NORTHWESTERN LAKES OF THE UNITED STATES: BIOLOGICAL AND CHEMICAL STUDIES WITH REFERENCE TO POSSIBILITIES IN PRODUCTION OF FISH.

By GEORGE KEMMERER, J. F. BOVARD, and W. R. BOORMAN,
Temporary Investigators, U. S. Bureau of Fisheries.

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Errata.

Page 61: Proportion of sodium carbonate in solution #3 should be 1.2045 grams and not 0.12045 grams.

Page 91: The indicated scale of the map on this page is incorrect. The correct scale is 4.9 miles to the inch. From this the greatest length of the lake is 40.4 miles (65 km.) with a shore line of 103 miles (166 km.). This corrects the measurements given in the text at top of page 91.

Page 94: The indicated scale of the map on this page is incorrect. The correct scale is 2.36 miles to the inch. From this the greatest length of Priest Lake is 18.5 miles (30 km.) with a shore line of 48 miles (77 km.). This corrects the measurements given in the text at bottom of page 92.

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TABLES.

INTRODUCTION.

The work described in this paper was conducted for the United States Bureau of Fisheries during the summers of 1911, 1912, and 1913. The investigation was in charge of George Kemmerer, who was responsible for the soundings, the temperature observations, and the chemical work in determining the dissolved gases. During the summer of 1911 John F. Bovard served as biologist, and in 1912 and 1913 W. R. Boorman.

In 1911 headquarters were established at Spokane, Wash., and the lakes of that section were studied. In 1912 some additional lakes in the vicinity of Spokane and the lakes of southern Idaho were investigated. In 1913 Lake Tahoe and Fallen Leaf Lake, of California, and Crater and Upper Klamath Lakes, of Oregon, were examined for comparison with the deep lakes, such as Chelan and Pend Oreille. The month of August, 1913, was spent on the lakes of western Washington.

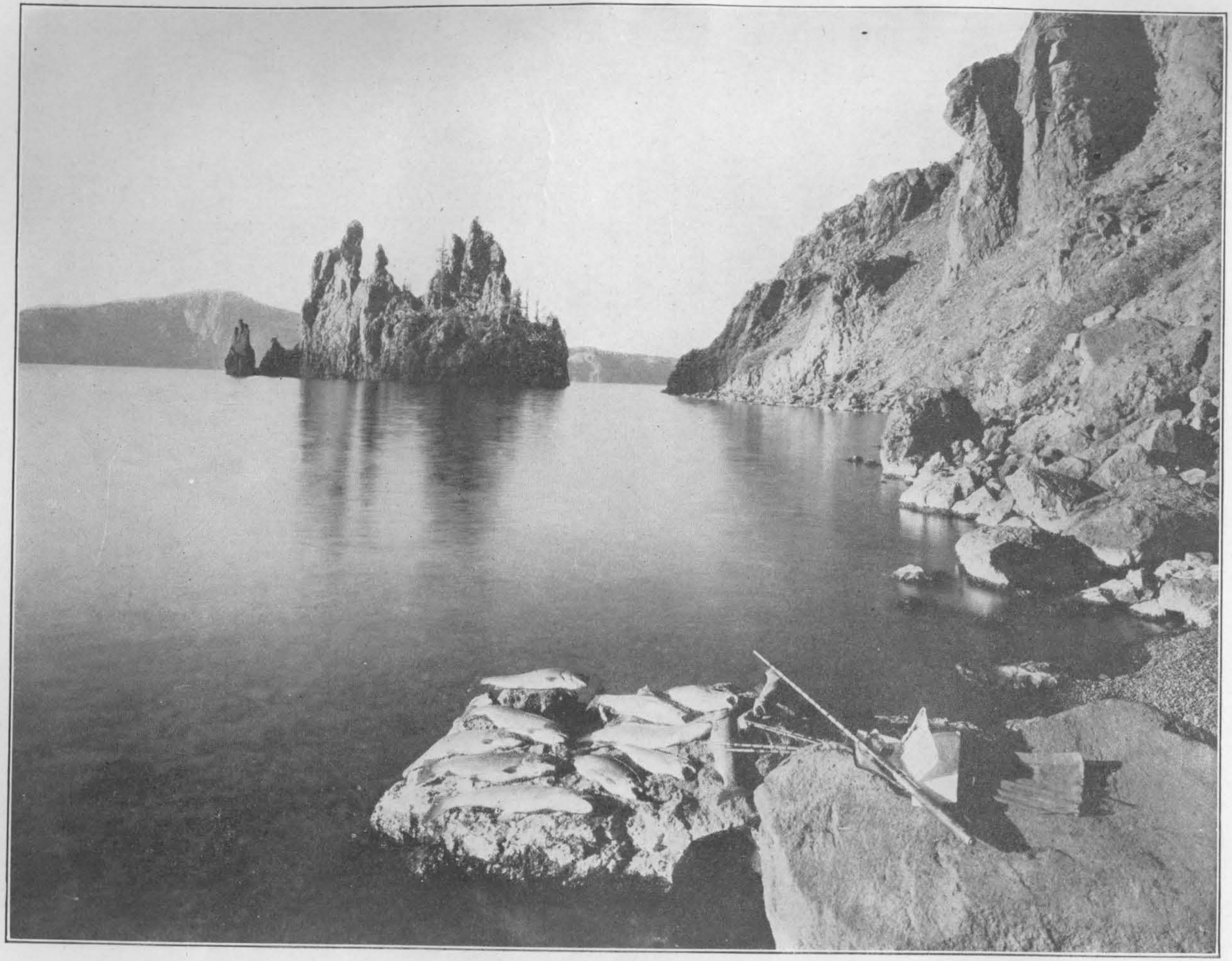

FIG. 1.—Crater Lake, Oreg.

The purpose of the investigation was to extend to these lakes an examination similar to the one that had been carried out on the Wisconsin lakes (Birge and Juday, 1911). Some of the methods, however, especially those for taking samples and plankton catches, had to be changed, as the lakes were much deeper. All of the results have been calculated similarly to those for the Wisconsin lakes in order that comparisons may easily be made. In most cases only one set of samples was secured from each lake, but these were taken during July and August, when they are most valuable, because the greatest variations of gas and thermal conditions exist at that time and the plankton is most abundant. Several of the more important lakes—Pend Oreille, Hayden, and Coeur d'Alene—were sampled two or three times to give some data on the variation during these months. When these results are compared with those obtained from the investigation on the Wisconsin lakes, the seasonal changes for the remainder of the year can be deduced.

The lakes studied vary in depth from Crater, 1,996 feet, the deepest known lake in the United States, to very shallow ones, such as Henry, 6 feet. The investigation includes some very large lakes—such as Pend Oreille, Tahoe, Klamath, Chelan, Washington, Coeur d'Alene—and many smaller ones. All of the lakes except Crater and Tahoe are the result of glacial action. Several have no large outlets, and some, like Crater, have no outlet or inlet. Lakes Tahoe, Chelan, Pend Oreille, Coeur d'Alene, Washington, Bear, and Priest have several inlets and give rise to quite large rivers as their outlets.

The report includes so many data that it is impossible to discuss them all, but they should be of great value to those who may wish to continue the study and to those interested in stocking the lakes with the fish best adapted to each lake.

In carrying on the work the investigators were aided greatly by the Spokane Chamber of Commerce, by the State and county fish and game wardens of Idaho and Washington, and by business men and others who donated both time and use of boats. These and many other favors were duly appreciated, and it is hoped that this work may repay, at least in part, all who assisted. The authors are also indebted to the Wisconsin Geological and Natural History Survey for use of apparatus; to Dr. A. S. Pearse, of the zoology department of the University of Wisconsin, for identifying several amphipods; to Prof. G. M. Smith, of the botany department of the University of Wisconsin, for identifying many algæ; and to Dr. E. A. Birge and Mr. Chancey Juday, of the Wisconsin Geological and Natural History Survey, for advice in the work. Mr. Juday has also spent a great deal of time revising the biological part of the report.

MAPS.

The map of eastern Washington and Idaho and the one of western Washington show the location of the lakes studied in those States. (See figs. 7 and 18, pp. 77 and 97.) The maps of Coeur d'Alene, Pend Oreille, Priest and Upper Priest Lakes (figs. 9, 14, and 17, pp. 82, 91, and 94, respectively) were copied from county maps. The soundings were located only roughly from the boat, but since this is the only information available concerning the depths of these lakes, it is shown on the maps. The dots locate the soundings; the depth is given in meters.

SOUNDINGS.

No attempt was made to sound the lakes thoroughly, but where the deepest place was not known, which was usually the case, a sufficient number of soundings was made to locate the greatest depth. The first rough soundings were made in the shallow lakes with a $\frac{1}{8}$-inch water-proofed linen line and a 2-pound lead weight. The line was checked frequently with a steel tape. On the deep lakes a 10-pound lead weight was used on the sounding line, which was checked with a steel tape and with the wire sounding machine. It was impossible to get the exact depth, as all the lakes change their level during the year, and besides there were but few gauges for reference.

ANCHOR RELEASE.

During the summer of 1911 the boats from which we worked were anchored with a 10-pound folding anchor on all the lakes but Chelan and Pend Oreille. On these lakes the samples were taken, without anchoring, on calm days. This proved a great waste of time, but it was impossible to haul an anchor from the deepest places in these lakes without a power winch. The anchor release described below was designed and built to overcome this difficulty, and since it has proved so efficient it is described here in the hope that it may be of use to fishermen or others who wish to anchor in deep water.

The anchor release (fig. 2) is made of 3-inch section of $\frac{3}{4}$-inch brass pipe fitted with a cap. This exactly telescopes into a similar capped piece of 1-inch brass pipe. A $\frac{1}{4}$-inch hole allows the line to pass through both caps, below which it is tied through a rubber stopper. The sections of pipe are held together by a screw in the outer section that slides in a vertical slot in the inner section. The inner pipe is held up by a small phosphor-bronze spring that must be weak enough to allow the weight of the messenger alone to push it down, for in deep water one can not tell when the messenger strikes, and if the boat is pulling on the line it will not trip until the line is slacked.

For an anchor a stone weighing from 20 to 60 pounds is harnessed with marlin, leaving a small double loop that is placed in the catch of the release.

The messenger is made of a 2-inch section of 1-inch brass pipe filled with lead with a $\frac{3}{8}$-inch hole left through the center and a V-shaped slot extending from this hole through one side. This allows the messenger to be slipped on the line at any place and is much simpler and cheaper than a divided messenger.

This apparatus can be built for $1, and it has been used with boats from 15 to 30 feet long in the deepest water of all lakes studied since 1911.

TEMPERATURE DETERMINATIONS.

THERMOMETERS USED.

The determination of temperature, except at the bottom of the deep lakes, caused little trouble. A deep-sea Negretti-Zambra thermometer, attached to the calibrated sample line, was held at the desired depth for three minutes and tripped. The thermometers used in 1911 and 1912 were not calibrated, but they were compared with a standard thermometer in the field and found to agree within 0.2° C. Each

Negretti-Zambra deep-sea thermometer is sealed in a second glass tube, surrounding it with an air chamber so that is it not affected by the increase in pressure in deep water. This air chamber is partly filled with mercury, which conducts the heat to or from the bulb of the thermometer.

The thermometer used in 1913 was standardized by the United States Bureau of Standards, and the corrections given have been applied on the deep lakes.

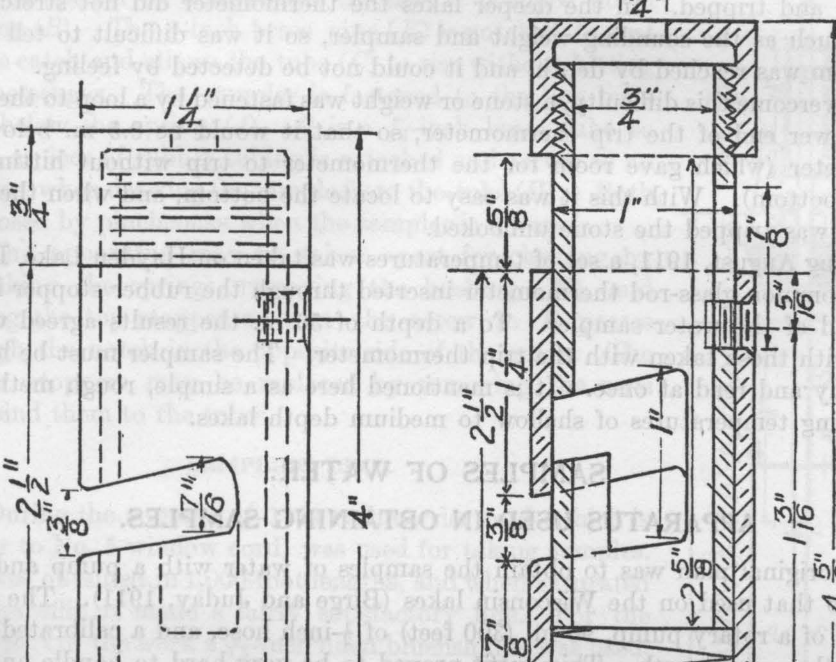

FIG. 2.—Anchor release.

Great care was taken to read the thermometer at the temperature of the surface water, and the correction for the expansion of the column of mercury at that temperature was applied. These thermometers were graduated to 1° F., and the fractions were estimated. After the first set of temperatures on Crater Lake was taken the standardized thermometer was checked with a standard thermometer at the University of Washington and was found to agree within 0.1° C., which is considered the limit of error in reading.

The Schmidt-Vossberg thermometer, which was used on Crater Lake September 5, 1913, and on Lake Chelan, was graduated to 0.1° C. It was not standardized but was checked at the New Mexico School of Mines especially at 4° C. and the correction applied.

BOTTOM TEMPERATURES.

In lakes not over 100 m. deep it is comparatively easy to tell when the thermometer strikes bottom. It is then raised 0.25 to 0.5 m., allowed to become constant, and tripped. In the deeper lakes the thermometer did not stretch the line as much as the sounding weight and sampler, so it was difficult to tell when the bottom was reached by depth, and it could not be detected by feeling.

To overcome this difficulty, a stone or weight was fastened by a loop to the hook on the lower end of the trip thermometer, so that it would be 0.5 m. below the thermometer (which gave room for the thermometer to trip without hitting the stone or bottom). With this it was easy to locate the bottom, and when the thermometer was tripped the stone unhooked.

During August, 1911, a set of temperatures was taken on Hayden Lake, Idaho, using a common glass-rod thermometer inserted through the rubber stopper in the upper end of the water sampler. To a depth of 56 m. the results agreed within 0.5° C. with those taken with the trip thermometer. The sampler must be hauled up quickly and read at once. It is mentioned here as a simple, rough method of determining temperatures of shallow to medium depth lakes.

SAMPLES OF WATER.

APPARATUS USED IN OBTAINING SAMPLES.

The original plan was to obtain the samples of water with a pump and hose similar to that used on the Wisconsin lakes (Birge and Juday, 1911). The outfit consisted of a rotary pump, 90 m. (300 feet) of ½-inch hose, and a calibrated brass chain of the same length. This outfit proved to be very hard to handle on lakes 50 to 60 m. deep, and it could not be used on the very deep lakes. The first sets of samples on Hayden and Coeur d'Alene lakes were taken with this outfit, after which it was abandoned and all other samples were taken with a sampler.

THE SAMPLER.

The sampler used on Lake Pend Oreille and Upper Priest Lake in 1911 was loaned by the Wisconsin Geological and Natural History Survey. The line parted and the sampler was lost in Priest Lake. The sampler used during the remainder of the summer was designed and built in Spokane. Another sampler was built at the New Mexico School of Mines. It is similar to the one built in Spokane, except that it is a little shorter and is screwed together, whereas the Spokane model was soldered. A description of it follows, as it is thought to be the simplest and cheapest apparatus to be had for taking samples in deep water.

The sampling apparatus (fig. 3) consists of a 16-inch piece of 2½-inch brass tubing (*A*) that is closed by rubber stoppers (*E*) at each end. The lower one of these stoppers is attached to an ⅛-inch brass pipe (*C*) that passes through guides in the tube (*A*). The upper stopper is attached to a piece of brass tubing (*D*) that telescopes closely over the pipe (*C*). These tubes pass through guides in the main tube (*A*), and the latter is supported, when the apparatus is open, by a screw in (*D*) below the upper guide. The stoppers are drawn together by springs (*I*) made of No. 16 phosphor-bronze wire. They are held open by a double catch attached to the upper stopper that locks over the bushing (*M*) on the central tube (*C*). This catch is opened by a messenger (*L*) that is dropped down the line (*B*). The $\frac{3}{4}$-inch brass pipe (*K*) is notched to rest on the catch and allows the tube (*C*) to rise without hitting the messenger. The sampler is fastened to the line by a knot below the spring (*J*). *G* is a $\frac{3}{16}$-inch brass tube to which a piece of rubber tubing is attached and serves as an air vent when drawing the sample from the tube (*H*). Both are closed by pinchcocks when the sampler is lowered.

The apparatus may be taken apart for cleaning by unhooking the springs, removing the bushing (*M*), and turning the top stopper so that the screw in *D* passes through the notch in the opposite side of the guide. The rubber stoppers may be replaced by removing the nuts that bind them to the tubes.

SAMPLING LINE.

During the summer of 1911 cash carrier cord (which is similar to No. 5 window cord) was used for taking samples. This was obtained in 1,000-foot lengths, and when saturated with paraffin it made a fairly satisfactory line. For the latter part of the work a $\frac{3}{16}$-inch linen bluefish line was used. This was saturated with melted paraffin, stretched, dried, and calibrated in meters. These calibrations were later checked with a wire sounding machine under working conditions and found to be accurate to about 1 per cent.

BOTTLES.

The samples were taken in 250 cc. pop bottles, which were loaned by the Wisconsin Geological and Natural History Survey. These bottles have snap stoppers so arranged that only rubber comes in contact with the water or solution. The stoppers are easily closed, leaving no air bubbles in the bottle, and put the water under a slight pressure. The bottles have numbers ground on the side, and the volume of each bottle is recorded with the number. They are carried in light wooden cases containing 16 squares in which the bottles fit. The bottles were

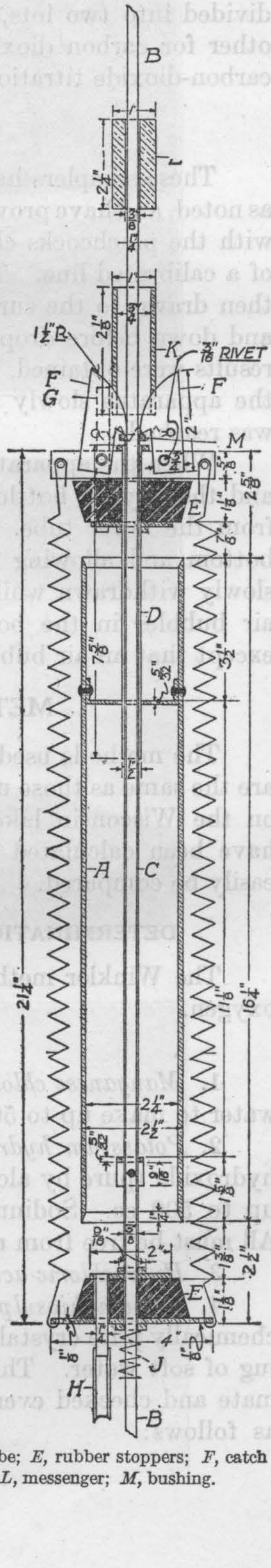

FIG. 3.—Deep-water sampler. *A*, main tube; *B*, line; *C*, central tube; *D*, telescopic tube; *E*, rubber stoppers; *F*, catch mechanism; *G*, air vent; *H*, sample tube; *I*, springs; *J*, open spring; *K*, brass pipe; *L*, messenger; *M*, bushing.

divided into two lots, one of which was always used for oxygen samples and the other for carbon dioxide, because the acid used in the oxygen bottles alters the carbon-dioxide titration.

METHOD OF TAKING SAMPLES.

These samplers have been used for taking all the samples in this work, except as noted, and have proved satisfactory in every way. In use the sampler is set open with the pinchcocks closed and is lowered slowly to the required depth by means of a calibrated line. The messenger is then dropped, closing the sampler, which is then drawn to the surface. It was at first thought best to churn the sampler up and down before dropping the messenger, but numerous tests showed that better results were obtained, especially at the bottom and in the thermocline, by lowering the apparatus slowly and dropping the messenger as soon as the required depth was reached.

When the apparatus is brought to the surface, the upper pinchcock is removed and the oxygen bottles rinsed three times with a small quantity of water drawn from the lower tube. Each bottle is then filled by placing the tube (*H*) at the bottom and allowing the bottle to fill slowly to overflowing. The tube is then slowly withdrawn while flowing and the snap stopper closed so that there are no air bubbles in the bottle. The carbon dioxide sample is then taken similarly, except that an air bubble is left below the stopper.

METHODS OF ANALYSIS OF SAMPLES.

The methods used in determining the dissolved oxygen and the carbon dioxide are the same as those used by the Wisconsin Geological and Natural History Survey on the Wisconsin lakes, except for a few changes in manipulation. All results have been calculated and stated as in the Wisconsin report, so that they may easily be compared.

DETERMINATION OF DISSOLVED OXYGEN BY WINKLER METHOD.

The Winkler method (Winkler, 1888) was used for determining the dissolved oxygen.

SOLUTIONS REQUIRED.

1. *Manganese chloride.*—Dissolve 200 g. of c. p. manganese chloride in distilled water to make up to 500 cc.

2. *Potassium hydroxide and potassium iodide.*—Dissolve 180 g. of potassium hydroxide (pure by alcohol) and 75 g. of chemically pure potassium iodide. Make up to 500 cc. Sodium hydroxide may be substituted for potassium hydroxide. All must be free from nitrites which would liberate iodine.

3. *Hydrochloric acid.* Concentrated chemically pure.

4. *Sodium thiosulphate.*—This solution was prepared in the field by adding 6 g. of chemically pure crystallized sodium thiosulphate ($Na_2S_2O_3 5H_2O$) to a one-half-gallon jug of soft water. This solution was then standardized against potassium bichromate and checked every two or three days. Sodium thiosulphate is standardized as follows:

FIG. 4.—Determining carbon dioxide and oxygen.

