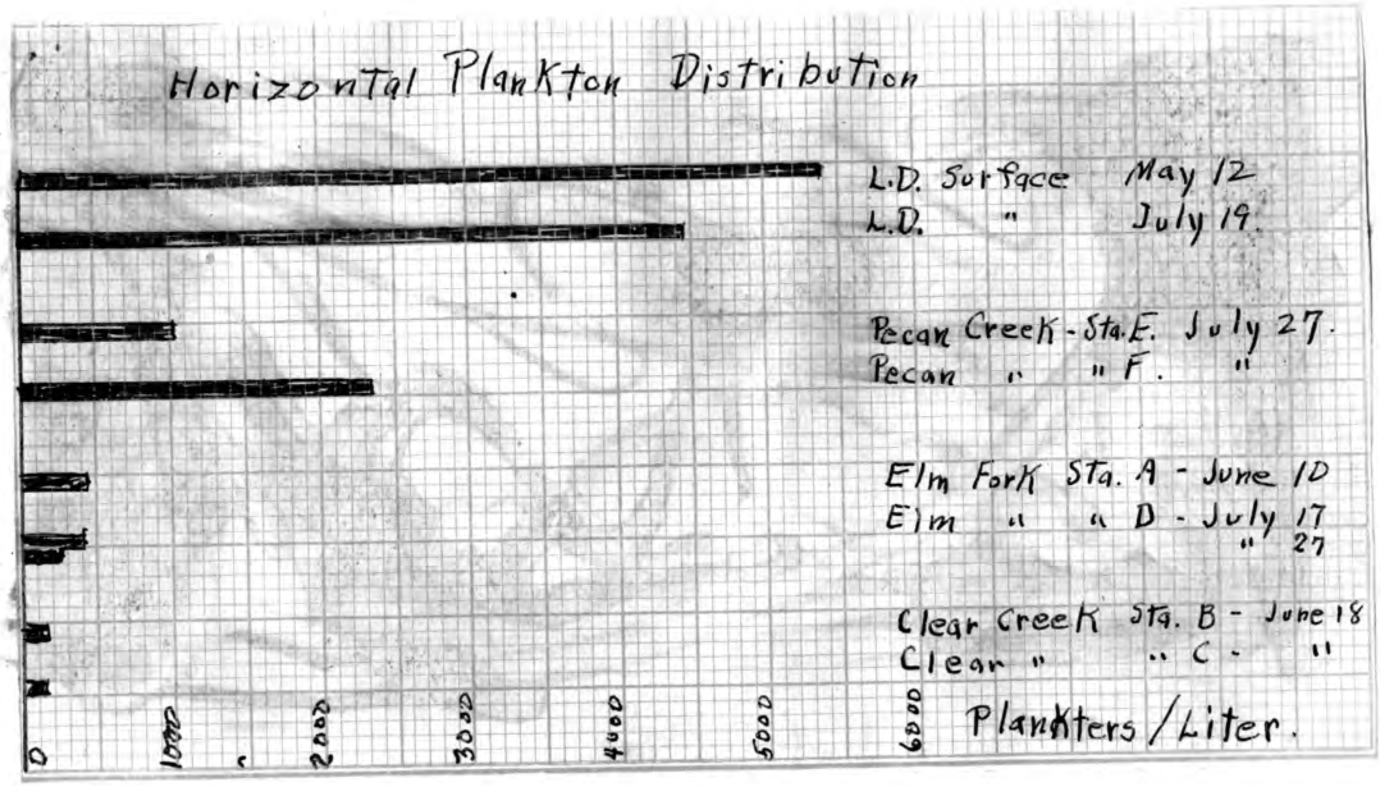


Fig. 13 Horizontal Distribution

TABLE V.

TEMPERATURE RECORD

Locality-Lake Dallas

Depth meters	Temperature ° C. March 30	April 23	June 21	July 19
Surface	-	17.6	-	31.0
1	19.0	17.4	30.9	30.4
2	17.0	17.4	29.1	29.8
3	16.8	17.6	28.9	29.4
4	16.2	16.8	28.9	29.0
5	16.0	16.6	27.8	28.75
6	16.0	-	27.2	28.50
7	16.0	-	27.2	28.25
8	15.0	-	27.2	28.00
9	14.8	-	27.0	-

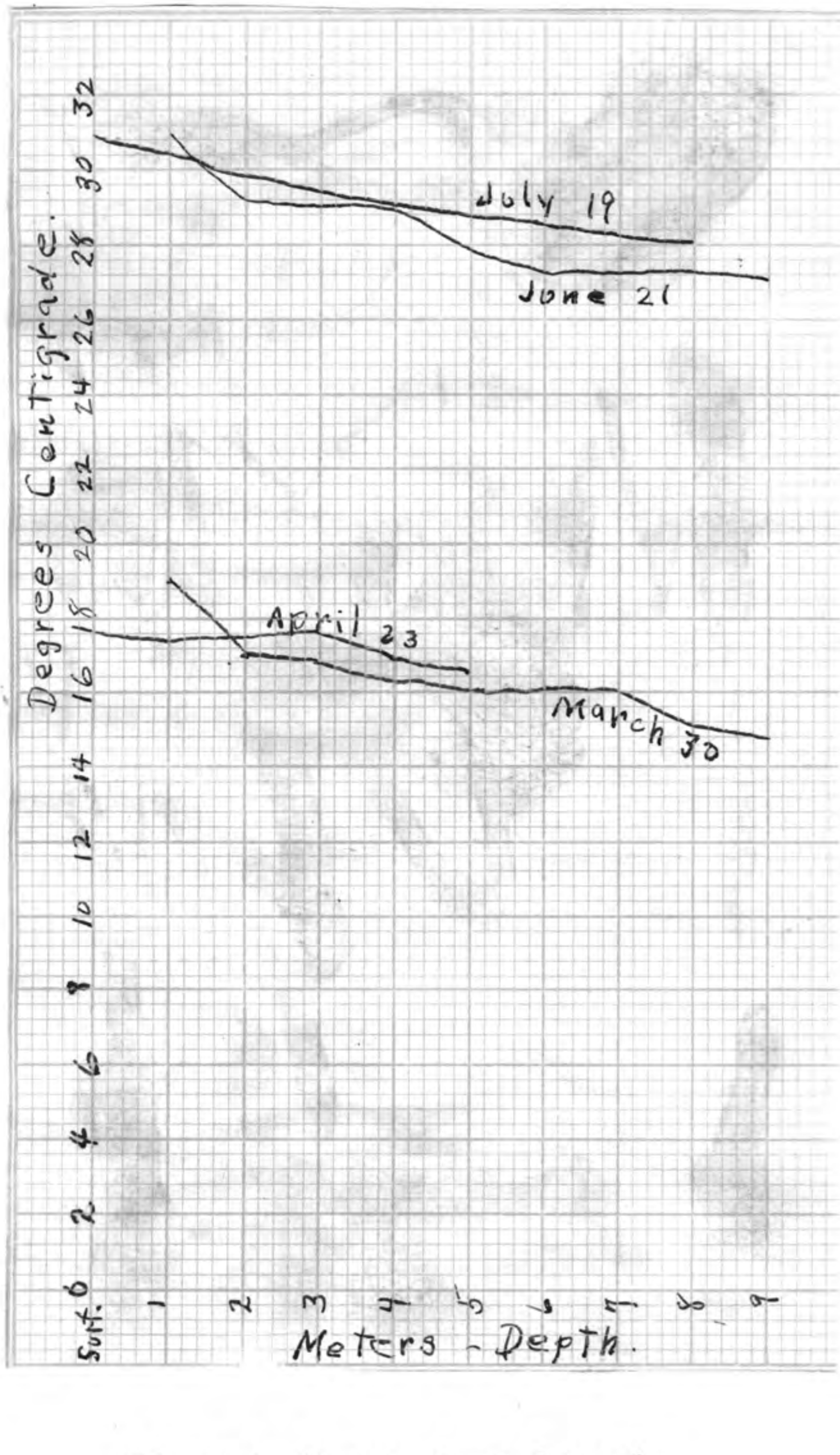


Fig. 14 Temperature Record

TABLE VI.

DISSOLVED GASES

Locality-Lake Dallas — Air Temperature- 20.2° C.

Date -April 23, 1936 — Sky - Clear

Time -2-4 p. m.

Depth meters	pH	O_2 p.p.m.	CO_2-p.p.m. Free	Bicarb.	Carb.
Surface	8.4	9.2	6	153.5	0
1	8.4	9.2	8	151.5	0
2	8.4	9.2	6.3	150.0	0
3	8.4	9.0	7	149.5	0
4	8.4	8.8	7	149.0	0
5	8.5	8.7	8	151.0	0

TABLE VII.