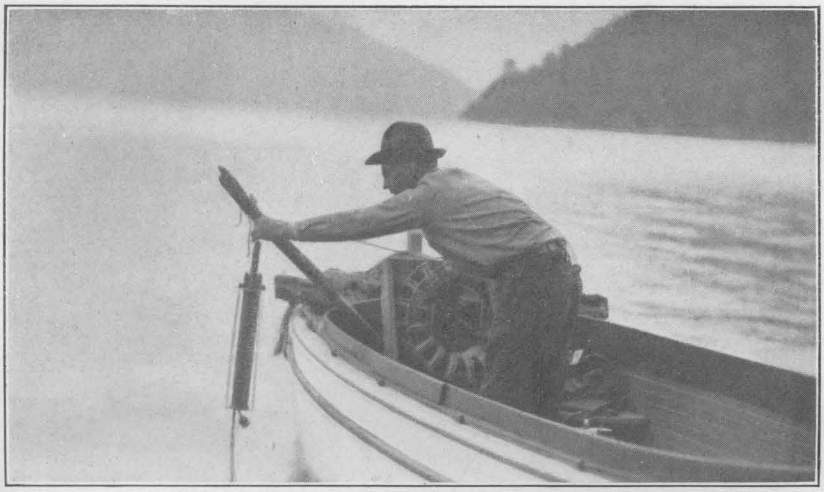

FIG. 5.—Taking in a water sample.

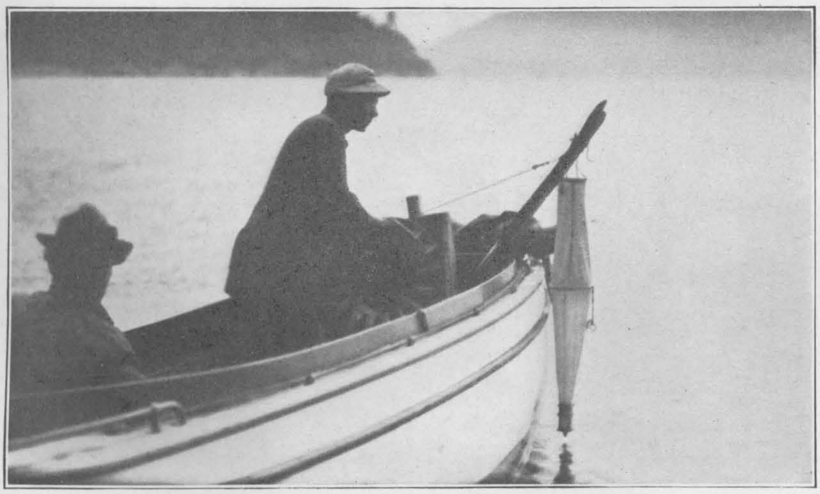

FIG. 6.—Lowering the plankton net.

Measure 25 cc. of N/100 $K_2Cr_2O_7$ with a burette or a corrected pipette into the No. 4 casserole. Add 1 cc. of potassium hydroxide-potassium iodide solution and 2 cc. of concentrated hydrochloric acid. Titrate until a faint yellow remains, add starch, and continue until the blue just disappears. The number of cc. of thiosulphate required to titrate 25 cc. of N/100 $K_2Cr_2O_7$ is used directly in the formula for calculating the oxygen (p. 60).

5. *Potassium bichromate N/100.*—Weigh 0.4903 g. of chemically pure $K_2Cr_2O_7$, which has been dried at 130° C. for 30 minutes; dissolve it in distilled water and make up to 1 liter. One cc. of this solution is equivalent to 0.00008 g. or 0.055983 cc. of oxygen at 0° and 760 mm. This solution is very stable if evaporation is prevented. No appreciable change could be detected in a solution that had been mixed for two years and shipped from Socorro, N. Mex., to Spokane, Wash., and return.

6. *Starch solution.*—Mix 1 g. of potato starch with 25 cc. of cold water, then pour into 200 cc. of boiling water, boil a few minutes, let settle, and use clear solution when cold. This solution will keep only a few days even if chloroform is added. During the last two summers Low's starch was substituted for the above. A sufficient amount was prepared before starting for the summer, and it did not change with age and shipping. The end point was as good or better than the regular starch solution, and a great deal of time was saved in the field. Low's starch is prepared as follows (Low, 1919):

Make a cold saturated solution of commercial sodium chloride in distilled water and filter it. To 500 g. of this solution add 100 cc. of 80 per cent acetic acid and 3 g. of starch. Mix cold. Boil until nearly clear, about two minutes. Add a little water to replace that lost by boiling, perhaps 25 cc. A true solution of all starch is thus obtained. No filtering or settling is required, and the solution may be cooled and used at once. It keeps indefinitely and gives sharper end points than ordinary starch liquor.

METHOD OF PROCEDURE.

The sample of water, about 250 cc., collected as described on page 57, is carefully opened and 1 cc. of manganese chloride added to the lower part by means of a pipette. One cc. of the potassium hydroxide-potassium iodide solution is then added in a similar manner, using care not to stir the contents of the bottle. The stopper is then closed and the contents thoroughly mixed by shaking, after which they are allowed to settle. The bottle is then opened, and 2 cc. of concentrated hydrochloric acid are added to the center of the bottle by means of a pipette, after which the bottle is closed and shaken. The samples were treated this far as soon as possible after collecting, and usually the remainder of the process was completed at once, but in a few cases it was necessary to keep them over night before titrating. When the precipitate is dissolved, or nearly so, the contents of the bottle are poured into a No. 4 casserole and titrated with standard sodium thiosulphate, using starch, as the yellow color fades, to determine the end point.

When potassium hydroxide is added to the sample containing manganese chloride, white manganous hydroxide, $Mn(OH)_2$, is precipitated. If there is no dissolved oxygen present, it remains white. If the sample contains dissolved oxygen, it oxidizes the manganous hydroxide, forming higher oxides or hydroxides, which are brown. All of the oxygen is thus taken up by the manganous hydroxide.

When hydrochloric acid is added, the higher oxides or hydroxides of manganese are dissolved, forming manganese chloride, $MnCl_2$, and the excess of oxygen liberates its equivalent of chlorine, which reacts with potassium iodide and liberates iodine. Each atom of oxygen dissolved in the water thus liberates two atoms of iodine, and the amount of iodine is determined by titrating with sodium thiosulphate solution that has been standardized.

CALCULATION OF OXYGEN CONTENT.

The dissolved oxygen may be calculated by several formulæ, but in this work all results have been stated in cubic centimeters per liter, and the following formula has been used:

$$\frac{0.055983 \times 1{,}000 \times b \times n}{N'V}$$

In this formula b equals the number of cc. of potassium bichromate used in standardizing thiosulphate, that is, 25 cc; N' equals number of cc. of thiosulphate required to titrate the 25 cc. of potassium bichromate; n equals number of cc. of thiosulphate required to titrate sample of water; V equals capacity of bottle less 2 cc. that is deducted for the water displaced by the 2 cc. of solutions added.

Since 25 cc. of bichromate was always used the formula has been simplified thus:

$$\frac{0.055983 \times 1{,}000 \times 25n}{N' \times V} = \frac{1{,}399.57 \times n}{N' \times V}$$

which equals

$$\frac{1{,}399.57 \times \text{no. cc. thiosulphate to titrate sample}}{\text{No. cc. thiosulphate to titrate 25 cc. N/100, } K_2Cr_2O_7 \times \text{capacity of bottle}}$$

which equals cubic centimeters of oxygen per liter.

This method has proved very satisfactory, especially when one considers the rough handling to which the apparatus and chemicals have been subjected and the great variety of conditions under which the analyses have been carried out. In a very few cases an oxygen sample has been found not to agree with the check sample taken at the same depth, but in most instances this has been traced to incomplete mixing after adding the potassium hydroxide and potassium iodide.

Winkler (1914 and 1914*a*) has modified the above method for the determination of oxygen in waters containing organic matter and nitrites. Standard Methods of Water Analysis (American Public Health Association, 1920) also gives a method for the oxidation of these substances before using the Winkler method. Hale and Melia (1913) state that waters containing 0.1 part of nitrite nitrogen per million, or considerable organic matter, change the results of the regular Winkler method. Very few lake waters contain sufficient nitrite or organic matter to affect the regular method, but one of these modifications should be used on river or lake waters that are contaminated with sewage.

Winkler (1913) describes a colorometric method of estimating oxygen. He uses adurol, a photodeveloper that is colorless in neutral solutions but turns brown in proportion to the oxygen present when made alkaline with ammonia or borax.

DETERMINATION OF CARBON DIOXIDE BY SEYLER METHOD.

This method (Seyler, 1894) has been used as on the Wisconsin lakes.

SOLUTIONS REQUIRED.

1. *Phenolphthalein.*—Dissolve 1 g. in 200 cc. of 50 per cent alcohol.
2. *Methyl orange.*—Dissolve 0.2 g. of the powder in 200 cc. of distilled water.
3. *N/44 sodium carbonate.*—This solution is the standard by which the hydrochloric acid is prepared, so should be made with great care. Dry the purest Na_2CO_3 just below the fusing point (best by placing a platinum crucible inside a porcelain crucible and heating for 30 minutes over a Méker burner), cool, and weigh 0.12045 g.; dissolve it in carbon-dioxide-free water and make up to 1 liter in a standardized flask. This solution is then checked by titrating with a N/44 hydrocholoric acid solution standardized with Sorensen's sodium oxalate which has been dried at 130° C., weighed, then ignited to sodium carbonate.
4. *N/44 hydrochloric acid.*—Add chemically pure hydrochloric acid to carbon-dioxide-free distilled water until it exactly titrates the above N/44 Na_2CO_3, using methyl orange as indicator.

The solutions were also checked against N/100 H_2SO_4 solution, the H_2SO_4 content having been determined gravimetrically.

It is important that carbon-dioxide-free distilled water be used for both acid and alkali solutions. If the water contains carbon dioxide, the phenolphthalein and methyl orange titrations will not agree. The water is distilled and collected in Jena or similar hard glass flasks, in which it is boiled for three hours while a slow stream of carbon-dioxide-free air is bubbled through it.

The N/44 sodium carbonate solution is stored in 500 cc. hard glass bottles with the glass stoppers sealed in, and the N/44 hydrochloric acid is placed in similar 1-liter bottles. These solutions are exposed to the air as little as possible and are checked against each other every few days. A new bottle is opened once a week.

TITRATION FOR FREE CARBON DIOXIDE.

Measure 100 cc. of the water with a pipette into a tall beaker such as is used for the electrolytic determination of copper (about 110 mm. high, 47 mm. diameter at the bottom, and 65 mm. at the top). Add three drops of phenolphthalein solution. If it turns a very faint pink, the water is neutral and contains half-bound CO_2 equal to the fixed. If colorless, it is acid, containing an excess of CO_2, and is titrated with N/44 Na_2CO_3, stirring well until a faint pink color persists for three or four minutes. If the sample becomes pink when the phenolphthalein is added, it is alkaline and has less half-bound CO_2 than fixed. It is titrated with N/44 HCl until the pink color just persists.

If the water contains much free CO_2, some is lost during the titration in an open beaker. Few of these samples were encountered on these lakes, but during the summer of 1913 all CO_2 titrations were carried out in 100 cc. calibrated glass-stoppered flasks with a 25 to 30 cc. bulb blown in the neck above the calibration as used by Tillmans and Heublein (1911). The use of these flasks may require a little more time than stirring in beakers, but it is believed that all end points are more easily determined. The loss of CO_2 and loss by spattering are entirely eliminated.

TABLE 1.—*Analyses of water of five lakes, shown in milligrams per liter.*

[Analyses made by Bureau of Chemistry for Bureau of Fisheries.]

	Priest Lake, Idaho.	Bear Lake, Idaho.	Lake Chelan, Wash.	Lake Pend Oreille, Idaho.	Hayden Lake, Idaho.
	Miscellaneous division number.				
	17780	17781	17782	17783	17784
IONS.	*Mg.*	*Mg.*	*Mg.*	*Mg.*	*Mg.*
Phosphoric acid (PO_4)	.08	.06	.04	.05	.06
Metaboric acid (BO_2)	0.0	0.0	0.0	0.0	0.0
Arsenic acid (AsO_4)	.00	.00	.00	.00	.00
Silica (SiO_2)	6.5	6.2	4.8	8.2	6.7
Sulphuric acid (SO_4)	1.9	96.8	2.8	7.2	1.0
Carbonic acid (CO_3)	0.00	78.45	.00	0.0	0.0
Bicarbonic acid (HCO_3)	28.8	566	25.3	97	32.4
Nitric acid (NO_3)	.2	.2	.25	.25	.2
Nitrous acid (NO_2)	.000	.000	.000	.000	.000
Chlorin (Cl)	.2	78.5	.3	.4	.4
Bromin (Br)	0.0	0.0	0.0	0.0	0.0
Iodin (I)	.00	.00	.00	.00	.00
Iron (Fe) Aluminum (Al)	.07	.35	.14	.2	.14
Manganese (Mn)	.00	.00	.00	.003	.00
Calcium (Ca)	5.2	4.1	6.1	22	5.6
Strontium (Sr)	.00	.00	.00	.00	.00
Magnesium (Mg)	1.7	152	.9	5.9	1.7
Potassium (K)	1.3	10.5	.9	1.1	1.0
Sodium (Na)	2.9	66.3	2.1	3.3	2.6
Lithium (Li)	.000	.07	.000	.005	.000
Copper (Cu)	[1]	[1]	[1]	[1]	[1]
Lead (Pb)	[1]	[1]	[1]	[1]	[1]
Zinc (Zn)	[1]	.65	[1]	[1]	[1]
Oxygen (O) (calculated)	.03	.15	.06	.102	.06
Total	48.88	1,060.33	43.69	145.710	51.86
HYPOTHETICAL COMBINATIONS.					
Lithium chlorid (LiCl)		.43		.03	
Potassium chlorid (KCl)	.4	20	.6	.8	.9
Potassium sulphate (K_2SO_4)	2.4		1.3	1.5	1.3
Sodium nitrate ($NaNO_3$)	.25	.3	.4	.39	.26
Sodium chlorid (NaCl)		16			
Sodium sulphate ($NaSO_4$)	.8		3.1	9.4	.5
Sodium carbonate (Na_2CO_3)		138			
Sodium bicarbonate ($NaHCO_3$)	9.3		3.6	.5	8.7
Magnesium chlorid ($MgCl_2$)		79.0			
Magnesium sulphate ($MgSO_4$)		121			
Magnesium bicarbonate ($Mg(HCO_3)_2$)	10	661	5.4	35.5	10.2
Calcium bicarbonate ($Ca(HCO_3)_2$)	19	16.6	24.2	89	23
Calcium phosphate ($Ca_3(PO_4)_2$)	.13	.1	.09	.085	.1
Ferric oxid (Fe_2O_3) Alumina (Al_2O_3)	.1	.5	.2	.3	.2
Manganous oxid (Mn_3O_4)				.005	
Zinc carbonate ($ZnCO_3$)		1.2			
Silica (SiO_2)	6.5	6.2	4.8	8.2	6.7
Total	48.88	[2] 1,060.33	43.69	145.710	51.86

[1] No detectable amounts in 2 liters.

[2] Precipitated in bottle calcium carbonate ($CaCO_3$)—5.0 per liter; magnesium carbonate ($MgCO_3$)—0.7 per liter.

NET PLANKTON.

METHOD OF OBTAINING AND ENUMERATING.

Samples of net plankton were obtained from the various lakes for the purpose of ascertaining the abundance and the vertical distribution of the different kinds of planktonts. No data were secured for the nannoplankton organisms found in these bodies of water. The net catches were taken with a closing net that consisted of an upper truncated cone of heavy muslin and a lower straining cone made of No. 20 silk bolting cloth. The lower end of the straining cone bore a detachable bucket into which the catch was concentrated. This bucket was then removed and the material was transferred to a small vial with enough 95 per cent alcohol to preserve it. (For further description of the net see Juday, 1916, p. 573.)

The net was usually hauled through a 5 m. stratum for each catch, but in some of the shallow lakes the haul was reduced to 1 m., and in the deepest lakes it varied from 10 to 200 m. The net was hauled at as uniform a speed as possible, the usual rate being about one-half a meter per second. The coefficient of the net was found to be 1.2; that is, the number of organisms obtained in a catch multiplied by this factor gave the total number for the column of water through which the net was drawn.

In enumerating the organisms the catch was concentrated to a volume of 10 cc. After shaking this material thoroughly 2 cc. were removed with a piston pipette and the Crustacea and Rotifera therein were counted with a binocular dissecting microscope. The number obtained in this count multiplied by 5 gave the total number for the catch. The concentrated sample was again shaken, and 1 cc. of the material was transferred to a Sedgwick-Rafter counting cell for the enumeration of the Protozoa and Protophyta. A compound microscope was used for this enumeration, and the number of organisms was ascertained in 20 different squares on the counting cell. The area of these squares was known, so that the total number of organisms in the catch could be readily determined. The results for the Crustacea and Rotifera, as well as those for the Protozoa and Protophyta, were finally computed to the number of individuals per cubic meter of water.

PHYSICAL CONDITIONS IN LAKES.

In considering the vertical distribution of the net plankton organisms certain chemical conditions must be taken into account. The Crustacea and Rotifera, for example, are not able to inhabit those strata of a lake that are devoid of free oxygen. On the basis of the amount of dissolved oxygen in the bottom water, lakes can be divided into three classes: (1) Those that have an abundance of dissolved oxygen through their entire depth; (2) those that have only a small quantity of free oxygen at the bottom; and (3) those that have at the bottom a stratum of varied thickness that is entirely devoid of free oxygen.

THERMAL CHANGES AND GAS CONDITIONS.

The thermal changes in a lake during the different seasons of the year are so closely connected with the gas conditions that it seems best to review them to better understand the summer thermal and gas conditions in these lakes.

These changes have been carefully studied on Lake Mendota, Wis. (Birge and Juday, 1911), and may be considered typical of most lakes of medium depth in the temperate zone; that is, where the winters are cold enough to cool the whole body of water below 4° C. or to freeze the surface.

When the ice breaks up in the spring, the water below the ice usually has a temperature varying from 1 to 3° C. With lakes that do not freeze but have been cooled below 4° C. the spring circulation will start with the first warm days. In either case, as the surface is warmed the water increases in density until it reaches 4° C. This denser warmer water settles and is replaced by the colder lighter water from below. This starts convection currents which circulate the whole lake until it reaches a temperature of 4° C., the temperature of water at maximum density. The strong winds that usually prevail at this season of the year materially aid this circulation.

With all of the water at 4° C. and with the same density the whole body of water is kept in circulation by the wind. A strong wind will pile up the water on the lee shore. This water must return; part may return around the shore on the surface, but if the difference in temperature of the water is not over 2 or 3° C. part of the water will return along the bottom and so mix the whole lake. This is called the vernal or spring circulation. It usually continues until some time in May or June. During this circulation all of the water comes in contact with the air and is saturated, or nearly so, with oxygen.

As the season advances the surface is warmed more rapidly, the winds are not as strong, and so the complete circulation is not continued. A part of the cold bottom water is not circulated by the wind. The surface water becomes warmer, therefore lighter and harder to mix with the colder denser bottom water. This difference in temperature and density increases until the lake is divided into three strata—the upper or circulated stratum, which is separated from the lower uncirculated stratum by a shallow stratum, the thermocline, in which the temperature falls rapidly. As the season advances the circulated stratum becomes deeper and the thermocline more definite. Birge and Juday (1911) have called the stratum above the thermocline the epilimnion and that below, the hypolimnion.

The epilimnion is circulated by the wind, so there is a very small variation of temperature from the surface to the lower part of the epilimnion. In the thermocline, which may be from 1 to 5 m. thick, the temperature drops very rapidly, usually from 1 to 10° C. per m. In the hypolimnion there is a very gradual decrease in temperature from the thermocline to the bottom. During the remainder of the summer the hypolimnion is not circulated by the wind. It absorbs a small amount of heat through the thermocline, but the temperature of the hypolimnion increases very little during the summer.

As the cool fall nights arrive the surface water is cooled, becomes denser than the warmer water, and settles. This continues until the difference in temperature between the surface and bottom waters is in the neighborhood of 3° C., when the difference in density is so small that the wind again takes an active part in the circulation of the whole lake. This is called the fall overturn and circulation. It continues until the lake reaches its minimum winter temperature or freezes. When the water reaches the temperature of 4° C., the convection currents set up by difference in density of the warm and cold water cease to aid the circulation. Water cooled below 4° C. becomes lighter and tends to stay on the surface, but this difference in density is not enough to prevent the wind from continuing the circulation. This circulation will continue all winter if the lake is not cooled until it freezes. If the temperature of the water drops to 1°, a cold, still night will cool the surface until it freezes.

When a lake freezes, the water below the ice has a temperature below 1° C. from the ice to the bottom of the lake. During the winter the lake lies dormant. There is very little circulation. The oxygen that the water dissolved from the air during the fall overturn is gradually used up by the slow decay of organic matter and the respiration of the animal life. Both of these processes go on much more slowly in winter than in summer.

The comparison of the dissolved gases and thermal conditions of these lakes is simplified by arranging them in groups that will bring similar lakes together. A classification suggested by Birge and used in comparing the Wisconsin lakes is based upon the thermal and gas conditions. Group I includes the lakes that have the entire body of water kept in circulation during the summer; that is, they have similar gas and thermal conditions from surface to bottom. Generally these lakes are shallow, but in a few cases large lakes or those exposed to strong winds are completely circulated where they have greater depth than smaller protected lakes, which fall in the next group.

Group II is composed of those lakes that are not completely circulated during the summer. In such lakes the three strata—epilimnion, thermocline, and hypolimnion—are found during the summer. The supply of oxygen in the hypolimnion is limited to that which it absorbed during the spring or vernal circulation. During the summer dead animal and vegetable material, mostly plankton, settles into this lower water and decays. This uses up the oxygen and increases the carbon dioxide in the water, and the respiration of the fish and plankton Crustacea uses an appreciable quantity of oxygen. If the hypolimnion has a small volume and there is a large amount of decomposition, the oxygen of the bottom water may be entirely exhausted during the late summer. On the other hand, if there is less decomposable material, a larger volume of water in the hypolimnion, or a shorter season, the oxygen may persist during the whole season. These facts have been used by Birge to make two divisions of the second group of lakes. The first division contains those lakes whose bottom water contains some oxygen during the whole summer. The second division is composed of the lakes in which the oxygen of the bottom water is entirely used up during the summer.