DISSOLVED GASES

Date -August 2, 1936

Locality	pH	O_2 p.p.m.	CO_2-p.p.m. Free	Bicarb.	Carb.
Lake Dallas	8.2	7.4	20	118	0
Clear Creek Station B	8.0	7.2	20	179	0
Elm Fork Station D	7.8	8.0	30	241	0
Pecan Creek Station E	8.4	12.8	10	160	0

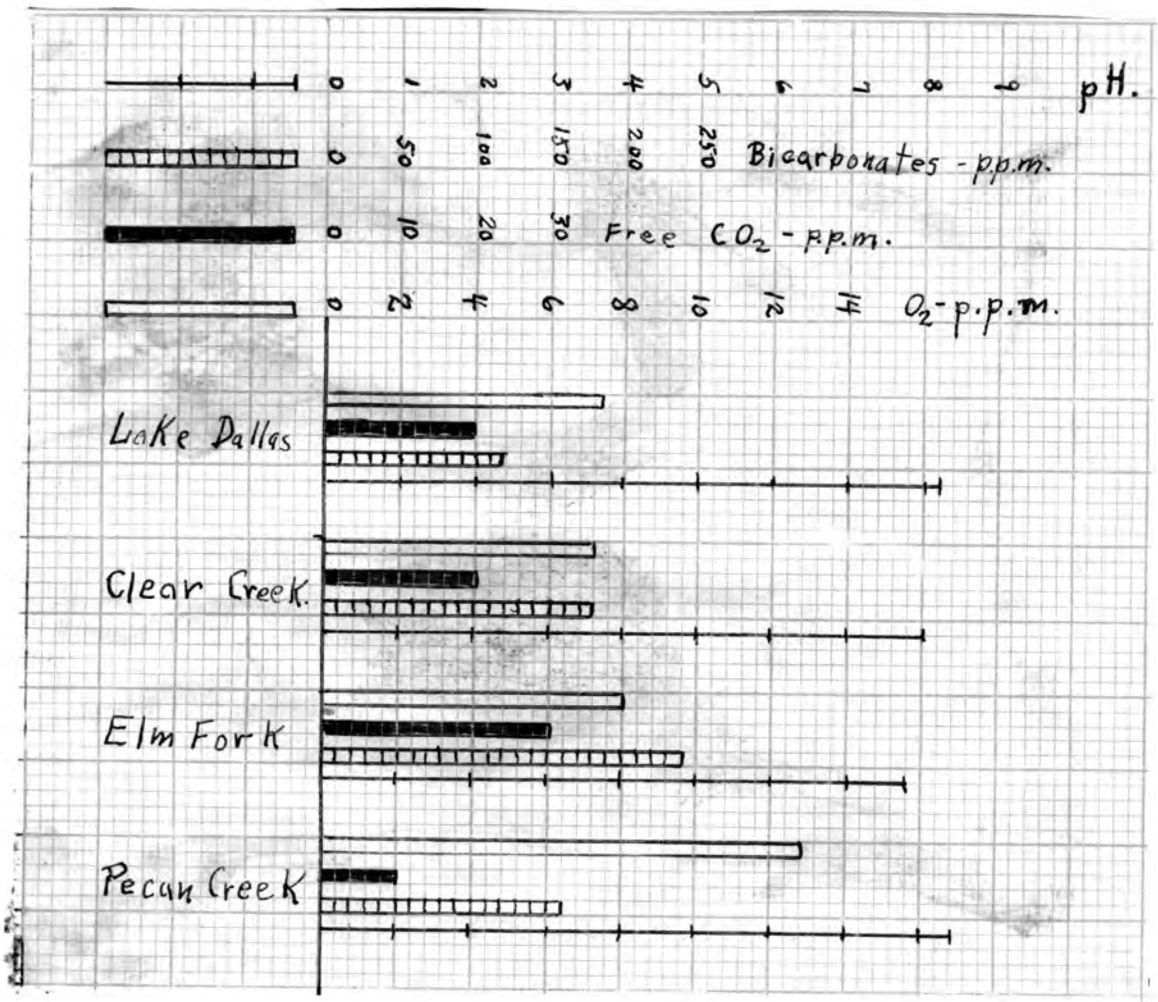


Fig. 15 Comparison of Dissolved gases in L. D. with S. S.

TABLE VIII.

DISSOLVED GASES

Locality-Lake Dallas Time: 1 p. m.

Date -March 30, 1936

Depth meters	pH	O_2 p.p.m.	CO_2-p.p.m. Free	Bicarb.	Carb.
1	8.0	9.3	2	180	0
2	8.0	9.3	5	152	0
3	8.0	9.2	8	157	0
4	8.0	9.1	8	157	0
5	8.0	9.1	8	145	0
6	8.0	9.0	8	145	0
7	8.0	9.0	8	142	0
8	7.8	8.8	12	149	0
9	7.8	8.4	14	149	0

TABLE IX.