In Group I there are seven lakes (Henry, Green, Upper Twin, Steilacoom, Liberty, Fish Trap, and Upper Klamath), which vary in depth from 2 to 11 m. Henry, Green, and Fish Trap are ideal examples of this group. There is little or no variation of temperature or dissolved gases from surface to bottom, thus showing complete circulation of the whole body of water. The others show some change in thermal and gas conditions. Where there is a lower bottom temperature it indicates incomplete circulation, but in no case does the oxygen disappear at the bottom, which would probably be the case if the lower water was entirely cut off from the upper by a thermocline. Upper Klamath shows a marked increase in temperature near the surface, which is accounted for by several hot, calm days previous to time of taking temperatures. This also shows slightly in the dissolved gases, but all of the conditions near the bottom prove that the whole body of water had been circulated. The oxygen content of these lakes is near the saturation point. In no case did we find marked supersaturation near the surface. In Liberty, Upper Twin, and Steilacoom there is less oxygen at the bottom, and the free carbon dioxide increases there, thus showing the results of decomposition and respiration. Henry Lake has a lower surface temperature, which would increase the solubility of oxygen, but the altitude decreases the solubility in about the same proportion, so that the average amount of oxygen, 5.2 cc. per liter, is 97.5 per cent of saturation at that altitude.

Most of the lakes investigated fall into Group II, division 1; that is, those having a definite thermocline and oxygen present in the bottom water during the whole of the summer. This series includes the following lakes, arranged according to depth:

Crater.	Coeur d'Alene.	Sammamish.
Tahoe.	Stevens.	Williams.
Chelan.	Clear.	Silver.
Pend Oreille.	Loon.	Chaplain.
Crescent.	Upper Priest.	Calvert.
Priest.	Sutherland.	Padden.
Fallen Leaf.	Spirit.	Martha.
Whatcom.	Deer.	Newman.
Sullivan.	Swan.	Cottage.
Payette.	Samish.	Goodwin.
Hayden.	Ki.	Spanaway.
Bear.	Lower Twin.	

The first four lakes in this list are the deepest known lakes in the United States. Crater is 608 m. deep; Tahoe, 516; Chelan, 458; and Pend Oreille, 371. We hoped that these lakes would furnish some new gas and thermal conditions. Excepting the minimum temperature of Crater Lake (see p. 107) the conditions in these deep lakes are very similar to those found in Crescent, Priest, Fallen Leaf, Whatcom, Sullivan, and Bear Lakes. All of these lakes, except Bear, are over 95 m. deep. The fact that they all have more dissolved oxygen at the bottom than at the surface differentiates them from the rest of the series. This is easily accounted for by the immense volume of water in the hypolimnion and the low temperature, which tends to retard decomposition at or near the bottom. Therefore, the oxygen which the water dissolved during the vernal overturn is very largely retained throughout the summer.

Most of the very deep lakes do not freeze during the winter. This is accounted for by the large volume of water that must be cooled to approximately 1° C. before the surface will freeze. No data are at hand regarding the winter temperatures of these lakes. When a lake does not freeze, circulation continues through the winter, and the water probably reaches a temperature near freezing, except in mild climates.

Crater Lake, which is reported as not freezing, is the most striking example. With a summer surface temperature of approximately 12° C. and with 500 m. of its 608 m. of depth with temperatures between 3.5° and 4°, it must be cooled to very near freezing by the long cold winters. On the other hand, Lake Whatcom is near sea level and so close to the Pacific coast that it probably does not reach the temperature of maximum density. The higher temperature of the bottom water, 5.4° C., seems to substantiate this. The bottom waters of both lakes are well supplied with oxygen, indicating a fall overturn and circulation.

It should be noted that Bear Lake, with a depth of 56 m., has more oxygen at the bottom than at the surface, while no other lake less than 95 m. deep had this large supply of oxygen at the bottom. This may be accounted for by the high altitude (2,216 m.), which shortens the summer season.

The percentage of saturation of oxygen in the very deep lakes varies a little from the others. Since the surface water is usually colder there is a smaller growth of phytoplankton, and the one set of determinations on Pend Oreille is the only one that shows a marked supersaturation in the epilimnion. In most cases the water at the thermocline is very nearly 100 per cent saturated. At the bottom, although there is more oxygen present, the percentage of saturation is not high. Lake Chelan has 90 per cent saturation (calculating the saturation from the altitude of the surface, page 114), and all the others have less than 90 per cent saturation.

Birge and Juday (1914) have studied the Finger Lakes of New York and have found similar oxygen conditions in Seneca, Cayuga, Skaneateles, and Canandaigua, which are 173, 122, 83, and 80 m. deep, respectively.

In the deeper lakes the bottom temperature usually approaches 4° C., the temperature of water at maximum density at atmospheric pressure. (See Crater Lake, p. 107.) The depth of a lake changes the position of the thermocline very little; that is, the depth of the epilimnion is no greater in a deep lake if the size and the protection from wind are the same. It is the hypolimnion that is increased in depth and volume by the increased depth of the lake. Since it takes a longer time to warm the larger volume of water before the thermocline is formed in the spring and because of a small diffusion of heat through the thermocline, the temperature of the epilimnion of a deep lake is usually a little lower than that of a shallow one. This lower temperature of the epilimnion retards the growth of algæ; therefore there is not as much algal material to decay in the lower water. The larger volume of the hypolimnion furnishes a proportionately larger supply of oyxgen to carry out this decomposition.

The plankton algæ are found chiefly in the warm water of the epilimnion. When they die, they settle slowly in the warm water; but when they reach the cold water at the thermocline, which has a greater density, their settling is retarded, if not stopped entirely for a time. This has been shown by investigations in some of the Wisconsin lakes. A definite decrease in the oxygen has been noted just below the thermocline, which indicates more decomposition at this depth than farther down. The cold water of the hypolimnion also retards both the speed of settling and of decay.

The viscosity of the water must also play a definite part in this speed of settling, because the viscosity of the cold water of the hypolimnion is almost twice that of the epilimnion. The viscosity or lack of fluidity retards the settling of these algæ, because their specific gravity is only a little greater than that of the water. In very deep lakes the combination of the increasing density and the viscosity may retard the settling of the decaying algæ, so that they are largely decomposed before they reach the bottom. This would use up more of the oxygen of the upper hypolimnion and there would be less decomposition and loss of oxygen at the bottom. This is shown in all of the very deep lakes of this section by the very small, if any, decrease in oxygen at the bottom, while in the lakes less than 95 m. deep (except Bear Lake) there is a marked decrease in the oxygen at the bottom. In some of the lakes not over 20 m. deep (Martha, Silver, Williams, Sammamish) there is a fairly large amount of oxygen at the bottom. Martha and Williams had few algæ, but Sammamish and Silver had a fairly large amount of algæ, which would die and decay later in the season. The oxygen at the bottom of some of the very shallow lakes (Spanaway, Goodwin, Cottage, Newman) is probably accounted for by a partial circulation. It is very probable that these lakes might be entirely circulated and changed to Group I by a high wind. The single set of results that we have could not answer this, but Cottage and Spanaway especially possess a large crop of algæ, and the oxygen would either disappear entirely later in the summer, or the supply would be replenished by more or less complete circulation.

Division 2 of Group II contains the lakes that lose all of the oxygen at the bottom during late summer. The following seven lakes belong in this division: Luna, American, Silver (in east Washington), Cow, Wildwood, Chatcolet, and Paradise. They vary in depth from 8 to 26 m. In most respects they are very similar to division 1 of this group. The complete removal of the oxygen is caused by a larger amount of organic material that decays in the hypolimnion or by a smaller supply of oxygen to carry out this decay. Here there is a more marked increase of free carbon dioxide caused by the decay and corresponding with the decrease in oxygen.

SATURATION OF WATER WITH OXYGEN.

The amount of oxygen dissolved by a unit volume of water is dependent upon the partial pressue of the oxygen in the air. When the atmospheric pressure is decreased by altitude or otherwise, the partial pressue of oxygen is correspondingly decreased and the amount of oxygen that a unit volume of water will absorb is decreased in the same proportion.

The saturation of distilled water with oxygen has been determined with dry air at a pressure of 760 mm. by Fox (1907) and tabulated by Birge and Juday (1914). These figures have been used in calculating the per cent of saturation of the lakes at or near sea level. Juday (1915) states that the amount of oxygen 1 liter of water will absorb from the atmosphere is decreased approximately 1 per cent for each 82 m. (270 feet) of altitude. It can not be calculated exactly, as the barometer varies from day to day at each elevation and as the temperature and humidity also vary. The results calculated in this paper have been taken from the Smithsonian Meteorological Tables, 1907, Table 25. Since the variation of the barometric pressure at any altitude is by far the largest error in this calculation, no attempt has been made to correct for humidity and temperature.

Most of the lakes in western Washington are so near the sea level that it is not necessary to apply a correction, but with some of the mountain lakes it becomes important, as shown by the calculation for these lakes.

TABLE 2.—*Elevation of certain lakes and per cent of sea-level saturation of dissolved oxygen.*

Lake.	Elevation.	Sea-level saturation.	Lake.	Elevation.	Sea-level saturation.
	Meters.	*Per cent.*		*Meters.*	*Per cent.*
Bear	1,806	79.8	Hayden	683	92
Crater	1,883	79	Henry	1,961	78
Coeur d'Alene	647	92.3	Payette	1,520	82
Chelan	329	96	Pend Oreille	625	92.5
Crescent	204	97.4	Tahoe	1,897	78.6
Fallen Leaf	1,939	78.9			

CARBON DIOXIDE CONTENT.

Since the fixed carbon dioxide of these lake waters is largely combined with calcium and magnesium, the amount present shows the relative hardness of the water.

In studying the Wisconsin lakes, Birge and Juday (1911) divided the lakes into three classes on the basis of the fixed carbon dioxide content. Those lakes containing less than 5 cc. per liter are classed as soft, those containing from 5 to 22 cc. per liter as medium, and those above 22 cc. as hard. For the sake of comparisons the same divisions will be used here.

In the soft-water group there are 21 lakes. Western Washington has 11, including Martha and Ki, which are the softest, with 1.26 cc. per liter. Eastern Washington has 9. Fallen Leaf, of California, also belongs in this class.

In the class of medium-hard water, varying from 5 to 22 cc. per liter, there are 24 lakes. Eastern Washington and Idaho have 8, western Washington 13. Tahoe, Crater, and Klamath lakes also belong in this class. Of these 24 lakes 17 have less than 10 cc., leaving 7 that range from 10 to 17.4 cc.

In the hard-water class, containing more than 22 cc. per liter, there are 8 lakes, all in eastern Washington and Idaho. Four of these contain from 22 to 29 cc. and are similar to the hard-water lakes of southeastern Wisconsin, which reach a maximum of about 50 cc. per liter. Silver and Clear Lakes have about 75 cc.; Bear, 130.4; and Medical, 478.6. It should be noted that Silver and Clear were reported as excellent bass lakes. Bear Lake furnishes a large number of trout to the market fishermen, but they are not caught by angling. The shallow north end was reported as offering good bass fishing. Medical Lake was reported as containing no fish.

The complete analysis of Bear Lake water (p. 64) shows 37 times as much magnesium as calcium present, although in most lakes there is more calcium than magnesium. This may be explained by the strongly alkaline water, which precipitates calcium more readily than magnesium.

The presence of 0.65 part per million of zinc is also interesting. When this is compared with the small amount of copper necessary to stop the growth of algæ, it seems that this quantity of zinc would have a similar effect. Since the low temperature and short summer season would also retard the growth of algæ, no definite conclusions can be drawn.

It may be assumed that the half-bound carbon dioxide is equal to the fixed in all waters that are neutral or acid to phenolphthalein, and in water that is alkaline it is reduced by an amount equivalent to the alkalinity; that is, where free carbon dioxide in the analysis is marked (−) it signifies that the half-bound carbon dioxide lacks the number of cubic centimeters indicated of being equal to the fixed carbon dioxide. Where the free carbon dioxide is marked (+), it indicates that the water is acid to phenolphthalein and that free carbon dioxide is present in excess of that combined as fixed and half-bound in acid carbonate.

The algæ are able to use the free carbon dioxide and a very large proportion of the half-bound, but not the fixed carbon dioxide. There is usually little free carbon dioxide in the epilimnion, where the largest part of the algæ thrive. They are therefore largely dependent on the acid or half-bound carbon dioxide for their supply. If the water is soft, it contains less carbon dioxide, and this limits the growth of algæ.

In shallow lakes of Group I, where the whole body of water is circulated by the wind, the softness of the water does not limit the carbon dioxide supply of the algæ to any great extent, because the carbon dioxide furnished by decaying organic material at the bottom is soon circulated and used by the algæ.

It appears also that the nitrogen content of the water plays an important part in the growth of algæ. The lakes that contain the largest percentage of nitrogen as nitrates, nitrites, and ammonia support a larger growth of algæ. In other words, these plants need fertilizer the same as land plants. This nitrogen is largely supplied from the drainage basin. If this basin is inhabited, cultivated, and fertilized, more fertilizer will be washed into the lake from it than from a wild, unsettled area.

FISH IN SMALL LAKES IN WASHINGTON AND IDAHO.

From Tables 7 and 8 (pp. 77 and 97) it will be noted that a large number of small lakes have been examined. In many cases these were the lakes in which the game wardens and sportsmen seemed to be the most interested, and they were anxious to have taken us to many more if time had permitted.

Many of these lakes—for instance, Chaplain, Cottage, Cow, Martha, Padden, Paradise, and Silver, in western Washington, and Chatcolet, Deer, Loon, Liberty, Newman, Silver, and Twin, in eastern Washington—were originally trout lakes. To-day trout are occasionally caught in some of them. Others of them (Chaplain, Deer, Chatcolet) still offer fairly good trout fishing. In some there is practically no fishing, and many have been stocked with bass, for which the lakes seem to be especially well adapted if we judge from the large number caught a few years after planting. Chatcolet, Clear, and Cow Lakes are good bass lakes to-day. In Twin Lakes the trout have been replaced by perch.

If the depth, temperature, oxygen, and plankton of these lakes are compared with those of Wisconsin lakes, there is no marked or general difference, so bass and such fish should thrive. Probably trout would still live in the lakes, adapting themselves to conditions now found, if the lakes were not fished, but it must not be assumed that the conditions to-day are the same as when the trout thrived in these lakes.

Formerly most of these lakes were surrounded by virgin forests. The smaller ones were partially protected from the sun, and their inlets were largely shaded and cool. The tilling of the drainage basin and the increase of population increased the nitrogen content of such lakes, and this with the warmer water caused the vegetable plankton to increase. The growth of this plankton used up the carbon dioxide from the surface water, leaving it alkaline. Later the decay of the same plankton in the hypolimnion used the oxygen and produced carbon dioxide, making this water acid, and in some cases all or nearly all of the oxygen below the thermocline or in the cold water has been used. So the trout have been forced up into the warmer water. The curves of Clear and Silver Lakes show this best, while Cottage Lake is similar, except for the alkaline surface water. The others show similar conditions varying with the lakes and the date of testing.

MACKINAW TROUT.

One of the objects of the work on the lakes in Washington and Idaho was to determine those best suited for Mackinaw or Great Lake trout (*Cristivomer namaycush*).

The exact conditions necessary to the welfare of these trout are not definitely known, but, in general, we know that they require deep, cold water containing oxygen. That is, the lakes of Group II, division 1, which have oxygen in the bottom water during the whole summer, seem to be best adapted for Mackinaw trout.

The amount of oxygen necessary to allow the trout to live in this cold water, the hypolimnion, has not been definitely determined, but the work on the Wisconsin lakes (Birge and Juday, 1911) has shown that they can live in water containing 0.9 cc. of dissolved oxygen per liter.

A list of the lakes in which lake trout have been planted shows that the Bureau of Fisheries has furnished many fry that have been planted in the shallow lakes of Group I. It may quite safely be assumed that all of these fry have been wasted or at most have furnished a little food for the larger fish.

Many of the larger lakes have oxygen and temperatures similar to the Great Lakes, and lake trout would be expected to thrive in such. In some of these lake trout have been planted. They were reported as fairly plentiful in Fallen Leaf Lake and Lake Tahoe, Calif., and a few have been caught in Deer Lake, Wash. Beyond this all of our efforts to get information concerning catches were without results. Our time was too limited to fish for them ourselves, but sportsmen at many of these lakes promised to try for them and report. Several of them have written since, but with the exception of Deer Lake, Wash., all the results have been negative.

In some of these deep lakes it appeared from stories told us by the fishermen that one reason the plants of lake trout did not succeed might be the careless way in which they were planted. At two of the important large lakes, we were told that the cans of fingerlings were emptied off the wharves where the perch were the most plentiful.

A more careful comparison of the food to be found in the lakes in which they thrive with that in the lakes in which they do not may be of interest, likewise a comparison of the spawning grounds.

From this it may be concluded that all of the shallow lakes and some of medium depth, which do not have oxygen in the hypolimnion all summer, are not suitable for lake trout. In the deeper lakes it is hoped that the lake trout may be more carefully planted and the results watched.

Since writing the above in 1914 this report has been delayed and it seemed best to check up the catches of Mackinaw trout to 1921. A letter from R. A. Laird, of the Spokane Chamber of Commerce, sums it up as follows:

> Mackinaw trout continue to be caught in Deer and Loon Lakes, also at Badger Lake, located 18 miles southwest of Spokane. The supply continues to be fairly plentiful. The largest Mackinaw that I heard of being taken in Loon Lake in 1920 weighed 26 pounds. The largest Mackinaw taken from Deer Lake last year to my knowledge weighed 21 pounds. Mackinaws from Badger Lake appear to be smaller, running from 8 to 10 pounds. I have never heard of Mackinaws being captured in Coeur d'Alene, Pend Oreille, Priest, or Sullivan Lakes.

A similar letter from Al Wiesman, of Spokane, verifies the above, and he adds that he does not think that as many Mackinaws were caught in 1920 as other years. Several letters from Idaho fail to report a single catch in Coeur d'Alene or Pend Oreille Lakes.

Badger Lake, mentioned in Mr. Laird's letter, is a small lake located 2½ miles almost north of Williams Lake. It is much higher and, at high water drains into Williams Lake. It was not mentioned as a trout lake when we were there, and we have no data on it.

Deer, Loon, and Badger Lakes are all small. Deer Lake is 25 m. deep; Loon, 32. There is not a large supply of oxygen at the bottom in late summer. They are very similar to Trout, Little Trout, and Black Oak Lakes in northern Wisconsin, in which Mackinaw trout were native.

FISH FOOD IN CERTAIN LAKES.

BEAR LAKE, IDAHO.

One blue-nosed trout (*Salmo virginalis*) was obtained from this lake. The stomach was well filled with smaller fish, which proved to be whitefish (*Coregonus williamsoni*). It was found that the fish had also eaten a few mayflies (Ephemerida), beetles (Coleoptera), and ants (Hymenoptera). The fishermen around the lake said that all of the stomachs of the blue-nosed trout were filled with the small whitefish.

Four whitefish stomachs were secured, and they were fairly well filled with food. One contained mayflies (Ephemerida) entirely; two others contained 75 per cent mayflies (Ephemerida) and 25 per cent midges (Chironomidæ); the fourth contained 45 per cent mayflies, 45 per cent midges, and 10 per cent snails, bees, and clams. From this rather brief investigation it appears that the fish, both large and small, were not feeding directly on Crustacea at this time of the year.

HENRY LAKE, IDAHO.

At this lake, trout (*Salmo clarkii*) were abundant and the food supply of Crustacea was almost unlimited. Three trout, each 40 cm. in length, were obtained. The stomachs of two of the specimens were well filled; from 80 to 90 per cent of the material consisted of well preserved amphipods, about 5 per cent of mayflies (Ephemerida), and the remainder of a small quantity of beetles (Coleoptera), dragon flies (Odonata), ants (Hymenoptera), and a few Daphnias. The third stomach was only one-third full, and the material was so nearly digested that fully 90 per cent of it was unrecognizable. The remainder of the material consisted of about equal portions of fishbones, fish eggs, amphipods, beetles (Coleoptera), and may-flies (Ephemerida).

UPPER KLAMATH LAKE, OREG.

This lake is but 10 m. deep, and plant and animal life thrive in it abundantly. The lake is well stocked with unusually large rainbow trout (*Salmo irideus*), but the temperature of the lake was almost too warm to find a good quality for food. Several fish were caught and the contents of the stomach preserved. Nothing was found in these stomachs except small amounts of the remains of other fish.

CRATER LAKE, OREG.

Rainbow trout (*Salmo irideus*) seemed to be fairly abundant, and several stomachs were secured in order to ascertain on what they were feeding. The stomachs were fairly well filled. The following table shows the proportion of different kinds of food found in the stomachs:

TABLE 3.—*Food from stomachs of six rainbow trout, Crater Lake, Oreg., August 3, 1912.*

Number of trout.	Corethra larvæ.	Daphnia.	Mollusca.	Débris.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
3			90	10
1	75		20	5
2	20	80		

Three stomachs were full of univalve Mollusca and two were well filled with large *Daphnia pulex*. Near the shore of Wizard Island, where the fishing seemed to be best, a great many swarms of Daphnias could be seen along the shore. The abundance of food in this vicinity may account for the large number of trout in this area. The Daphnias were of unusually large size.

GREEN LAKE, WASH.

Several crappies (*Pomoxis annularis*) were secured from this lake. Daphnias seemed to form the predominant part of the fish food, although in many cases Corethra larvæ were found in large numbers in the stomachs, as is shown in the following table:

TABLE 4.—*Food from stomachs of five crappie, Green Lake, Wash., August 9, 1913.*

Number of crappie.	Corethra larvæ.	Crus-tacea.	Plants.	Débris.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
1	90	2	8	
1	5	60	15	20
1	50	50		
1	8	90		2
1	30	60		10

Green Lake is rather shallow and full of weeds and algæ, which accounts for this portion of the food in some of the stomachs. The stomachs of these fish were all well filled.

LAKE MENDOTA, WIS.

For purposes of comparison some specimens of the yellow perch (*Perca flavescens*) were obtained from Lake Mendota at Madison, Wis., and the contents of their digestive tracts were examined. During this investigation some perch were caught each month from January to August, 1913. During the winter months they were caught with hook and line in the deep water, but the summer catches were made near the shore in shallow water. The following table (5) gives the percentages of the different kinds of material found in the alimentary canals of the perch while the lake was covered with ice.

TABLE 5.—*Food from stomachs of 67 yellow perch caught in winter months, Lake Mendota, Wis.*

Date.	Number of perch.	Cyclops.	Daphnia.	Corethra larvæ.	Débris.	Miscellaneous.
1913.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
Jan. 14	12	10	80	3	7	Notholca.
Jan. 27	10	2	85	10	3	Crayfish.
Feb. 15	10	3	80	7	10	
Mar. 1	15	2	95	3	....	Algæ.
Mar. 15	10	5	60	10	20	Amphipod.
Apr. 1	10	2	70	10	15	Mollusca.

The stomachs of all of these perch contained relatively small amounts of material, but a great deal was found in the intestines. Daphnias were the predominant portion of the food, but Cyclops and Corethra larvæ were found in considerable numbers at times. Over 600 Daphnias were counted in some of the stomachs. A few *Notholca longispina* were noted in the stomach of one fish caught on January 14. A crayfish completely filled the stomach of one fish caught January 27. A most interesting discovery was a large number of algæ in a fish stomach obtained on March 1. Such algæ as Melosira, Cyclotella, Tabellaria, and Fragilaria were found. In the stomachs of several fish caught on March 15 a number of amphipods were noted, and on April 1 a few univalve Mollusca were found. The food at this season consisted entirely of aquatic life and largely of Micro-Crustacea.

During the months of May, June, July, and August, perch were taken only once a month. The results are shown in the following table (6).

TABLE 6.—*Food from stomachs of 42 yellow perch caught in summer months, Lake Mendota, Wis.*

Date.	Number of perch.	Corethra larvæ.	Amphipoda.	Daphnia.	Mayflies.	Débris.	Miscellaneous.
1913.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
May 15	12	95	3			2	Hydrachnidæ.
June 10	10	80	12	2	2	4	
July 10	12	2	50	3	40	5	Claw of crayfish.
Aug. 5	8	3	40	....	50	7	Minnow; Chætophora.

In the stomachs of the perch caught on May 15 Corethra larvæ constituted nearly the entire amount of food. Beginning in June we find a few mayflies (Ephemerida). Again in August large clusters of Chætophora were found in some of the stomachs. Several pieces of the larger aquatic plants were also noted. The proportion of mayflies increases very rapidly during July and August, and in some

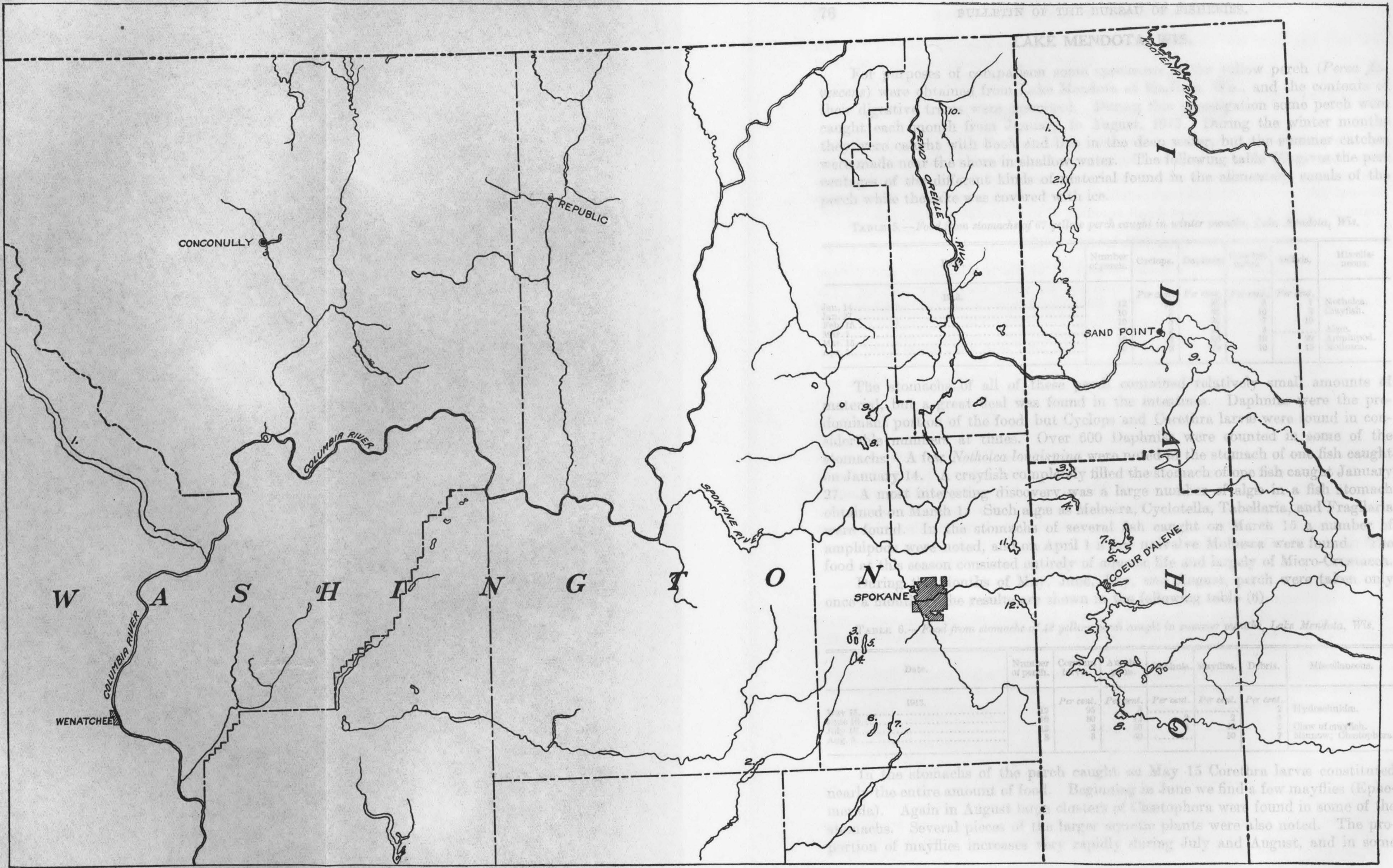

FIG. 7.—Map of eastern Washington and Idaho, showing location of lakes studied. Washington lakes: *1*, Chelan; *2*, Fish Trap; *3*, Medical; *4*, Clear; *5*, Silver; *6*, Calvert; *7*, Williams; *8*, Loon; *9*, Deer; *10*, Sullivan; *11*, Newman; *12*, Liberty. Idaho lakes: *1*, Upper Priest; *2*, Priest; *3*, Spirit; *4*, Twin Lakes; *5*, Coeur d'Alene; *6*, Hayden; *7*, Wright; *8*, Chatcolet; *9*, Pend Oreille.

of the stomachs obtained in August mayflies constituted the entire content of the stomach.

These results given in Tables 5 and 6 above show that the perch were feeding chiefly on insects and amphipods during the summer months, but that Daphnias constituted the major element of their food during the winter.

LAKES IN EASTERN WASHINGTON AND IDAHO.

TABLE 7.—*Lakes examined in eastern Washington and Idaho.*

Lake.	State.	County.	Greatest length.		Direction of greatest length.	Greatest breadth.		Elevation.		Maximum known depth.		Fish commonly caught.
			Km.	*Mi.*		*Km.*	*Mi.*	*M.*	*Feet.*	*M.*	*Feet.*	
Bear	Idaho	Bear Lake	32.0	20.0	N.-S.	6.5	4.0	1,806.0	5,924	56.0	183.6	Blue-nose trout.
Calvert or Deep.	Washington.	Spokane	1.0	.6	NE.-SW.	.5	.25			12.0	39.3	Black bass, perch.
Chatcolet	Idaho	Kootenai	3.2	2.0	NW.-SE.	2.0	1.24			13.0	42.6	Black bass, cutthroat trout.
Chelan	Washington.	Chelan	76.0	47.0	NW.-SE.	6.4	4.0	329.2	1,080	458.0	1,500.0	Dolly Varden trout.
Clear	do	Spokane	1.6	1.0	N.-S.	.5	.3			34.0	111.6	Bass.
Coeur d'Alene	Idaho	Kootenai	51.8	32.2	N.-S.	10.0	6.2	647.5	2,124	56.0	183.5	Cutthroat trout, perch.
Deer	Washington.	Stevens	5.0	3.7	NE.-SW.	3.2	2.0			25.0	82.0	Trout.
Fish Trap	do	Lincoln and Adams.	4.8	3.0	NE.-SW.	.5	.3			8.0	26.2	Bass.
Hayden	Idaho	Kootenai	8.1	5.0	NE.-SW.	3.0	1.8	683.5	2,242	57.0	187.0	Cutthroat trout, bass.
Henry	do	Fremont	9.6	6.0	N.-S.	5.5	3.4	1,961.0	6,433	2.0	6.5	Cutthroat trout.
Liberty	Washington.	Spokane	3.2	2.0	NW.-SE.	1.0	.6			8.0	26.2	Bass, perch, trout.
Loon	do	Stevens	4.86	3.0	NW.-SE.	2.5	1.5			32.0	104.9	Do.
Lower Twin	Idaho	Kootenai	4.0	2.5	N.-S.	1.0	.6	705.5	2,315	19.0	62.2	Perch, trout.
Medical	Washington.	Spokane	1.9	1.5	N.-S.	.5	.3			14.0	45.9	Not any.
Newman	do	do	4.8	3.0	N.-S.	3.2	2.0			9.0	29.5	Bass, perch, trout.
Payette	Idaho	Boise	7.5	4.6	N.-S.	4.0	2.5	1,520.0	4,987	67.0	219.7	Cutthroat trout.
Pend Oreille	do	Bonner and Kootenai.	49.0	30.4	N.-S.	13.0	8.1	625.0	2,050	371.5	1,218.5	Dolly Varden and cutthroat trouts, whitefish.
Priest	do	Bonner	38.5	24.0	N.-S.	7.0	4.3			112.5	369.0	Cutthroat trout.
Silver	Washington.	Spokane	3.2	2.0	N.-S.	2.0	1.2			24.0	79.0	Bass.
Spirit	Idaho	Kootenai	6.4	4.0	E.-W.	3.2	2.0	743.6	2,440	25.0	82.0	Cutthroat trout.
Sullivan	Washington.	Pend Oreille.	6.0	3.7	N.-S.	1.6	1.0	783.5	2,570	95.0	311.6	Do.
Upper Priest	Idaho	Bonner	6.0	3.7	NW.-SE.	1.6	1.0			32.0	104.9	Trout.
Upper Twin	do	Kootenai	2.0	1.25	E.-W.	1.6	1.0	705.5	2,315	5.5	18.0	Perch.
Williams	Washington.	Spokane	2.0	1.2	N.-S.	.5	.3			15.0	49.2	Bass, perch.
Wright	Idaho	Kootenai	1.0	.6	NW.-SE.	$\frac{1}{8}$	$\frac{1}{12}$			7.0	22.9	Bass.

BEAR LAKE, IDAHO.

Bear Lake is located in the southeastern corner of Idaho and in northern Utah, about one-half in each State. It is fed by numerous mountain streams, many of which afford excellent trout fishing. The lake is about 32 km. (20 miles) long, north and south, and 6.5 km. (4 miles) wide, and has an elevation of 1,806 m. (5,924 feet).

The east bank is steep, and the mountains on that side reach an elevation of 2,216 m. (7,270 feet). The west shore has a very gradual slope. The east beach is composed of coarse gravel, and the west beach is covered with a light blue marl, which gives the lake its characteristic opalescent blue color.

The soundings indicate that the bottom of the lake is a continuation of the shore slopes, as it deepens gradually from the west, and the deepest water was located within 0.4 km. ($\frac{1}{4}$ of a mile) of the east shore and a little south of the State line.

Large numbers of blue-nosed trout (*Salmo virginalis*) and Williamson's whitefish are taken from the lake. The trout are taken on set lines and in gill nets by the market fishermen. It is stated that they will not take a fly or trolling bait of any kind, so are of little interest to the sportsman. Chubs and suckers are the only fish caught in the lake by angling. Black bass have been planted in Mud Lake (a small shallow lake cut from the north end of Bear Lake), and a few have been caught.

Only two forms of Crustacea were found in the lake, namely, *Epischura nevadensis* and *Canthocamptus northumbricus*. Epischura was found throughout the entire depth of the lake, but the maximum number was in and above the thermocline. In the 10–15 m. stratum the number ran as high as 5,980 individuals per cubic meter of water. This distribution is characteristic of Epischura, for it rarely inhabits the region below the thermocline. The fact that Canthocamptus was found only in the 50–55 m. stratum is a most peculiar distribution. Just why it should be found only near the bottom of the lake is hard to say. A more complete study of the situation might reveal some interesting facts regarding this strange distribution.

Nauplii were found in every catch except in the 0–5 m. and the 42½–47½ m. strata. Three-fourths of them were found below the thermocline. and an especially large number was found in the 50–55 m. stratum.

The only rotifer found in the lake was *Polyarthra platyptera*. It was found in rather limited numbers in the 5–15 m. stratum, that is, in or above the thermocline. As a whole the zooplankton was rather scarce in Bear Lake.

Ceratium was found in the 5–10 m. stratum and numbered 15,690 per cubic meter of water.

The algæ were found just above the thermocline in the 5–10 m. stratum. Fragilaria was the only diatom, and the maximum number found was 7,850 per cubic meter of water. The blue-green alga Cœlosphærium was found to number 7,850 per cubic meter of water. Little vegetation existed along the shores, except at the north and northwest ends of the lake.

CALVERT LAKE, WASH.

This is a very small lake between two low hills. The upper and lower ends of the lake are shallow and marshy. Cladocera, Copepoda, nauplii, and Protozoa were most abundant in the 0–2 m. stratum.

LAKE CHATCOLET, IDAHO.

Lake Chatcolet presents an illustration of another type of lake in that at the bottom (11 m.) there was no dissolved oxygen. Both plants and animals were very abundant, and under the above-stated conditions it was to be expected that the Crustacea especially would be confined to the upper stratum of water where the free oxygen was more abundant. Somewhat more than 98 per cent of the copepod *Diaptomus ashlandi* occupied the 0–5 m. stratum. (See Table 12, p. 123.) This was found to be the case in the vertical distribution of *Cyclops bicuspidatus* and *Daphnia hyalina*. They were much more abundant in the upper water, although not as strikingly so as in the case of Diaptomus. *Diaphanosoma leuchtenbergianum* was confined to the 0–5 m. stratum of the lake. Taking the Crustacea as a whole, 23,000 individuals per cubic meter of water were in the 0–5 m. stratum of the lake, as contrasted with only about 6,000 in the 5–10 m. stratum.

The contrary was noted for the nauplii, for 79 per cent of them were in the lower 5 m. of the lake. There were only about 2,500 nauplii per cubic meter of water in the upper stratum of the lake and 8,900 in the lower. The rotifers varied somewhat in their general distribution. *Anuraea aculeata* and *Notholca longispina* were found in very small numbers entirely in the 5–10 m. stratum of the lake. *Polyarthra platyptera*, which comprised a large percentage of the rotifers, was found throughout the lake, but 61 per cent were found in the lower water. Asplanchna was distributed uniformly throughout the depth of the lake, and Mastigocerca was confined almost entirely to the 0–5 m. stratum. Taking Rotifera as a whole, they were rather uniformly distributed. There were 5,970 per cubic meter of water in the 0–5 m. stratum of the lake, and 6,220 in the 5–10 m. stratum.

Phytoplankton was present in very large quantities. The number of green and blue-green algæ ran as high as 683,000 per cubic meter of water in the 0–5 m. stratum and 405,000 in the 5–10 m. stratum. The diatoms numbered 480,000 per cubic meter of water in the 0–5 m. stratum, and 100,000 in the 5–10 m. stratum of the lake; 70 per cent of the algæ were in the 0–5 m. stratum of the lake.

LAKE CHELAN, WASH.

This magnificent body of water in north central Washington is located between high mountains and occupies a glacial valley extending south by east from the Cascade range. It is 76 km. (47 miles) long and has an average width of about 2 km. (1¼ miles). The shores on the upper portions are very precipitous, rising in many places to snowcapped peaks. At the south end the mountains are lower, and near the city of Chelan they open out into a level valley noted for its orchards. The lake has an elevation of 329.2 m. (1,080 feet) and a depth of 458 m. (1,500 feet). The bottom is therefore 128.8 m. (420 feet) below sea level. The greatest depth is off Falls Creek, which is very near the center. The deep area is small, the bottom rising toward the ends of the lake.

The largest inlets are Stehekin River, which enters at Stehekin, situated at the extreme north end of the lake, and Railroad Creek, at Lucerne 13 km. (8 miles) below. These, together with many small mountain streams, supply the lake with a large amount of cold water, which, with the small surface, largely shaded by mountains, accounts for the low temperature of the surface water and the almost imperceptible thermocline.

Since the bottom temperatures, 5.9° C. at 458 m., determined in August, 1911, were higher than in the other deep lakes, a special trip was made to the lake September 11, 1913, for taking a series of temperatures with the standardized thermometers used on Crater Lake. Two determinations, one with each thermometer, of the bottom temperature at 440 m. showed it to be 4° C., the two readings agreeing within 0.1° C. It should be stated that in 1911 we did not anchor the launch. The series of samples and temperatures were taken during calms on three different days. The temperatures were taken August 10. The 458 m. temperature was checked and the chemical samples were taken August 14.

Since the thermometer used on Lake Chelan in 1911 read 4° C. on the other deep lakes, agreeing with the later standardized thermometers, it probably gave the correct bottom temperature of Chelan as 5.9° C. at 458 m. The 1913 temperatures were not taken at the same place. The deepest place (458 m.) was very small and in a narrow part of the lake. A spring entering near that place could have warmed the bottom water. A possible explanation of the higher temperature is that the bottom of the lake at this depth is warmer than the water and so gives up heat to the lower strata of water. This explanation is supported by the fact that the bottom temperature (with the thermometer touching the bottom) is 0.3° C. higher than the next two temperatures above the bottom.

The water showed a high degree of transparency, since the white disk did not disappear from view until a depth of 14.25 m. was reached.

The maximum number of organisms was obtained in the 0–10 m. stratum. A relatively large number of Crustacea was found in every stratum above 50 m. The maximum number of *Chydorus sphæricus* was between 150 and 200 m. Almost 70 per cent of the Crustacea in the lake were Diaptomus; 21.6 per cent, *Cyclops bicuspidatus;* and the remainder, *Daphnia pulex* and *Bosmina longispina.* Two-fifths of the Diaptomus, one-fourth of the Cyclops, and one-third of the Daphnia and Bosmina were in the 0–10 m. stratum. (See Table 12, p. 123.) Nauplii were found in very small numbers, with the maximum number per cubic meter of water between 30 and 50 m. No rotifers were found in the limnetic catches. Ceratium was found chiefly in the upper 40 m. The diatom Melosira was found below 40 m., and Asterionella was confined to the upper 100 m.

CLEAR LAKE, WASH.

This is a shallow lake with the exception of a deep hole at one end. The lower end of the lake is a shallow marsh. There is no tributary stream, so the lake must depend on rainfall, seepage, and springs for its water supply.

Figure 8 shows the distribution of the plankton and the relation to the chemical conditions of the water. The Protozoa are abundant and show the typical form of distribution with the greatest numbers in the upper zone, 0 to 5 m. It will be noticed that the Cladocera and the Copepoda have moved up from the thermocline to a place near the surface and that the nauplii are not in the surface zone, but just below it. In other lakes these forms are not found in the warmer waters but are found in the transitional zone. In this lake the upper water is distinctly alkaline and this may have some effect; the same condition is noticed in Silver Lake.

LAKE COEUR D'ALENE, IDAHO.

This is the second largest lake in Idaho and, although comparatively narrow, it is 51.8 km. (32.2 miles) long. The elevation of the surface is 647.5 m. (2,124 feet), with a maximum variation of level of 3.7 m. (12 feet). (See fig. 9.) The forest comes down to the water's edge along the greater part of the very irregular shore line. The surrounding hills are not very high, and the valleys that run out from the lake are not very deep or precipitous. At the southern end, or head, the lake is fed by the St. Joe River, and at Harrison it receives the muddy waters of the Coeur d'Alene River, which drains an immense area, including the famous Coeur d'Alene mining district. These waters are so laden with silt that they may be traced far out into the clear water of the lake, the bottom of which shows the effect of the sediment from both rivers. The depth of water gradually increases from the head of the lake to within 3 miles of the outlet, where it begins to decrease. The deepest place, 56 m., is at one of the narrowest parts of the lake. The temperature recorded

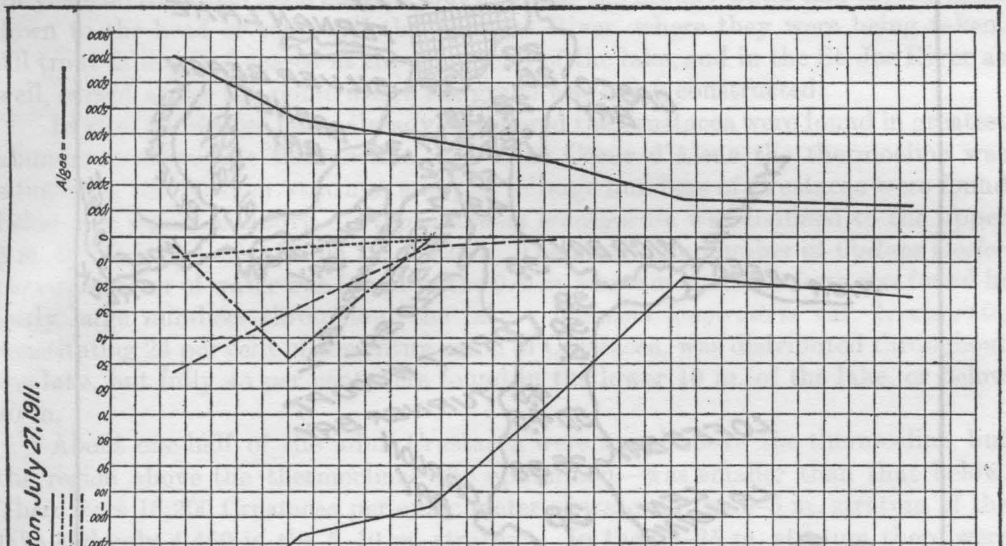

FIG. 8.—Curves for Clear Lake, giving the temperature, dissolved gases, and plankton at various depths. *C*, free carbon dioxide; *Cb*, fixed carbon dioxide; *O*, oxygen; each given in cc. per liter. Plankton numbers are per cubic meter of water.

here indicates that there may be a slight current even at the bottom of the lake. For instance, the bottom temperature, which was taken July 11, 1911, when the lake was high, was 0.7° higher than that read August 21, 1912, when the lake was 2 m. lower and the surface temperature 2.7° higher than July 11, 1911.