DISSOLVED GASES

Locality-Lake Dallas Time: 1 p.m.

Date -June 21, 1936

Depth meters	pH	O_2 p.p.m.	CO_2-p.p.m. Free	Bicarb.	Carb.
Surface	8.0	7.0	-	177	-
1	8.0	7.0	-	178	-
2	7.9	6.2	-	180	-
3	7.9	6.2	-	181	-
4	7.9	6.0	-	181	-
5	7.8	5.2	-	181	-
6	7.7	3.7	-	183	-
7	7.7	3.6	-	183	-
8	7.7	3.0	-	187	-

TABLE X.

DISSOLVED GASES

Locality-Lake Dallas   Time: 7-10 A. M.

Date   -July 19, 1936

Depth meters	pH	O_2 p.p.m.	CO_2-p.p.m. Free	Bicarb.	Carb.
0	8.0	7.0	1.0	-	-
1	7.95	7.0	3.0	-	-
2	7.9	6.8	5.0	-	-
3	7.9	6.6	7.5	-	-
4	7.9	6.4	10.0	-	-
5	7.85	5.8	27.5	-	-
6	7.8	5.2	45.0	-	-
7	7.7	5.0	60.0	-	-
8	7.6	5.0	75.0	-	-

DISCUSSION

General

This comparative study regarding the nature of certain fresh water environments tends to show that even in cases where all are physical continuations of the same body of water, each may possess slightly different physico-chemical properties and support plankton in differing proportions. The quantitative differences were more pronounced than the qualitative in the study of biota as a whole. In discussing horizontal distribution of plankton Welch says: "Uniformity is not an impossibility, but it is not the common condition in nature and may be rare."

The vertical temperature readings in the lake were fairly uniform indicating no real thermal stratification. When tested April 23, the variation was only one degree in five meters. In March the temperature was 19° C. at the one meter depth and decreased uniformly to 14.8° C. at nine meters. In both June and July, though the temperature was much higher, it decreased uniformly with less than a 4° drop in descending to the eight or nine meter level. (TABLE V). The pH on April 23 was on the alkaline side at 8.4. In June and July it was only slightly less basic, with pH at the surface of 8.0.

Later in the year on August 2 the pH of the lake was 8.2, in Pecan Creek the pH was 8.4, in Clear Creek 8.0, and in Elm Fork 7.8. According to our analysis of dissolved materials observed April 23, it is seen that this is almost a soft water lake according to Birge and Juday based on bound CO_2 content. Their classification of lakes on this basis includes three categories, those having less than 5 c.c. of carbonate per liter as soft, from 5-22 c.c. of CO_3 per liter as medium, and above 22 c.c. of CO_3 per liter as hard water lakes. Lake Dallas was found to have no bound-carbon dioxide on any of the above dates. The bicarbonate content or half-bound carbon dioxide was present in amounts varying from 149-153.5 p.p.m. which contributes only slightly to hardness of natural waters.

The dissolved oxygen was greater in Pecan Creek, being 12.8 p.p.m., than in the other localities studied. On no place was it found to be anywhere near as low as the minimal requirements of .4 p.p.m. necessary to support the aquatic life being investigated. The lowest found was 3 p.p.m. at eight meters on June 21 in the lake. As low as 2.2 p.p.m. will support life in current animals such as rainbow trout. As was expected the dissolved O_2 was less in the hot months of June and July (7 p.p.m. at one meter) than in the cooler spring months when it was 9.2 p.p.m.

(April 23) and 9.3 p.p.m. (March 30) at the same depth.

The free CO_2 was 6 p.p.m. in the lake in April. In July it varied from 1 p.p.m. at the surface to as high as 75 p.p.m. at eight meters down. Free CO_2 was 30 p.p.m. and bicarbonates 241 p.p.m. in Elm Fork on August 2, and in Pecan Creek on the same day CO_2 was 10 p.p.m. and bicarbonates 160. A more detailed study of the chemical properties of Lake Dallas was made by Addie Mae Curbo (1935).

Fig. 16 Elm Fork, "Station A"

It was found that plankton, which were plentiful in the lake were exceedingly scarce at all stations observed in Clear Creek and in Elm Fork. If plankton do occur in the lotic series, regardless of the nature of their origin in their environment, they would be expected to be fairly regular in their distribution from one point to another if the stream flow is slow and steady. Since the flowage of Clear Creek and of Elm Fork is slow and further, since no marked variation occurred in stations at various distances above their mouths, one may assume any sample or samples to be representative. It was found that limnoplankton were much in excess of rheoplankton, in both number of species and specimens. It is reasonable to consider therefore, that the plankton of Lake Dallas are decidedly more autogenetic than allogenetic in origin.