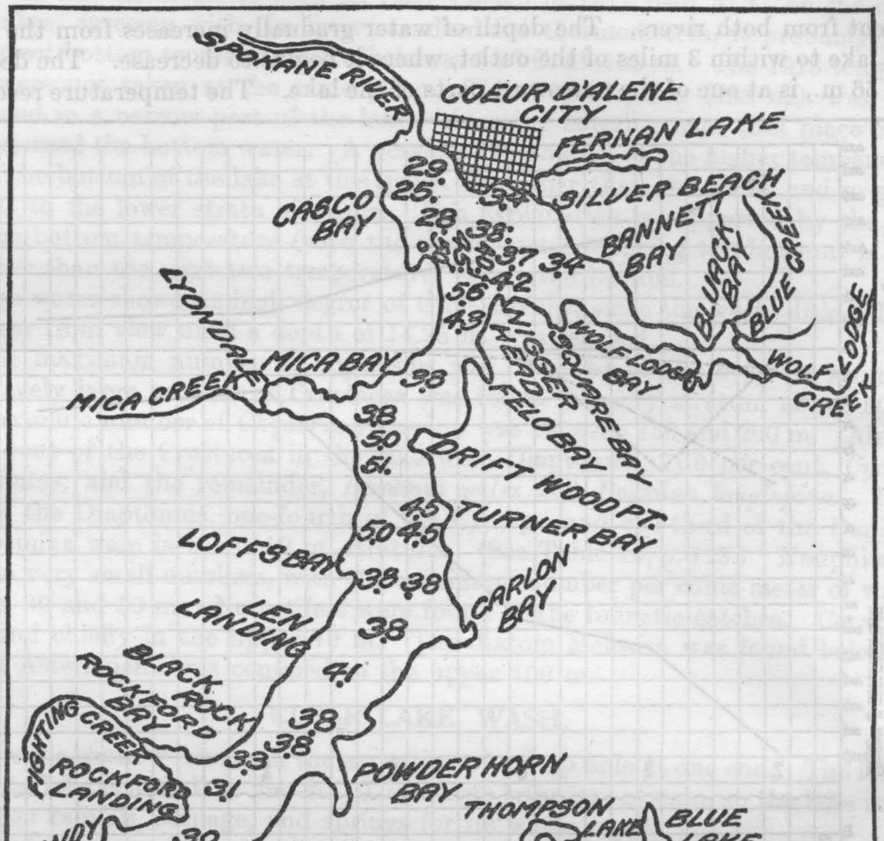

FIG. 9.—Map of Lake Coeur d'Alene, locating soundings and giving the depth in meters.

During the time of our visit to the lake the Milwaukee Railroad was building a grade up the St. Joe River and was sluicing the earth from the cuts into the water. The effect of this was noticeable 75 miles below at the lower end of the lake, where for years no trout had been caught; but this year the muddy water had driven them down to the head or source of the Spokane River, where they were being taken. All trout fishing had ceased at the upper end of the lake, and in the St. Joe River as well, except above the point where the grade was being constructed.

In all of the deeper lakes already considered the Crustacea were found in greatest abundance above the thermocline. In Lake Coeur d'Alene the thermocline was situated in the 10–12 m. stratum, and just as large numbers of Crustacea were found below this region as above. *Diaphanosoma brachyurum* was confined to the upper 5 m. of the lake. (See Table 12, p. 124.) The maximum number of *Cyclops bicolor* per cubic meter of water was found in the 0–5 m. stratum, and this form was found in fairly large numbers throughout the lake. *Bosmina longirostris* var. *brevicornis*, constituting 24 per cent of the entire catch of Crustacea, was distributed throughout the lake, but fully 45 per cent were found in the lower 10 m. of the lake, or below 40 m.

About one-half of the adult Crustacea were found above the thermocline, but the region above the thermocline—the epilimnion—was smaller than that below. There were 16,200 Crustacea per cubic meter of water in the 0–5 m. stratum of the lake and only 4,480 in the 5–10 m. stratum. In the 10–25 m. stratum there were 12,590 Crustacea and below 30 m. 12,680.

Nauplii were found in considerable numbers throughout the lake, especially below the thermocline. There were from 1,500 to 1,850 per cubic meter of water above the thermocline, but the maximum of 3,900 occurred in the 10–15 m. stratum.

The rotifers consisted of Mastigocerca, which was confined to the 0–10 m. stratum of the lake. (See Table 12, p. 124.) The maximum number of 1,720 per cubic meter of water was found in the 0–5 m. stratum.

The phytoplankton in the lake consisted of two diatoms, Tabellaria and Asterionella. Tabellaria was found entirely above 15 m., 43 per cent being in the 10–15 m. stratum. The remainder was distributed uniformly through the 0–10 m. stratum. A few Asterionellas were found in the 0–10 m. stratum of the lake and 58 per cent of the total number in the 10–15 m. stratum. No diatoms were found in the 20–45 m. stratum, but 31 per cent of the Asterionellas were found in the 50–55 m. stratum.

At the upper end of the lake, near Harrison City, the plankton was not abundant, but it showed the typical distribution. The results at this station were not satisfactory, because the silt hindered the counting of the Protozoa and the diatoms. The tributary waters are rich in both of these forms, and they are no doubt represented in the lake.

A set of plankton catches was taken in the deepest part of the lake. At this point, also, the plankton was scarce. The Crustacea were most abundant in the upper 5 m. of water. The rotifer Mastigocerca was confined to the upper 10 m., and nearly all of the algæ were found in the upper 15 m.

DEER LAKE, WASH.

Deer Lake is surrounded on three sides by hills; the fourth side looks out onto an open plain. The lake is not deep, 25 m. in the deepest part, and has a great deal of very shallow water around its borders.

The shallowness of the water gives the upper stratum a chance to become warmer than in lakes that are more uniform in depth. The surface water had a temperature of 22.2° C. There was a distinct thermocline, oxygen was present at

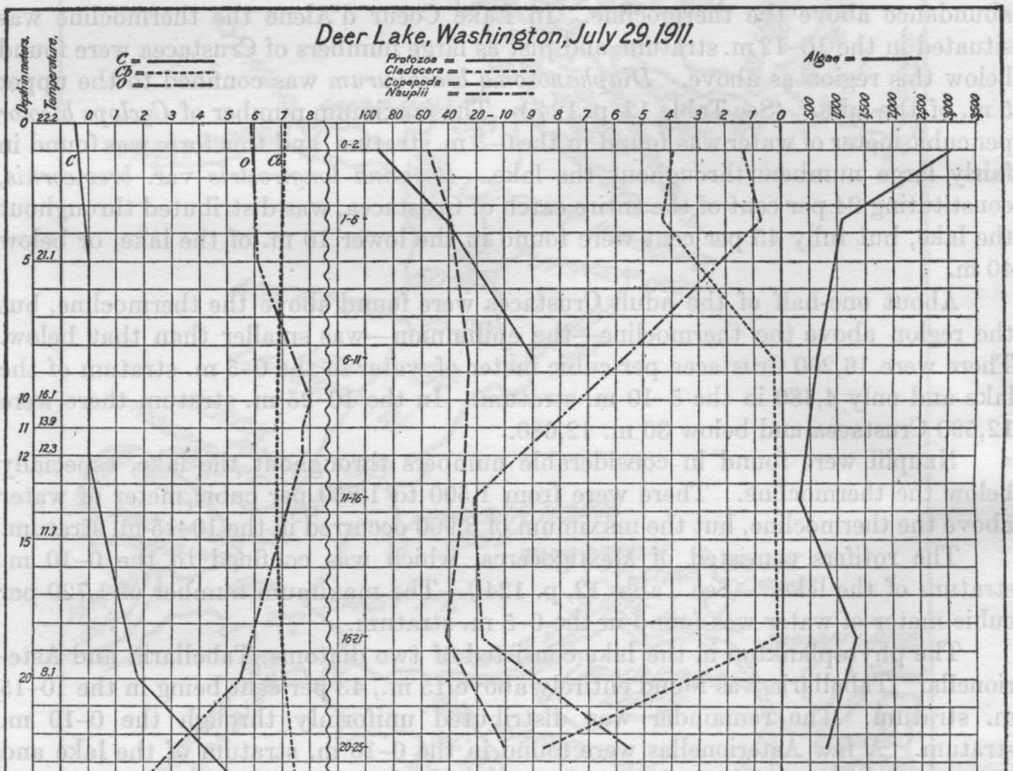

FIG. 10.—Curves for Deer Lake, giving the temperature, dissolved gases, and plankton at various depths. *C*, free carbon dioxide; *Cb*, fixed carbon dioxide; *O*, oxygen; each given in cc. per liter. Plankton numbers are per cubic meter of water.

the bottom, and free carbon dioxide was found in the lower strata and was absent in the upper. The Cladocera and the Copepoda were more abundant near the surface, a condition that was noticed in several other lakes. The nauplii, however, were found in their regular position near the thermocline. (See fig. 10.)

HAYDEN LAKE, IDAHO.

This beautiful little lake, irregular in outline, lies between Lake Pend Oreille and Lake Coeur d'Alene, 8.8 km. (5½ miles) north of Coeur d'Alene City. Its north, south, and east shores rise abruptly to mountains from 915 to 1,464 m. (3,000 to

4,800 feet) high, but the west shore rises only a few meters and forms a part of Rathdrum Prairie. The main or southern part of the lake is 8.1 km. (5 miles) long in a northeast line and 3 km. wide (1.8 miles). At the northeast corner a shallow neck of the lake extends 3.75 km. (2⅓ miles) due north. The elevation of the surface of the lake is 683.5 m. (2,242 feet) and its greatest depth is 57 m. (187 feet), which depth is very constant throughout the north half of the main part of the lake. Here over 40 soundings were made, covering an area of about 4 km.², and in no case did the depth vary as much as a meter.

The temperature of the water during July at the surface was 16.9° C., with a distinct thermocline between 8 (16.7° C.) and 20 m. (6.1° C.), while the thermometer showed 4.7° C. at the bottom.

The lake has a small outlet controlled by a dam, and water is pumped from the lake for irrigation, but the level is not materially changed.

Wright Lake is a small pond that has been enlarged by a 6-m. (20-foot) dam until it is 1 km. long by ⅛ km. wide. It lies about ¼ km. west of Hayden Lake on Mr. Wright's farm. According to Mr. Wright it was stocked with large-mouthed black bass (*Micropterus salmoides*) and cutthroat trout (*Salmo clarkii*) in 1896. The bass thrived and many have been caught, but only a few trout have been taken. This fact is mentioned here because it was due to a freshet that the bass were washed from Wright Lake into Hayden Lake, and this species was introduced with the cutthroat trout for which the lake was noted. To-day Hayden Lake offers excellent bass fishing especially in the shallow area and in the bay near the dam. Whether these bass have caused a decrease in the number of trout or not is a very interesting question and one not easily answered. From all reports the trout fishing is not as good as a few years back, but where is the lake within 40 miles of a large city, with direct rail connection and a good hotel, where the trout fishing has not decreased? There are still large numbers of cutthroat trout caught with flies in the early summer and by trolling with a small spoon just below the thermocline during the late summer.

Recent correspondence (1921) with several fishermen of the section seems to indicate that both the trout and the bass continue to thrive. It should be noted that a very active sportsmen's club has helped by keeping the lake well stocked with trout from its hatchery.

On August 25, 1912, the Crustacea were well distributed throughout Hayden Lake, resembling the distribution in Lake Coeur d'Alene, with a smaller portion of material in the epilimnion than in the hypolimnion. Only 32 per cent were above the thermocline. A rather peculiar thermocline was found, in that it was a stratum only 1 m. in thickness between 10 and 11 m. *Cyclops bicuspidatus* was the predominant crustacean, and it was abundant throughout the entire depth of the lake. The maximum number per cubic meter of water was in the 10–15 m. stratum. *Daphnia hyalina* was found in small numbers at all depths. *Bosmina longirostris* var. *brevicornis* was confined to the upper 25 m. of the lake, the maximum number per cubic meter of water being in the 0–5 m. stratum. *Diaphanosoma leuchtenbergianum* was above the thermocline.

Nauplii were very prominent in Hayden Lake, comprising about 47 per cent of the total number of Crustacea. They were found at all depths in the lake, but 52 per cent were in the 20–25 m. stratum. A limited number of rotifers, consisting of *Anuræa aculeata* and *Notholca longispina*, was found in the 20–30 m. stratum, and a small number in the 30–35 m. stratum. (See Table 12, p. 127, and figs. 11 and 12.)

Ceratium was distributed throughout the lake, with three-quarters of it in the upper 10 m.

Several strands of Melosira and Tabellaria were found in the 50–55 m. stratum.

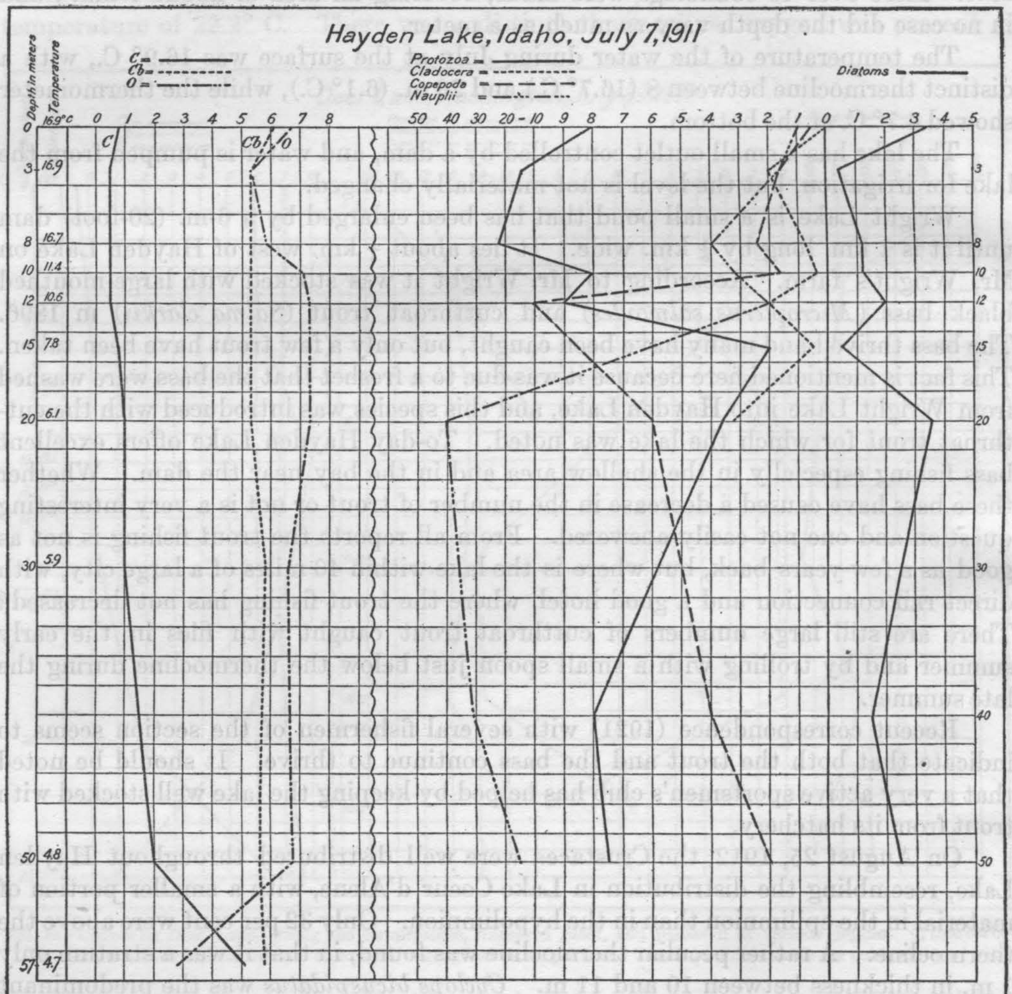

FIG. 11.—Curves for Hayden Lake, giving the temperature, dissolved gases, and plankton at various depths. *C*, free carbon dioxide; *Cb*, fixed carbon dioxide; *O*, oxygen; each given in cc. per liter. Plankton numbers are per cubic meter of water. See Figure 12 for the conditions later in the season.

DIURNAL MOVEMENT OF PLANKTON CRUSTACEA.

Night catches of net plankton were taken on August 26 and 27, 1911, for the purpose of ascertaining whether there was any marked diurnal movement of the plankton Crustacea. Table 12 (p. 127) shows that there was an appreciable upward movement of the Cladocera and of the Copepoda.

In July the greater part of the net plankton was found in the thermocline and the hypolimnion. The maximum number of copepods per cubic meter of water was found at 12 m. and of nauplii at 20 m.

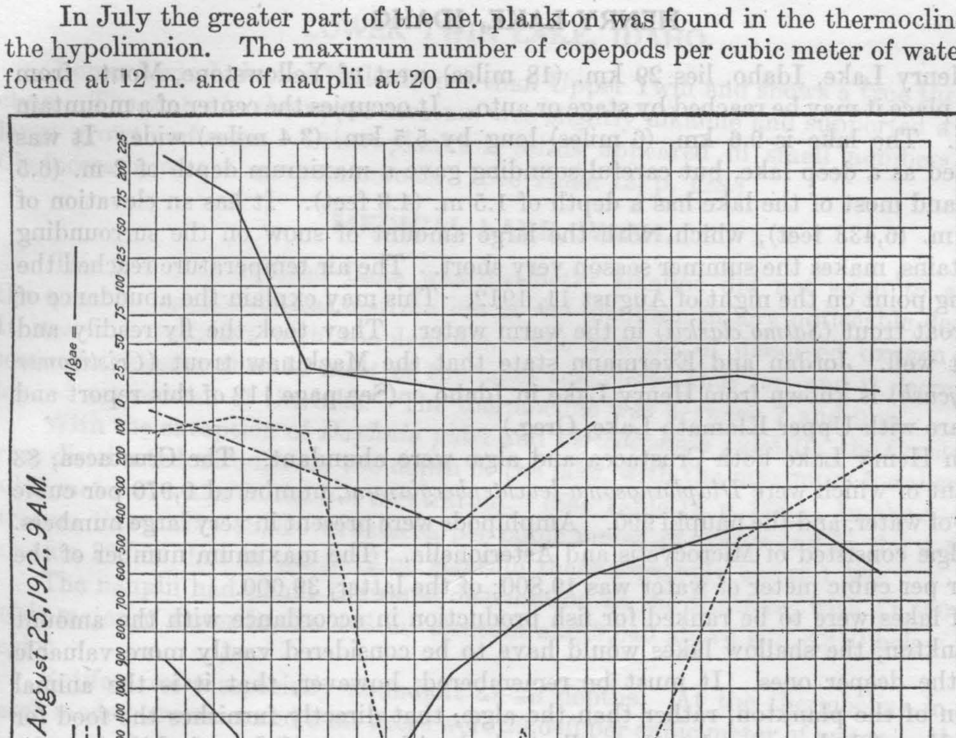

Fig. 12.—Curves for Hayden Lake, giving the temperature, dissolved gases, and plankton at various depths. *C*, free carbon dioxide; *Cb*, fixed carbon dioxide; *O*, oxygen; each given in cc. per liter. Plankton numbers are per cubic meter of water.

At the time of the second visit, on August 26, the various organisms in the net catches showed substantially the same vertical distribution as in early July, except that the Protozoa had shifted to the upper water, being most abundant in the 0–5 m. stratum. The Protozoa and copepods were more abundant in the August than in the July catches.

HENRY LAKE, IDAHO.

Henry Lake, Idaho, lies 29 km. (18 miles) west of Yellowstone, Mont., from which place it may be reached by stage or auto. It occupies the center of a mountain marsh. The lake is 9.6 km. (6 miles) long by 5.5 km. (3.4 miles) wide. It was reported as a deep lake, but careful sounding gave a maximum depth of 2 m. (6.5 feet), and most of the lake has a depth of 1.5 m. (4.8 feet). It has an elevation of 1,961 m. (6,433 feet), which, with the large amount of snow on the surrounding mountains, makes the summer season very short. The air temperature reached the freezing point on the night of August 11, 1912. This may explain the abundance of cutthroat trout (*Salmo clarkii*) in the warm water. They took the fly readily and fought well. Jordan and Evermann state that the Mackinaw trout (*Cristivomer namaycush*) is known from Henry Lake in Idaho. (See page 112 of this report and compare with Upper Klamath Lake, Oreg.)

In Henry Lake both Crustacea and algæ were abundant. The Crustacea, 83 per cent of which were *Diaphanosoma leuchtenbergianum*, numbered 9,970 per cubic meter of water, and the nauplii 990. Amphipods were present in very large numbers. The algæ consisted of Microcystis and Asterionella. The maximum number of the former per cubic meter of water was 19,800; of the latter, 39,600.

If lakes were to be ranked for fish production in accordance with the amount of plankton, the shallow lakes would have to be considered vastly more valuable than the deeper ones. It must be remembered, however, that it is the animal portion of the plankton, rather than the algæ, that directly furnishes the food for fish. Henry Lake seemed to be well stocked with trout (*Salmo clarkii*), but the water was so warm (63.2° F. or 17.3° C.) that the flesh of the trout had a poor flavor. Many of the trout were found in the creeks that flowed into the lake, but even the creeks were too warm for good, healthy trout.

LIBERTY LAKE, WASH.

This is also one of the very shallow lakes with marshy places on two sides. The lake was just in the "bloom" stage of its history at the time of our visit. The algæ were so very thick that the other representatives of the plankton were counted with difficulty.

The Cladocera were reproducing rapidly, the brood chambers of adult females showing many eggs in various stages of development.

LOON LAKE, WASH.

Loon Lake is about 32 m. (104.9 feet) deep and has a marshy place at the upper end where a small stream flows into it. The water is very clear; the disk was read at 8.5 m. For the most part the shore is gravel or fine, clean sand, which adds greatly to its clearness.

Algæ were scarce in the net plankton of this lake. They were most abundant in the region of the thermocline. Copepods and nauplii were also most abundant in this stratum.

LOWER TWIN LAKE, IDAHO.

Lower Twin Lake is a little deeper than Upper Twin and shows a true thermocline. The water in the upper stratum was slightly alkaline and supported a very large growth of algæ. Other plankton forms appeared in small numbers, the Cladocera being the most numerous. (See Table 12, p. 128.)

MEDICAL LAKE, WASH.

The fact that Medical Lake was distinctly alkaline did not seem to affect the quantity or the vertical distribution of the plankton in any noticeable degree. It was well supplied with zooplankton. The amount of dissolved oxygen was somewhat smaller than in most of the lakes considered thus far, and it decreased toward the bottom of the lake. The thermocline was between 7 and 9 m.

With the exception of *Daphnia pulex* and *Ceriodaphnia pulchella*, the Crustacea were distributed throughout the depth of the lake, with the maximum number per cubic meter of water in the 0–4 m. stratum. (See Table 12, p. 128.) In the 0–4 m. stratum there were 38,000 Crustacea per cubic meter of water and in the 4–8 m. stratum 25,000; but in the 8–12 m. stratum there were only about 1,500.

The nauplii had about the same distribution as the Rotifera, with 11,590 per cubic meter of water in the 4–8 m. stratum and 3,640 above and 3,310 below this region.

Rotifera were especially abundant at all depths. At the thermocline in the catch made between 4 and 8 m. there were 29,640 per cubic meter of water. Above this region there were only 4,640 and below it 1,490 per cubic meter of water.

The algæ seemed to be well distributed throughout the lake, but the numbers were small. In the 0–4 m. stratum there were 1,030 algæ per cubic meter of water, in the 4–8 m. stratum 920, and in the 8–12 m. stratum only 130. The chief characteristic of this lake is the large quantity of zooplankton and the relatively small amount of algæ.

The large quantity of Crustacea and other animal life in Medical Lake ought to furnish an abundant supply of fish food, but because of the alkalinity of the water no fish will live there for any period of time.

NEWMAN LAKE, WASH.

Newman Lake is a small, shallow body of water, with 9 m. (29.5 feet) as the maximum depth. It shows no plankton distribution of unusual interest. The Protozoa were most abundant at the surface, and the nauplii were found in largest numbers at the bottom. There was no thermocline, and the water was alkaline from top to bottom. (See fig. 13.)

PAYETTE LAKE, IDAHO.

Big Payette Lake, Payette Lake, or Payette Lakes all apply to the same body of water, which is divided by a narrow neck into two basins. The southern basin, which is oval, is a little larger than the more irregular northern basin. It lies in northern Boise County, Idaho, and is reached by a 29 km. (18-mile) stage ride from New Meadows, Idaho. Its greatest length is 7.5 km. (4.6 miles). It is 4 km. (2.5 miles) wide, and its elevation is 1,520 m. (4,987 feet).

The deepest water (67 m.) was found in the center of the southern basin, about a mile out from McCall, Idaho. The narrows, which was reported very deep, proved to be 45 m. in depth. A mile farther up, the north basin reached a depth of 62 m., beyond which the depth gradually decreased. The variation in level was reported as 8 feet and is controlled by a dam, the water being used for power purposes.

Payette is noted for its Rocky Mountain whitefish (*Coregonus williamsoni*), which are taken in large numbers each fall. It also furnishes good trout fishing, the silver trout (*Salmo gibbsii*) being one of the species for which it is noted.

The catches of net plankton were all made in the deepest place found in the lake. The thermocline was near the surface in the 4–7 m. stratum.

Diaptomus constituted 51 per cent of the total number of Crustacea, and 70 per cent of them were found in the 0–5 m. stratum, or directly above the thermo-

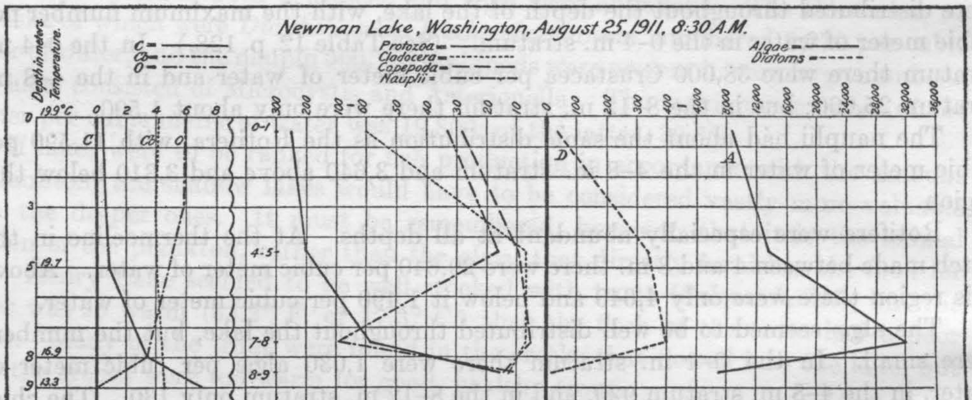

FIG. 13.—Curves for Newman Lake, giving the temperature, dissolved gases, and plankton conditions in a typical shallow lake. *C*, free carbon dioxide; *Cb*, fixed carbon dioxide; *O*, oxygen; each given in cc. per liter. Plankton numbers are per cubic meter of water.

cline. (See Table 12, p. 129.) *Cyclops bicolor* was well distributed throughout the lake, but 74 per cent were in and above the thermocline and only 3 per cent were found in the 60–65 m. stratum. *Daphnia hyalina* was found in about the same abundance as Cyclops, but it was confined to the upper 15 m. of water. As a whole, the Crustacea were especially prominent in the upper portion of the lake. It will be noted that they numbered 43,000 individuals per cubic meter of water in the 0–5 m. stratum. They decreased to 19,000 in the 5–10 m. stratum and to 7,000 in the 10–15 m. stratum. Below 30 m. the number was less than 1.000 per cubic meter of water.

With the exception of *Anuraea aculeata* all of the Rotifera were below 20 m. The maximum number of Triarthra per cubic meter of water was found in the 20–25 m. stratum, and this form was uniformly distributed below this depth. Notholca and Mastigocerca were found only in the 40–45 m. stratum.

The algæ were most abundant in the 0–5 m. stratum. In this region the diatoms numbered 430 and the other forms 1,060 per cubic meter of water.

LAKE PEND OREILLE, IDAHO.

This lake ranks first in size and fourth in depth among those included in this study. It is situated in Bonner and Kootenai counties, Idaho. Its greatest length is 49 km. (30.4 miles), and it has 595 km. (372 miles) of shore line. The elevation

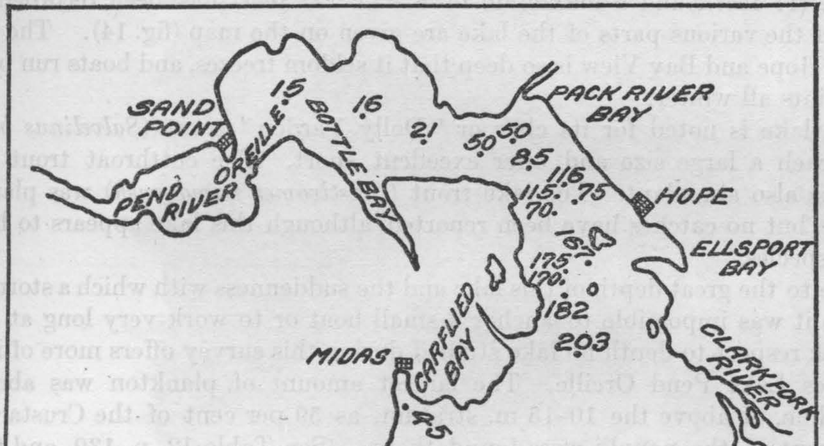

FIG. 14.—Map locating the soundings in Lake Pend Oreille. The depths are given in meters.

of the surface of the lake is 625 m. (2,050 feet). The southern part of the lake lies in a beautiful valley between mountains rising to 1,524 m. (5,000 feet) on each side. Most of the shores are steep, leaving few places where boats may land. Cape Horn rises abruptly from the lake to 1,373 m. (4,503 feet), and across the bay Chilco Mountain reaches a height of 1,678 m. (5,503 feet). The northern end of the lake is surrounded by comparatively low, flat shores. Beyond the city of Sandpoint the lake is shallow and empties into the Pend d'Oreille River.

Clarks Fork and Pack River with the numerous mountain streams bring a tremendous amount of water into the lake, especially during the "spring rise." Although there is no dam at the outlet the average change of level during a season is 5.2 m. (17 feet), and a maximum of 8.2 m. (27 feet) has been recorded. The depths of the various parts of the lake are given on the map (fig. 14). The section between Hope and Bay View is so deep that it seldom freezes, and boats run between these points all winter.

The lake is noted for its char or "Dolly Varden" trout (*Salvelinus bairdii*), which reach a large size and offer excellent sport. The cutthroat trout (*Salmo clarkii*) is also abundant. The lake trout (*Cristivomer namaycush*) was planted in this lake, but no catches have been reported, although this lake appears to be ideal for this species.

Due to the great depth of this lake and the suddenness with which a storm could come up it was impossible to anchor a small boat or to work very long at a time.

With respect to depth no lake studied during this survey offers more of interest than does Lake Pend Oreille. The largest amount of plankton was above the thermocline, or above the 10–15 m. stratum, as 59 per cent of the Crustacea and 66 per cent of the nauplii were found there. (See Table 12, p. 130, and fig. 16.) A few nauplii, however, were found as deep as 200 m. Both *Diaptomus ashlandi* and *Cyclops bicuspidatus* were found in a catch at the bottom of the lake (360 m.). The maximum numbers of Diaptomus and *Daphnia hyalina* per cubic meter of water were found in the 0–10 m. stratum. *D. hyalina* was not found below 50 m. *Notholca longispina* was the only rotifer noted in the limnetic catches.

Very little phytoplankton was found in any of the catches. Oscillatoria was the predominant alga and was confined to the upper 20 m. of the lake, 11 per cent of the strands being found in the 0–10 m. stratum of the lake and 81 per cent in the 10–20 m. stratum. Between 200 and 300 m. a few strands of Fragilaria and Tabellaria were found. Even the larger forms of aquatic plants were comparatively scarce. Most of the shore of the lake was of such a nature that it would be almost impossible for them to get a foothold.

PRIEST LAKE, IDAHO.

This beautiful body of clear, soft water lies 32 km. northeast of Sand Point, Idaho. It is usually reached by a 40 km. (25 mile) drive from Priest River, Idaho. It is completely surrounded by virgin forest, being a part of the Kaniksa National Forest. Its greatest length is 38.5 km. (24 miles), which with its irregular shape (see map, fig. 17) gives it an extended shore line.

Although mountains surround the lake, they are some distance from it, and most of the shore rises gradually, offering numerous beautiful camping sites. This, combined with the clean sand beaches and good trout fishing, makes the lake very popular as a summer resort.

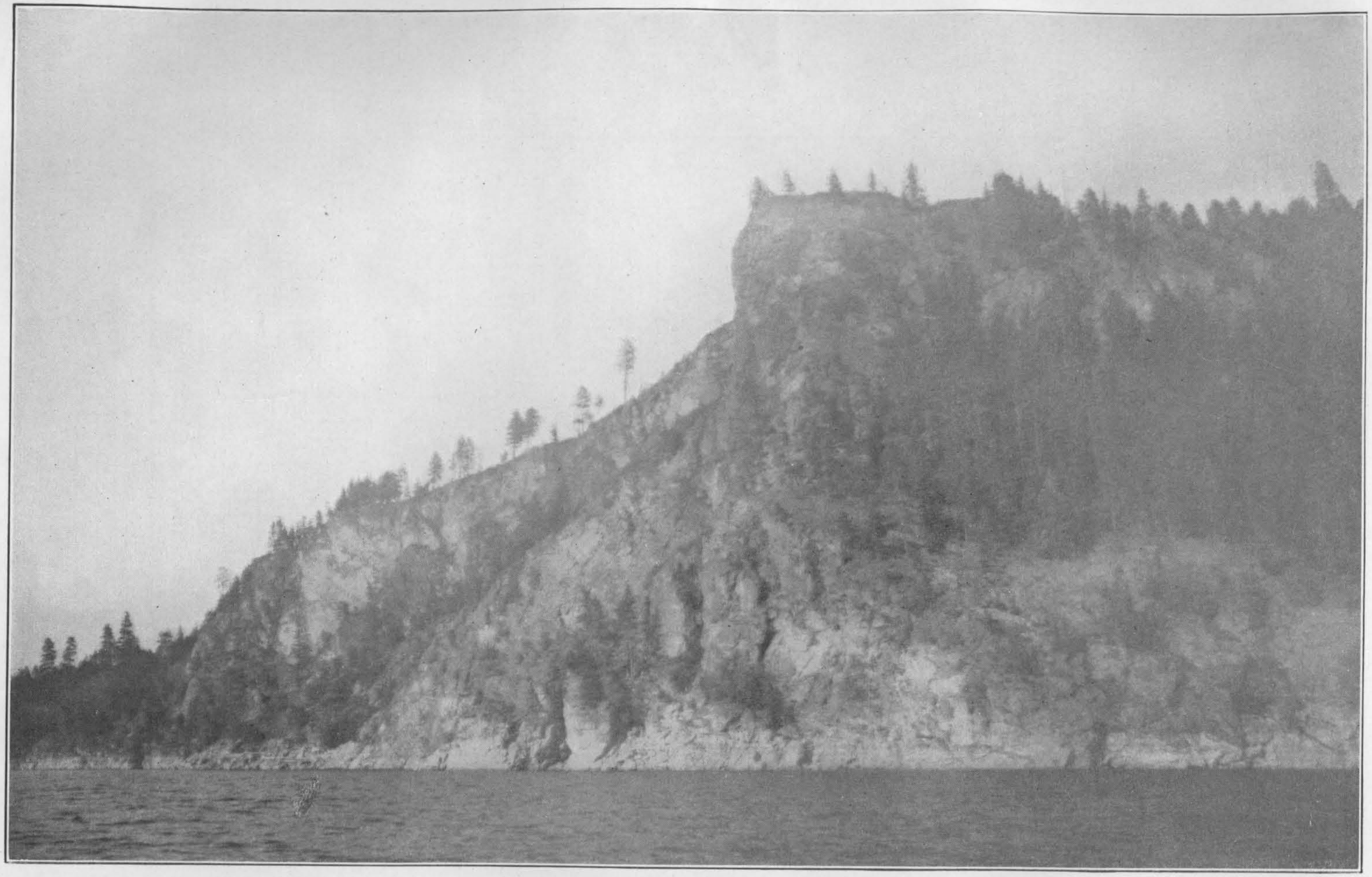

FIG. 15.—Granite Point, Lake Pend Oreille, Idaho.

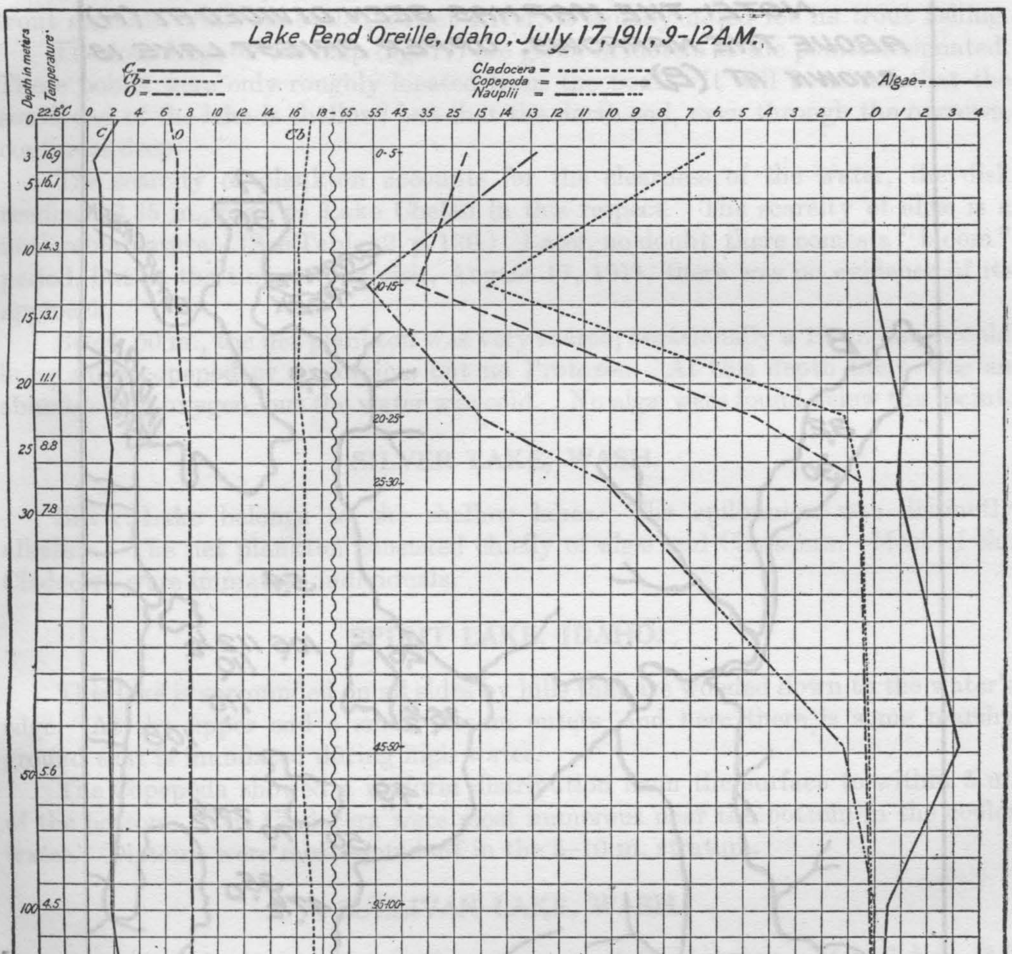

Fig. 16.—Dissolved gases, temperature, and plankton curves for Lake Pend Oreille, a typical deep lake. *C*, free carbon dioxide; *Cb*, fixed carbon dioxide; *O*, oxygen; each given in cc. per liter. Plankton numbers are per cubic meter of water.

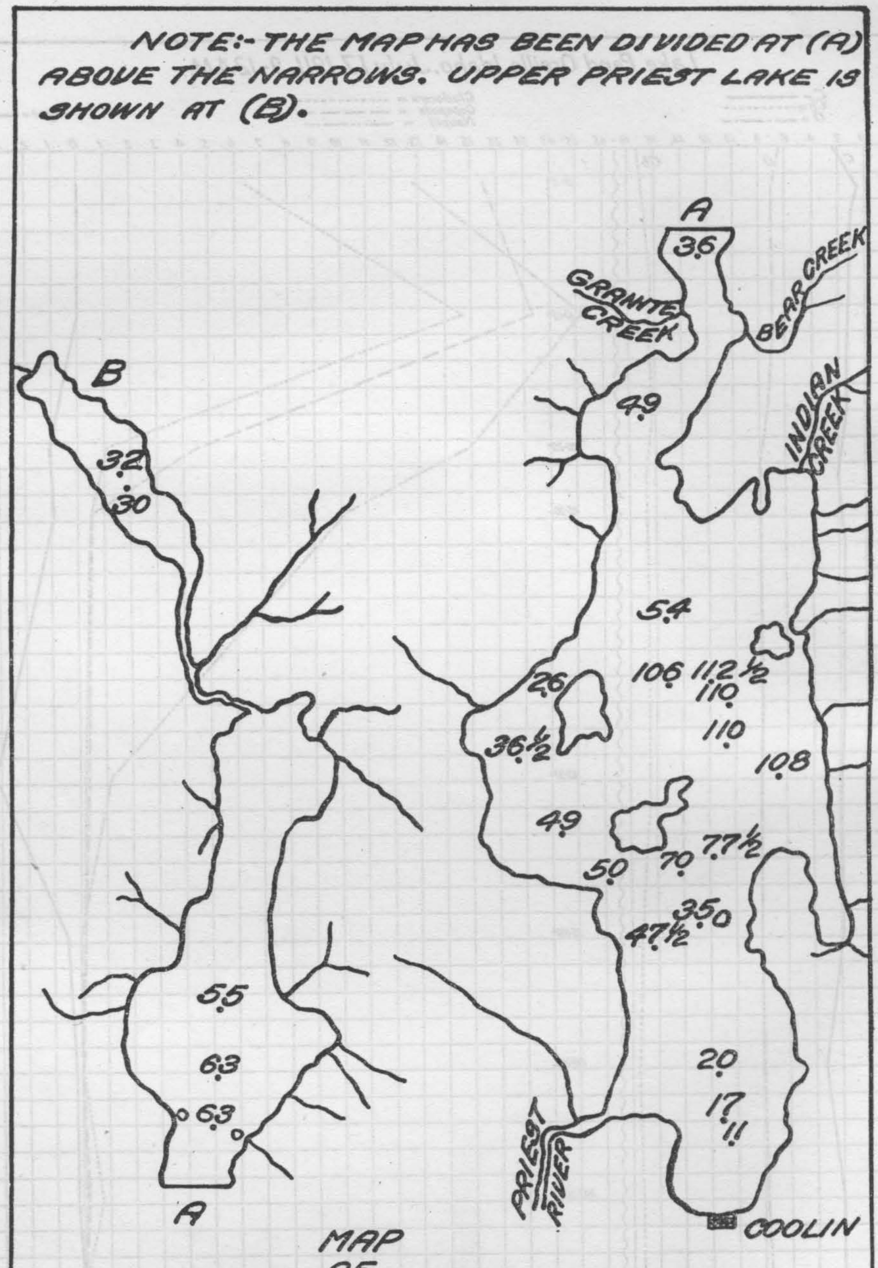

FIG. 17.—Map of Priest Lake and Upper Priest Lakes locating soundings. The depths are given in meters.

The lake is fed by a large number of inlets, practically all of which are good trout streams, while its outlet, Priest River, is equally noted for its trout fishing. The soundings on the map (fig. 17) are given in meters at the points designated. These points were only roughly located from the boat. It will be noted that the south end of the lake is shallow, but that the north end, even through the narrows, continues deep.