In the sampling of July 8 at "Station D" on Elm Fork, the only specimen obtained was one Corethra, which is generally a benthic organism. It is possible that its occurrence in net plankton was due to one of three causes. It may have become churned up from the bottom region due to shallow water and other sampling difficulties resulting from taking samples while standing on a bridge forty feet above the water. A second possible explanation is that the tracheal expansions of the Corethra larva may be true buoyancy organs, as claimed by some investigators, placing it more in either the littoral or the limnetic than in the benthic group as to distribution. Or third, although Corethra is a normal member of the benthos, it is subject to diurnal migrations, and is often collected in day time, if direct light on the water surface is greatly reduced. In the locality of this station, shade trees protect the surface waters and the declivitous banks contribute greatly to light reduction.

The writer was interested in Pecan Creek, since it carries the water freed from sludge after passing through the Imhoff tanks, of the Denton sewage plant. It was found that this source stream was practically as rich in plankton as the lake. It differed very much from the other source streams in respect to productivity possibly due to its dissolved organic materials inflowing from the sewage plant.

A number of investigators, including Moore (1912), have done experimental work on the relative ability of aquatic organisms, both plankton and higher forms, to utilize the dissolved organic materials found in water as their source of food. Putter (1907) working with lobsters, octipi, and starfish concluded that they get two-thirds of their food from the dissolved materials. Birge and Juday (1927) found that fresh water has more dissolved organic matter than sea water, that plankton on death return little organic material to water, and that organic material in water is sixteen times more abundant as potential food than are plankton as actual food. Some think that organisms put on an exclusive diet of water and dissolved materials live for a time by the utilization of their own body protein, which is replaced by water. But many protozoa and lower life forms may be able to live with only water and dissolved material for food.

Where the productivity of a running stream is shown to be fairly high, it is evident that the biotic potential must be of very great magnitude. As previously stated by the writer, these source streams are subject to sudden rises or pulses and during this time may expose the plankters to many hazards often ending in almost complete destruction. Thus repopulation is dependent on the rate at which the organisms reproduce. If the population is high in a source stream at normal level, one may safely assume a high biotic potential, if circumstances are the reverse, then the potential is definitely not high.

In the centrifuge sample which was obtained July 27 from close to mouth of Pecan Creek in the lake near Station E, there were identified Chlorella, Stichococcus, Ankistrodesmus, and a great many Bacteria.

Fig. 17 Centrifuge in operation

Conclusions

1. The variations in O_2, CO_2, bicarbonates, and pH, while noticeable in the different environments, do not occur in sufficient extremes or with enough uniformity to justify any conclusion regarding them as causal agents for plankton differences.

2. On the whole, characteristic species were found in the lake and in lesser quantity in the source streams, but no exclusive species for any one habitat were observed.

3. Lake Dallas which is generally less than 34 ft. deep draws from a fertile watershed, and is sufficiently favorable in all dissolved substances to be a fairly

productive lake.

4. Vertical distribution indicated the most productive plankton area as slightly below the surface.

5. Clear Creek and Elm Fork have practically no plankton, hence these sources constitute a dilution process.

6. On the other hand Pecan Creek which receives inflow from the sewage disposal plant is rich in plankton, especially green algae and bacteria, and may contribute slightly to the plankton crop.

7. Since the relative amount of water flowing into the lake from Clear Creek and Elm Fork appears to be much larger than from Pecan Creek and since Elm and Clear Creek carry few plankton, even during periods of near stagnation or slow flowage, it may reasonably be concluded that the plankton crop of Lake Dallas is largely autogenetic in origin.

SUMMARY

1. Fresh water biology with especial reference to plankton, though two generations old elsewhere, is a new field of study in Denton county.

2. This is a comparative study of the plankton of Lake Dallas and the three main source streams.

3. Standard methods and time tried apparatus were used along with some newly designed equipment.

4. The physiography and morphometry of Lake Dallas and the source streams were studied and mapped.

5. Data is presented relative to the organisms taken from the lake and from the source streams.

6. The results obtained are discussed.

7. The plankton seem to be largely autogenetic in Lake Dallas, the source streams Elm Fork and Clear Creek form a dilution process, but Pecan Creek is practically as rich as is the lake.

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