The scarcity of plankton accounts for the clearness of the water, the disk reading 13.35 m., next to Lake Chelan in this respect. The scarcity of algæ is a noticeable feature. (See Table 12, p. 130.) Later, no doubt, there comes a "bloom" period, but at the time of our visit, August 17, 1911, there was no evidence of its approach.

Below 50 m., the net plankton was very scarce; occasionally a 10-m. haul would bring up a copepod or a nauplius but no Protozoa. At this depth there was an abundance of oxygen, but the water was cold. No algæ were found below this point.

SILVER LAKE, WASH.

Silver Lake belongs to the shallow lakes. The epilimnion was distinctly alkaline. The net plankton consisted chiefly of algæ and Cladocera. Most of the Cladocera were immature individuals.

SPIRIT LAKE, IDAHO.

This lake is surrounded on all sides by hills that are wooded down to the water's edge. At the upper end a small stream enters, and here there is some marshy ground that is inundated during high water.

The Copepoda showed a uniform distribution from the surface to within 5 m. of the bottom. The Cladocera were most numerous near the bottom in the cooler water. Diatoms were most abundant in the 5–10 m. stratum.

SULLIVAN LAKE, WASH.

Sullivan Lake lies in the northeast corner of Washington. It is 6 km. (3.7 miles) long and 1.6 km. (1 mile) wide, extending north and south between two ridges of high mountains. The lake has recently been raised by a 3 m. (10 foot) dam and is used as a reservoir to supply power at Metaline Falls. It has an elevation of 783.5 m. (2,570 feet). Its shores are very steep, and a large part of the lake is more than 50 m. deep. The deepest place, 95 m., is at the center of the lake. At the upper end the lake is fed by a small stream and at the lower end gives rise to a tributary to Sullivan Creek.

The lake contained a few logs when we visited it, and it was reported to have had many more. These gave the water a brown color and probably decreased the disk reading. It is noted for its cutthroat-trout fishing.

Most of the net plankton was found in the upper 20 m. Among the Crustacea the copepods were more abundant than the cladocerans.

UPPER PRIEST LAKE, IDAHO.

Upper Priest Lake, a small body of water, lies 3 km. (1.8 miles) north of Priest Lake, connected with it by a winding thoroughfare passing through marshy land. We investigated only the lower part of this lake, which is quite marshy, and that during a rain. At the southern end the shores are steeper and more rocky than those of Priest Lake.

The lake has a very irregular outline (fig. 17) and is surrounded on all sides by hills. The arms of the lake as they run into little valleys give all conditions of depth—very shallow places and, out in the more open parts, deep water.

The water of the lake is clear; the disk was read at 9 m., and the surface water had a rather low temperature, 18.1° C. In July the thermocline was between 6 and 15 m. The net plankton was most abundant in this region.

UPPER TWIN LAKE, IDAHO.

This is a very shallow lake, 5.5 m. (18 feet) deep, surrounded on three sides with marshy land. The water at this time of the year was greenish-brown, and the thermocline had entirely disappeared. The lake is slightly alkaline and shows enormous quantities of algæ. A 1-meter haul was sufficient to clog the net.

WILLIAMS LAKE, WASH.

Williams Lake is small and shallow, the maximum depth being 15 m. (49.2 feet). The water was fairly transparent, the disk not disappearing from view until a depth of 5 m. was reached. The net plankton was most abundant in the upper 2 m.

This lake was reported to contain bass and perch in 1911. It has been stocked with silver trout, and in 1920 was reported as one of the best lakes for silver-trout fishing.

WRIGHT LAKE, IDAHO.

This lake (see also p. 85) has a maximum depth of only 7 m. (22.9 feet), and, as is usually the case in shallow lakes, it was well supplied with plankton, especially phytoplankton. The Crustacea consisted of Cyclops, *Diaptomus leptopus*, *Daphnia hyalina*, and *Diaphanosoma leuchtenbergianum*. *Daphnia hyalina* composed about one-third of the total number of Crustacea. (See Table 12, p. 135.) About 17 per cent of the Crustacea consisted of nauplii. Notholca and Conochilus were the only rotifers found, and they numbered 2,200 individuals per cubic meter of water. The algæ consisted chiefly of Anabæna and Glœotrichia. The fish-food supply was unusually large, and the lake ought to yield a large number of fish.

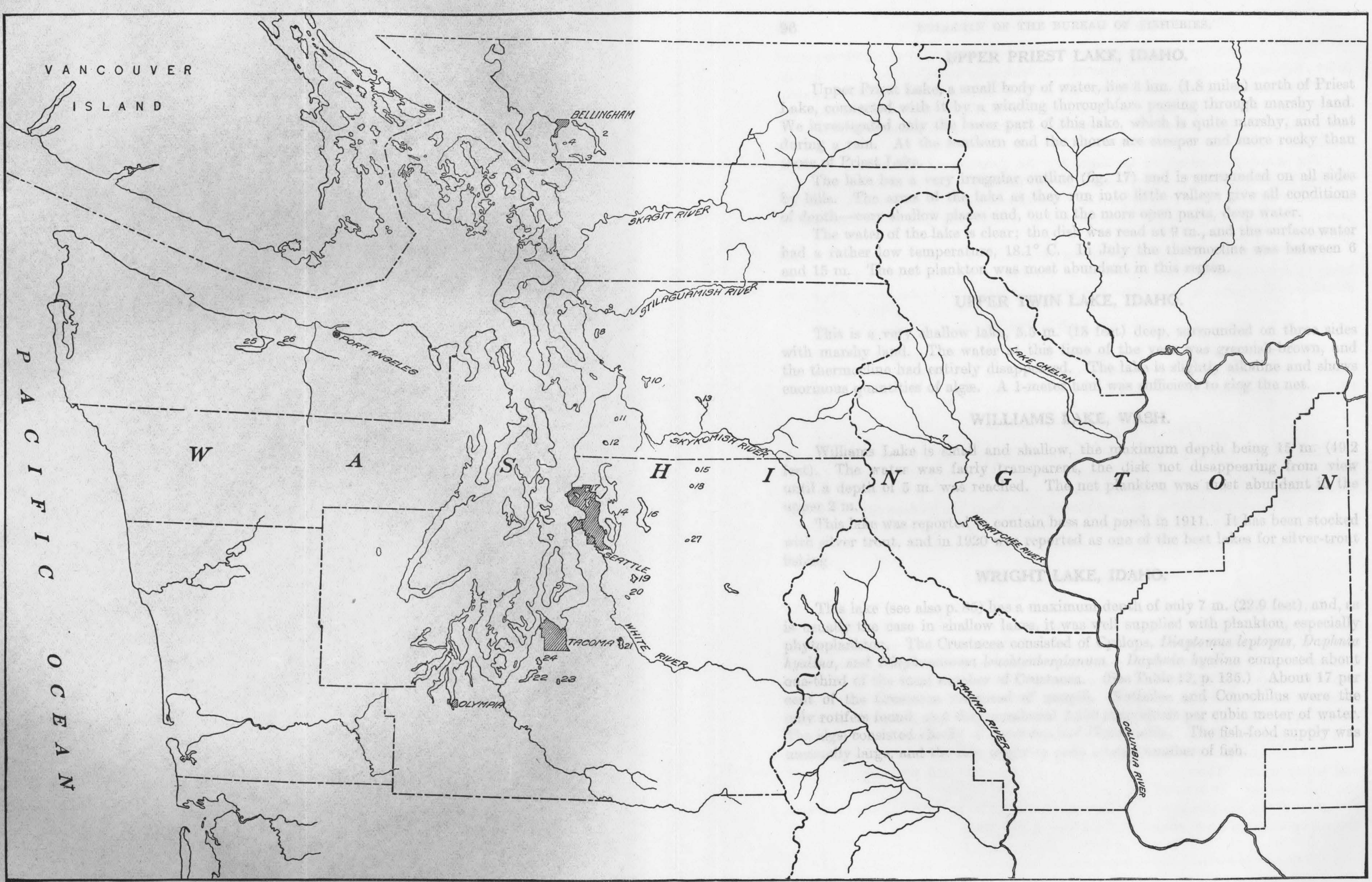

Fig. 18.—Map of western Washington, showing location of lakes studied. *2*, Whatcom; *3*, Samish; *4*, Padden; *5*, Wildwood; *6*, Luna; *8*, Goodwin; *9*, Ki; *10*, Stevens; *11*, Silver; *12*, Martha; *13*, Chaplain; *14*, Washington; *15*, Paradise; *16*, Sammamish; *17*, Green; *18*, Cottage; *19*, Swan; *20*, Cow, *21*; Tapps; *22*, American; *23*, Spanaway; *24*, Steilacoom; *25*, Crescent; *26*, Sutherland.

LAKES IN WESTERN WASHINGTON.

TABLE 8.—*Lakes examined in western Washington.*

Lake.	County.	Greatest length.		Direction of greatest length.	Greatest breadth.		Elevation.		Maximum known depth.		Fish commonly caught.
		Km.	*Miles.*		*Km.*	*Miles.*	*M.*	*Feet.*	*M.*	*Feet.*	
American	Pierce	8.0	5.0	N.-S.	6.4	4.0	......	......	26.0	85.3	Cutthroat trout, bass.
Chaplain	Snohomish	1.6	1.0	NW.-SE.	.5	.3	......	......	12.0	39.4	Trout.
Cottage	King	1.0	.6	E.-W.	.5	.3	......	......	8.0	26.2	
Cow	do	2.0	1.2	NW.-SE.	.5	.3	......	......	24.0	78.7	
Crescent	Clallam	14.5	9.0	E.-W.	2.0	1.2	204.0	670	175.0	574.0	Trout.
Goodwin	Snohomish	2.0	1.2	N.-S.	.8	.5	......	......	9.0	29.5	Trout.
Green	King	.9	.5	N.-S.	.8	.5	......	......	4.5	14.6	
Ki	Snohomish	2.0	1.2	E.-W.	1.0	.6	......	......	20.0	65.6	
Luna	San Juan, Blakeley Island.	.5	.3	N.-S.	.5	.3	......	......	28.0	91.8	Trout.
Martha	Snohomish	.5	.3	NW.-SE.	.5	.3	......	......	9.0	29.5	Trout.
Padden	Whatcom	1.6	1.0	NW.-SE.	.8	.5	......	......	9.0	29.5	Bass.
Paradise	King	.4	.25	N.-S.	.2	$\frac{1}{8}$	......	......	8.0	26.2	Trout.
Samish	Whatcom	3.2	2.0	NW.-SE.	.8	.5	......	......	21.0	68.9	Trout, bass.
Sammamish	King	12.0	7.4	N.-S.	2.4	1.5	......	......	19.0	62.3	
Silver	Snohomish	.5	.3	N.-S.	.5	.3	......	......	14.0	45.9	Trout.
Spanaway	Pierce	1.6	1.0	N.-S.	1.0	.6	......	......	7.0	22.9	Trout, bass.
Steilacoom	do	1.0	.6	N.-S.	.7	.4	......	......	6.0	19.7	Do.
Stevens	Snohomish	3.2	2.0	N.-S.	3.2	2.0	71.8	236	45.0	147.6	Trout.
Sutherland	Clallam	4.0	2.5	E.-W.	1.6	1.0	188.9	620	26.0	85.2	Do.
Swan	King	3.2	2.0	N.-S.	.5	.3	......	......	22.0	72.1	Trout, bass.
Tapps	Pierce	4.8	3.0	N.-S.	1.6	1.0	245.0	534	24.0	78.7	
Washington	King	32.0	19.8	N.-S.	7.0	4.3	......	......	67.6	222.0	Bass.
Whatcom	Whatcom	19.3	12.0	NW.-SE.	4.8	3.0	......	......	96.0	311.0	Trout.
Wildwood	San Juan, Blakeley Island.	.2	.1	N.-S.	.2	.1	58.0	190	22.0	72.1	Bass, trout.

AMERICAN LAKE, WASH.

Almost two-thirds of the Crustacea were *Cyclops viridis* var. *americanus*, and 43 per cent of them were found below 20 m. A few *Epischura nevadensis* var. *columbiæ* were found in this stratum, too, with the maximum number per cubic meter of water between 10 and 15 m. One-half of the *Daphnia longispina* var. *hyalina* and two-thirds of the *Diaphanosoma leuchtenbergianum* were in the surface stratum. (See Table 12, p. 122.)

The maximum number of nauplii per cubic meter of water occurred between 15 and 20 m., or just below the thermocline; over half of the nauplii were in this stratum.

The largest number of Rotifera per cubic meter of water was found between 10 and 15 m. No rotifers were noted above 10 m.

Anabæna was the predominant alga, with a few specimens of Microcystis and Aphanocapsa. Some diatoms belonging to the genera Cyclotella and Melosira were obtained in the 10–20 m. stratum, and some Melosira in the 20–25 m. stratum.

LAKE CHAPLAIN, WASH.

The thermocline in Lake Chaplain was between 3 and 5 m., the rapid drop in the temperature being due, in part at least, to the protection from the winds afforded by the surrounding forest. The maximum number of Crustacea per cubic meter of water was in the 0–3 m. stratum. All of the *Epischura nevadensis*, *Diaphanosoma leuchtenbergianum*, and *Holopedium gibberum* were confined to the surface stratum of the lake. No Crustacea were found below 9 m. (See Table 12, p. 123.)

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The maximum number of nauplii per cubic meter of water was found just below the thermocline, or in the 6–9 m. stratum, and just above the region having a very small amount of oxygen.

The largest number of rotifers per cubic meter of water occurred in the 0–3 m. stratum. The lower stratum of the lake between 9 and 12 m. was entirely devoid of them. *Polyarthra platyptera* comprised 83.2 per cent of the rotifers, and over three-fourths of this number were in the 0–3 m. stratum. A few *Anuraea cochlearis* were found between 6 and 9 m. *Notholca longispina* was found above 9 m., with the maximum number per cubic meter of water between 3 and 6 m.

Mallomonas was found between 3 and 9 m.

Anabæna was obtained in the 0–3 m. stratum and Microcystis in the 3–9 m. stratum. The diatoms showed an irregular vertical distribution.

COTTAGE LAKE, WASH.

The maximum number of Crustacea per cubic meter of water in Cottage Lake was found between 2 and 5 m. Eighty-six per cent of the *Cyclops bicuspidatus* and a very small number of *Diaphanosoma leuchtenbergianum* were in this stratum. All of the *Epischura nevadensis*, which composed one-fourth of the Crustacea, were in the 0–2 m. stratum.

Almost three-fourths of the nauplii were in the 0–2 m. stratum. A few were found below the thermocline.

Among the rotifers, all of the *Polyarthra platyptera* and *Anuraea aculeata* were in the surface stratum. About 73 per cent of the *Notholca longispina* and all of the Mastigocerca were in the 2–5 m. stratum, which contained the maximum number of rotifers per cubic meter of water. (See Table 12, p. 125.)

Epistylis, Dinobryon, and Ceratium were found in the upper 2 m.

Aphanocapsa was noted only between 0 and 2 m., and Anabæna was obtained at all depths. The diatom Cyclotella was noted in the 0–2 m. catch and Asterionella in the 2–7 m. stratum.

COW LAKE, WASH.

Over three-fourths of the Crustacea in Cow Lake were above the thermocline, or above 8 m., with the maximum number per cubic meter of water in the 0–4 m. stratum. All of the *Bosmina longirostris* and *Epischura nevadensis*, which together composed about two-thirds of the Crustacea, and 85 per cent of the *Daphnia longispina* var. *hyalina* were in the 0–8 m. stratum. There were no Crustacea between 16 and 20 m., but a few *Cyclops modestus* occurred in the 20–24 m. stratum.

The nauplii, also, were confined largely to the region above the thermocline, with the maximum number per cubic meter of water in the upper 4 m. Eighty per cent of the nauplii were above 12 m., with 27.8 per cent in the 0–4 m. stratum.

The maximum number of Rotifera per cubic meter of water was found in the epilimnion, especially in the 0–4 m. stratum of the lake.

Specimens of Ceratium and Dinobryon were secured between 4 and 12 m. They were not found above or below this stratum.

Asterionella was the only diatom found in Cow Lake and was confined entirely to the 0–4 m. stratum.

CRESCENT AND SUTHERLAND LAKES, WASH.

To the south of the Strait of Juan de Fuca, in Clallam County, Wash., lie two interesting lakes, Crescent and Sutherland.

Crescent Lake lies 24 km. (15 miles) west and 8 km. (5 miles) south of Port Angeles. It is a beautiful lake, 14.5 km. (9 miles) east and west by 2 km. (1¼ miles) north and south, lying between the main range of the Olympic Mountains and the coast range at an elevation of 204 m. (670 feet). Soundings gave a depth of 145 m. in the center of the east bay and 75 m. in the narrows. The deepest water (175 m.) was located near the center of the lake, 3.25 km. (2 miles) west of the narrows.

The temperature and clearness of this lake are similar to those of the very deep lakes, such as Chelan and Tahoe. The water is very clear, but not as clear as that of Tahoe and Crater lakes. The temperature decreases gradually from 16.4° C. at the surface to 5.6 at the bottom, with no marked thermocline.

Crescent Lake is noted for the blueback trout (*Salmo beardsleei*), which is caught by trolling in deep water with a heavily weighted or wire line. Speckled trout (*Salmo crescentis*) and the long-headed trout (*Salmo bathœcetor*) are found in this lake. Lake Sutherland contains Jordans trout (*Salmo jordani*) and the salmon trout (*Salmo declivifrons*). Besides these, both lakes are said to contain cutthroat trout (*Salmo clarkii*), and a few salmon are said to run into each.

Crescent is one of the deeper lakes that has a very small amount of plankton. A few Crustacea, however, were found at all depths, even at the bottom.

Epischura was the only copepod noted in the plankton catches of Crescent Lake. It was found at all depths. A few Daphnias were found in the catch taken between 20 and 30 m.

Most of the nauplii were secured in the upper 10 m. (See Table 12, p. 126.)

The maximum number of rotifers per cubic meter of water was obtained in the 0–20 m. stratum. Some specimens of Dinobryon were noted in the 10–20 m. catch. The predominant alga was the diatom Gonatonema.

Sutherland Lake lies 1 mile east of Crescent Lake at an elevation of 188.9 m. (620 feet). It is 4 km. (2.5 miles) long by 1.6 km. (1 mile) wide. It lies at the base of mountains 1,000 m. high, from which it receives most of its water. Indian Creek is the outlet. The lake is surrounded by trees, which, with the mountains, protect it from the wind. The thermocline is well marked and lies between 9 and 11 m. The oxygen decreases below the thermocline, but on August 18 there was still sufficient for fish life near the bottom.

About 52,000 Crustacea per cubic meter of water were found in the surface stratum. The most abundant crustacean in this stratum was *Diaphanosoma brachyurum*, although large numbers of *Cyclops prasinus* and *Diaptomus tyrelli* were present. One-fourth of the *Cyclops prasinus* and the maximum number of *Bosmina longirostris* per cubic meter of water were in the 16–20 m. stratum.

LAKE GOODWIN, WASH.

The maximum number of Crustacea per cubic meter of water was found in Lake Goodwin in the 0–3 m. stratum.

Nauplii were found in largest numbers between 3 and 6 m. Three-fourths of the nauplii were in this stratum, with only 9.7 per cent in the surface stratum and 14.7 per cent in the bottom stratum.

Only a few rotifers were obtained in the catches, the maximum number per cubic meter of water being noted in the 0–3 m. stratum. The algæ were distributed throughout the lake, with the maximum number per cubic meter of water occurring in the surface stratum. Glœotrichia was the predominant alga, although the figures indicate a larger number of Microcystis and Anabæna.

GREEN LAKE, WASH.

This lake is only 4.5 m. (14.6 feet) deep, and the water was rather turbid, the disk disappearing from view at a depth of 1 m. Cyclops and Daphnia were about uniformly distributed from surface to bottom, but Bosmina and Diaphanosoma were found only in the 2–4 m. stratum. Nauplii were most abundant in the upper 2 m. The majority of the rotifers and of the algæ were obtained in the 0–2 m. stratum.

LAKE KI, WASH.

The thermocline in Lake Ki was between 7 and 9 m., and most of the Crustacea were below this region, with the maximum number per cubic meter of water between 8 and 12 m. Over three-fourths of the Crustacea were *Cyclops bicuspidatus*, and two-fifths of them were between 8 and 12 m. All of the *Diaphanosoma leuchtenbergianum* and *Holopedium gibberum* and most of the *Epischura nevadensis* var. *columbiæ* were above the thermocline. Most of the nauplii were below the thermocline, with the maximum number per cubic meter of water between 12 and 16 m. The rotifers were well distributed throughout the lake, with the largest number per cubic meter of water between 12 and 16 m. Dinobryon was found in very limited numbers above 8 m. Only a small number of algæ was obtained.

LUNA LAKE, WASH.

In Luna Lake *Bosmina longirostris* was the predominant crustacean in the epilimnion, *Diaptomus oregonensis* in the thermocline, and *Cyclops bicuspidatus* in the hypolimnion. The nauplii, also, were confined almost entirely to the epilimnion and the thermocline. Triarthra and Mastigocerca were the predominant rotifers. They were most abundant in the upper 8 m. The flagellate Ceratium was confined to the upper 8 m. Staurastrum and Asterionella were found in the 4–8 m. stratum.

LAKE MARTHA, WASH.

All of the Crustacea in Lake Martha were found in and above the region of the thermocline, the maximum number per cubic meter of water being in the 0–3 m. stratum. Eighty per cent of the *Epischura nevadensis* var. *columbiæ*, 85 per cent of the *Diaphanosoma leuchtenbergianum*, 97.5 per cent of the *Holopedium gibberum*, and 83.7 per cent of the *Bosmina longispina* were in this stratum. No adult Crustacea were found below 6 m.

Nauplii were found at all depths, with the maximum number per cubic meter of water in the 0–3 m. stratum. All of the Conochilus and Mastigocerca, two-fifths of the *Polyarthra platyptera*, one-fourth of the *Anuræa cochlearis*, and one-third of the *Notholca longispina* were in the 0–3 m. stratum. Ceratium and Staurastrum occupied the 0–6 m. stratum.

LAKE PADDEN, WASH.

Lake Padden is one of the small, shallow lakes with the maximum amount of net plankton per cubic meter of water concentrated in the surface stratum. *Diaptomus oregonensis* and *Diaphanosoma brachyurum* predominated, and nearly 90 per cent of each species was found in the 0–3 m. stratum. All of the *Daphnia longispina* var. *hyalina, Bosmina longispina*, and *Chydorus sphæricus* were confined to the 0–3 m. stratum.

The maximum number of nauplii per cubic meter of water was also in the surface stratum. Over 92 per cent was found in this stratum. (See Table 12, p. 129.)

The rotifers, too, were most abundant near the surface. All of the Conochilus, 85.7 per cent of the *Polyarthra platyptera*, and 69.5 per cent of the Mastigocerca were in this region. *Notholca longispina* was found in the 3–6 m. stratum.

Fairly large numbers of Ceratium and Anabæna were found at all depths, with the maximum number per cubic meter of water in the 0–3 m. stratum. Likewise, Anabæna was found at all depths in fairly large numbers, with the maximum number per cubic meter of water in the 0–3 m. stratum. Cœlosphærium was obtained in the 3–6 m. stratum. Asterionella was the only diatom found in the lake. It occurred most abundantly between 3 and 6 m.

PARADISE LAKE, WASH.

The maximum number of Crustacea per cubic meter of water in Paradise Lake, which is only 8 m. deep, was in the 0–2 m. stratum. About 90.9 per cent of the *Epischura nevadensis*, 67.5 per cent of the *Cyclops bicuspidatus*, and 73.7 per cent of the *Daphnia longispina* were found in this stratum. (See Table 12, p. 129.) The absence of free oxygen at the bottom of the lake accounts for the scarcity of Crustacea in the 6–8 m. stratum, only a few Cyclops being found there.

The largest number of nauplii, or 73 per cent of the total number, was in the 0–2 m. stratum of the lake. None was found between 6 and 8 m., where there was a very small amount of dissolved oxygen.

The rotifers were most abundant, also, between the surface and 2 m., with none at the bottom of the lake. *Polyarthra platyptera* comprised 36.8 per cent, *Anuræa aculeata* and *brevispina* 24.6 per cent, *Notholca longispina* 36 per cent, and Conochilus and Asplanchna 2.5 per cent of the total number of rotifers.

The maximum number of algæ per cubic meter of water was found in the 0–2 m. stratum.

LAKE SAMISH, WASH.

The thermocline of Lake Samish was between 8 and 12 m., and over three-fourths of the Crustacea were above this region. This was due to the fact that nearly all of the *Diaphanosoma leuchtenbergianum* and 70.3 per cent of the *Cyclops bicuspidatus* were above 8 m.

Over half of the nauplii were below the thermocline, with 28.1 per cent between 16 and 20 m. Many nauplii were found at the bottom of the lake, where only a small amount of free oxygen was present.

The maximum number of rotifers per cubic meter of water was in the 0–4 m. stratum. Mastigocerca comprised 87 per cent of the total number of rotifers and was found most commonly above the thermocline. A few *Polyarthra platyptera* were found above 12 m. *Notholca longispina* was about evenly distributed in very small numbers throughout the lake.

Aphanocapsa was the predominant alga.

Cyclotella was the only diatom found in the lake.

LAKE SAMMAMISH, WASH.

The Crustacea in this lake were largely crowded into the 0–3 m. stratum, where there were 52,000 individuals per cubic meter of water. This number decreased very rapidly to only 9,000 between 3 and 6 m. In the upper stratum of the lake there were 60.5 per cent of the *Epischura nevadensis*, 35 per cent of the *Cyclops bicuspidatus*, 74.8 per cent of the *Diaphanosoma leuchtenbergianum*, and 42.9 per cent of the *Bosmina obtusirostris*.

The maximum number of nauplii per cubic meter of water was found in the region of the thermocline, or between 9 and 12 m.

The majority of the rotifers were Mastigocerca, while 25.1 per cent were *Notholca longispina* and 16.7 per cent were *Polyarthra platyptera*. The maximum number per cubic meter of water was found in the 0–3 m. stratum. There was a slight decrease in numbers in the stratum between 6 and 9 m. Fifty per cent of the Polyarthra, 42.8 per cent of the Mastigocerca, and one-third of the Notholca were above 3 m.

Diatoms were present in considerable numbers at all depths. The maximum number per cubic meter of water of other algæ, such as Staurastrum, Microcystis, Aphanocapsa, and Anabæna, was in the 0–3 m. stratum of the lake.

SILVER LAKE, WASH.

The vertical distribution of the Crustacea was quite uniform, with the maximum number per cubic meter of water just below the thermocline, or between 5 and 10 m. All of the *Epischura nevadensis* var. *columbiæ* were in the 0–5 m. stratum of the lake. *Daphnia longispina* var. *hyalina* and *Diaphanosoma leuchtenbergianum* were both above 10 m. Sixty per cent of *Cyclops bicuspidatus* was between 5 and 10 m., but none was found above 5 m.

The maximum number of nauplii per cubic meter of water was noted at the bottom of the lake, between 10 and 14 m. Over three-fifths of the nauplii were found in this stratum. The rotifers were rather evenly distributed throughout the lake, with the maximum number per cubic meter of water between 10 and 14 m. Almost one-half of *Polyarthra platyptera*, slightly over half of *Anuræa cochlearis*, and almost one-third of *Notholca longispina* were found in this stratum of the lake. Conochilus and Mastigocerca were in the surface stratum.

Ceratium was found in small numbers above 10 m.

The algæ were not very numerous for a lake of this depth. They occurred in largest numbers between 5 and 10 m. Anabæna was found in small numbers above 10 m.

Fragilaria and Asterionella were the only diatoms found. The maximum number per cubic meter of water was in the 0–5 m. stratum. None was found below 10 m.

LAKE SPANAWAY, WASH.

This lake is very much the same as Lake Steilacoom, but it has a very much smaller amount of plankton. The largest number of Crustacea per cubic meter of water was in the 0–2 m. stratum. Almost two-thirds of the Crustacea were *Epischura nevadensis*, and 65 per cent of this number were in the surface stratum. *Diaphanosoma leuchtenbergianum* was confined to the upper 4 m., and *Bosmina longirostris* to the upper 2 m.

The nauplii, likewise, were most abundant in the surface stratum. About 80 per cent of them had congregated in this region. (See Table 12, p. 131.)

Only two species of rotifers were found in this lake, and the maximum number was in the 2–4 m. stratum. *Notholca longispina* comprised almost three-fourths of the total number of rotifers, and about 60 per cent were in the 2–4 m. stratum. In addition to the Notholca, a few *Anuræa cochlearis* were found between 4 and 7 m. The maximum number of algæ per cubic meter of water was noted in the 0–2 m. stratum.

LAKE STEILACOOM, WASH.

This lake is very shallow. The maximum number of Crustacea per cubic meter of water was obtained in the 0–2 m. stratum. The Crustacea consisted of 57.9 per cent *Epischura nevadensis*, 17.3 per cent *Ceriodaphnia reticulata*, 20 per cent *Bosmina longirostris*, and a few *Diaphanosoma leuchtenbergianum* and *Daphnia longispina* var. *hyalina* form *galeata*.

Seven-eighths of the nauplii were in the 0–2 m. stratum also, and three-fourths of *Notholca longispina* were in this same region.

No diatoms were found in the limnetic catches. Mougeotia and Anabæna were the only algæ found. A very large number of Anabæna was found in the surface stratum, and Mougeotia was found between 2 and 5 m.

LAKE STEVENS, WASH.

The Crustacea in Lake Stevens had a rather uniform distribution with the maximum number per cubic meter of water in the 0–5 m. stratum. This was due to the large number of *Epischura nevadensis* in this region and to the fact that all of the *Diaphanosoma leuchtenbergianum* were confined to this stratum, too. *Cyclops bicuspidatus* was well distributed throughout the lake, with the maximum number per cubic meter of water between 5 and 10 m., or in the region of the thermocline.

Nauplii were found mainly in two separate regions of the lake, namely, above 10 m. and between 35 and 45 m., with the maximum number per cubic meter of water in the bottom stratum. About one-half of the nauplii were above 10 m., and 43.9 per cent in the 35–45 m. stratum.

Notholca longispina and *Anuræa brevispina* comprised over two-thirds of the rotifers. Notholca was most abundant in the surface stratum, Anuræa in the bottom stratum. All of the Triarthra and *Polyarthra platyptera* were found in the upper water. Mastigocerca was distributed throughout the entire lake, with the maximum number per cubic meter of water in the 0–5 m. stratum.

The maximum number of algæ per cubic meter of water was found in the upper 10 m., but a relatively large number was found at all depths.

SWAN LAKE, WASH.

Although many Crustacea were found at all depths in Swan Lake, the maximum number per cubic meter of water was found in the 0–3 m. stratum. Over half of the Crustacea were above the thermocline. This was due chiefly to the large number of *Diaphanosoma leuchtenbergianum* and *Epischura nevadensis* in this stratum.

Although a few nauplii were found above the thermocline, by far the largest number was below this region, with the maximum number per cubic meter of water in the 9–12 m. stratum.

Several species of rotifers were obtained in this lake. Conochilus was most abundant in the 0–3 m. stratum. The other species were rather uniformly distributed throughout the depths of the lake.

LAKE TAPPS, WASH.

The vertical distribution of the Crustacea in Lake Tapps was peculiar in that the organisms were abundant at the bottom of the lake, between 20 and 24 m. There was a large number of Crustacea, also, in the surface stratum, with relatively few organisms between the surface and bottom strata. *Daphnia longispina* var. *hyalina* and *Diaptomus eiseni* composed about 84 per cent of the total number of Crustacea in about equal proportions. It is interesting to note in this connection, also, that 82.6 per cent of the Daphnia were in the 0–4 m. stratum and 84 per cent of the Diaptomus in the 20–24 m. stratum.

The nauplii, also, were most abundant in the surface and bottom strata.

The rotifers, likewise, had the same general distribution as the Crustacea and nauplii, with the maximum number per cubic meter of water in the surface and bottom strata and a decided decrease in number between these regions.

Dinobryon and Ceratium were most abundant in the upper 8 m.

Microcystis and Aphanizomenon were most numerous in the 0–4 m. stratum. The maximum number of diatoms per cubic meter of water was found in the 0–4 m. stratum. Below 4 m. only a limited number was found. Asterionella was by far the predominant diatom in the lake.

LAKE WASHINGTON, WASH.

Lake Washington lies partly within the city limits of Seattle. It is a long narrow body of water extending 32 km. on a north and south line with a width of 7 km. The lake has been sounded and marked by the United States Geodetic Survey (Lake Survey, 1841–1881) which reports a depth of 37 fathoms. On account of the strong wind we were unable to locate this place, and our deepest sample was taken at 60 m. (32.9 fathoms). A canal was completed in 1916 that connects the lake and the sound and lowers the lake 3 m.

The climate in this section is so mild that Lake Washington never freezes over, so it would be of interest to carry out determinations similar to these throughout the year.

This lake showed a larger number of Crustacea per cubic meter of water than any other lake included in these studies. Although a certain amount of net plankton was found at all depths, over 65 per cent of the zooplankton was above 10 m., or above the thermocline. (See Table 12, p. 134.)

LAKE WHATCOM, WASH.

Lake Whatcom is one of the deeper lakes, with a thermocline between 16 and 19 m. The maximum number of Crustacea per cubic meter of water was found in the 0–10 m. stratum. About one-third of *Cyclops bicuspidatus*, which comprised fully one-half of the Crustacea, and 86 per cent of *Epischura nevadensis*, which comprised almost one-third of the Crustacea, were in this stratum. Cyclops was the only crustacean found below 30 m.

The maximum number of nauplii per cubic meter of water was found between 15 and 20 m. A large number of nauplii was found in the 20–30 m. stratum, but there was a rapid decrease in numbers below 30 m.

Rotifers were found in greatest abundance between 5 and 10 m. *Polyarthra platyptera* was the predominant rotifier and was found at all depths. All of the Conochilus were between 5 and 15 m. *Notholca longispina* was most abundant in the 10–20 m. stratum.

The maximum number of algæ per cubic meter of water, consisting of Microcystis and Aphanocapsa, was in the 0–5 stratum. Only a comparatively few algæ were found below the thermocline. Asterionella was the only diatom found above and Cyclotella the only one found below the thermocline. No diatoms were found below 20 m.

LAKE WILDWOOD, WASH.

The Crustacea were most abundant above the thermocline, especially between 3 and 6 m. *Diaptomus oregonensis* was confined to the upper 6 m. *Cyclops bicuspidatus*, which composed 70 per cent of the Crustacea, was found at all depths. The lack of free oxygen below 20 m. may account for the rise in the number of Crustacea in the 12–17 m. stratum. (See Table 12, p. 135.)

The nauplii were well distributed throughout the lake, with the maximum number per cubic meter of water between 6 and 9 m. Fully one-third of the nauplii were in this stratum.

The major portion of the Rotifera in Lake Wildwood was below the thermocline, with the largest number per cubic meter of water between 9 and 12 m. Over one-third were Triarthra, and almost one-half were *Polyarthra platyptera*. All of the Conochilus were above 6 m.

Ceratium was most abundant in the 3–6 m. stratum. A few Dinobryon were found in the 0–3 m. stratum. Asterionella comprised the major portion of the diatoms.

LAKES IN CALIFORNIA AND OREGON.

CRATER LAKE, OREG.

Crater Lake is situated in the Cascade Mountains of Oregon. It is 104 km. (65 miles) north of Klamath Falls and 128 km. (80 miles) east of Medford.

The lake occupies a geologically recent caldera in a now extinct volcano, Mount Mazama (Diller, 1897, 1912). In most places its shores rise sheer to 300 m. (1,000 feet) above the lake, and there were but few places where the water could be reached without building trails. The lake is nearly round, with an average diameter of about 8 km. (5 miles). The area of the lake is given (Diller, 1897) as 64.4 km.² (25 square miles), and its drainage basin adds but 15.5 km.² (6 square miles) to this.

The elevation of the surface of the lake (U. S. Geological Survey map, 1911) is given as 1,883 m. (6,177 feet). The elevation of the rim varies from 2,073 to over 2,498 m. (6,800 to 8,200 feet). The precipitation at the lake is said to be from 152 to 177 cm. (60 to 70 inches), mostly in the form of snow. The lake has no inlets and no known outlets, and still the water is soft. Total residue is 80 parts per million. Walton Van Winkle and N. M. Finkbinder (1913) of the U. S. Geological Survey, Salem, Oreg., have published an analysis of the water, which varies but little from many of the soft-water lakes, from which the following is quoted:

> That the analysis really shows concentration almost identical with that of other surface waters of the region is explained, however, by the fact that no sedimentary materials are exposed, the andesites, dacites, and basalts forming the basin of the lake, being nearly insoluble in the cold water, and, therefore, incapable of rapidly increasing its content of mineral matter. Concentration of chlorides is great as compared with that of other materials, an indication of the concentrated character of the water. As the published analyses of rocks indicate that almost no chloride exists in these formations, it is possible that the high percentage of that radicle in the water is due almost entirely to accumulated "cyclic" chlorine precipitated with the rain and snow. The unexpectedly high percentage of sulphates is possibly caused by solution of sulphur that remained in the bottom of the caldera in a more or less oxidized condition at the cessation of active volcanism. No other features of the analysis seem unusual, when it is compared with the accompanying analyses of waters collected from Wood and Rogue Rivers in the same season.

The water of Crater Lake is a deep clear blue. The 12 cm. Secchi disk was read at 25 m. August 1, 1913, and 27 m. September 5, 1913, and Diller (1897) states that "a white dinner plate 10 inches in diameter may be seen at a depth of nearly 100 feet." This agrees fairly well with the above results.

The greatest depth recorded is 608.4 m. (1,996 feet). On our first trip we found bottom at 602 m. with our sample line and the second trip at 600 m. Since the line had not been corrected for this depth and weight, we were probably nearer the deepest water than these results indicate.

Originally there were no fish in Crater Lake. W. G. Steel (1907), S. S. Nicoline, and E. D. Dewart carried rainbow-trout minnows from Gordans ranch 41 miles to the lake. Thirty-seven were placed in the lake September 1, 1888. The first trout were caught in 1901. Others have been planted since that date, and the lake now (1913) offers some of the best trout fishing we have ever enjoyed.

TEMPERATURES.

The low surface temperature (11.7 to 12.1° C.) of Crater Lake is readily accounted for when we consider its altitude and latitude, together with the facts that it occupies a deep basin that collects large quantities of snow during the winter and that the summer heat is not sufficient to completely melt this snow. On August 1, 1913, large banks of snow were very plentiful from the top of the rim to the surface of the lake. On September 1 much snow could still be found in the shady places. The small amount of warm weather at this place is best shown by the facts that in the same year the rim was first reached on foot July 4 and that the first autos arrived on July 20 by a road shovelled through the snow. When we left on September 5 it was freezing at night on the rim, and snow was expected at any time. In 1912 a heavy snow fell during the first week in September. The high wall of the crater helps to protect the snow from the sun. The high walls surrounding the lake protect it from the direct rays of the sun during the early morning and late evening, but this is of small consequence, because the early morning sun and the late evening sun furnish but a small percentage of the total heat for the day (Kimball, 1910).

Although only two surface temperatures were taken, it seems that the latter, 12.1° C., must be very near the maximum surface temperature, unless it was a little higher before the storm, which lasted for four days immediately preceding September 5. During this period the waves ran so high that we were unable to go on the lake with a 25-foot launch. This storm is mentioned here because it may have lowered the surface temperature by mixing the epilimnion and increasing the temperatures just below the surface, and it also gives some idea of the winds in this crater. The first thought is that there would be little wind in such a depression, but such does not seem to be the case, as on this occasion the lake appeared as completely covered with whitecaps as other lakes of similar size. If these windstorms were common one would expect a thermocline, but as the maximum difference in temperature between the surface and bottom of the lake is only 8.6° C. there is very little chance for a definite thermocline. The temperature drops gradually as far down as 70 to 100 m., where it reaches 4° C., the temperature of water at maximum density and at atmospheric pressure. This is the lowest temperature found in any of the deep lakes of the United States during the summer season. In Crater Lake the temperatures at 100 m. and below are less than 4° C.

These temperatures were checked with all possible care, using a standardized Negretti-Zambra thermometer, which was then checked at the University of Washington. For the second set of readings a Schmidt-Vossberg (Berlin) thermometer was used with the one above mentioned. The Schmidt-Vossberg instrument was calibrated to 0.1° C. and contained a small thermometer to give the temperature of the mercury column, so that the correction for the expansion of the latter could be applied. After numerous trials more concordant results were obtained by reading it at the temperature of the surface water. This thermometer was not standardized when used on Crater Lake, but the correction was afterwards determined and applied.

TABLE 9.—*Temperatures taken at 100 m. and below, Crater Lake, Oreg., 1913.*

Depth in meters.	Negretti-Zambra thermometer.		Schmidt-Vossberg thermometer.	Depth in meters.	Negretti-Zambra thermometer.		Schmidt-Vossberg thermometer.
	Aug. 1.	Sept. 5.	Sept. 5.		Aug. 1.	Sept. 5.	Sept. 5.
	°*F.*	°*F.*	°*C.*		°*F.*	°*F.*	°*C.*
100	38.9		3.9	400		38.2	
200	38.4			500	38.3		3.45
300	38.2		3.45	500			3.5
300			3.5	600	38.3	38.3	3.5

A temperature below 4° C., although not found in any other fresh-water lake in the United States during the summer season, is readily explained by the table of temperatures of water at maximum density under pressure in Landolt-Börnstein's Physical Chemistry Tables. Hamberg (1911) copies the above-mentioned table and concludes that we should have many examples of temperatures below 4° C. in the deep fresh-water lakes. As he says, 10 m. of water adds, roughly, one atmosphere of pressure. When this is considered, together with the table that gives the temperature of maximum density at 10.5 atmospheres as 3.4° C., 41.6 atmospheres 3.3° C., 93.3 atmospheres 2° C., one would expect even much lower temperatures than those found in Crater Lake. Hamberg then gives the temperatures of several Alpine lakes, the bottom water of which is below 4° C., but in no case is the temperature as low as those given in the above table for the same pressure.

NET PLANKTON.

The limnetic zooplankton consisted almost entirely of *Daphnia pulex*. *Bosmina longispina* was found between 100 and 150 m. The largest number of Daphnias per cubic meter of water was found in the 60–80 m. stratum of the lake in August and in the 50–60 m. stratum in September. In August no Daphnias were found above 40 m., but in September a few were found between 30 and 40 m. There seemed to be more Daphnias in September than in August. (See fig. 19.)

No nauplii were found.

The Rotifera consisted largely of Asplanchna, with a few *Notholca longispina* and *Anuræa aculeata*. The maximum number of Rotifera per cubic meter of water was found in the 60–80 m. stratum in August and in the 80–100 m. stratum in September. No Rotifera were found above 30 or below 200 m.

A very small filamentous alga, probably Mougeotia, was found in fairly large numbers in Crater Lake. It was similar to the predominant alga found in Lake Tahoe, Calif. Its vertical distribution, also, was very much like that of Lake Tahoe alga, with the maximum number per cubic meter of water below 60 m. in both lakes. In Crater Lake the maximum number per cubic meter of water was between 60 and 80 m. in August and 100 to 150 m. in September.

Asterionella was the only diatom found in the lake. In August the maximum number per cubic meter of water was found between 150 and 200 m.; in September, between 100 and 150 m.

As a whole, the limnetic plankton was rather limited in supply. Around the shores of Wizard Island swarms of Daphnias were seen, and this may account to some extent for the fact that most of the trout were caught along the shores of the island.

FALLEN LEAF LAKE, CALIF.[1]

Fallen Leaf Lake, a small beautiful mountain lake, is situated just south of Lake Tahoe, into which it empties through a stream that is now dammed for power. The lake is 6.5 km. long in a north and south direction by 2 km. east and west and has an elevation of 1,939 m. (6,360 feet), which places it 42 m. above Lake Tahoe. It lies just at the east slope of Mount Tallac, from which it receives a number of small mountain streams. It also receives a large amount of water from the mountains that lie to the south of it.

[1] We visited Fallen Leaf Lake during a rain that raised the level of the lake 15 cm. This may have reduced the clearness and changed the composition of the surface water.

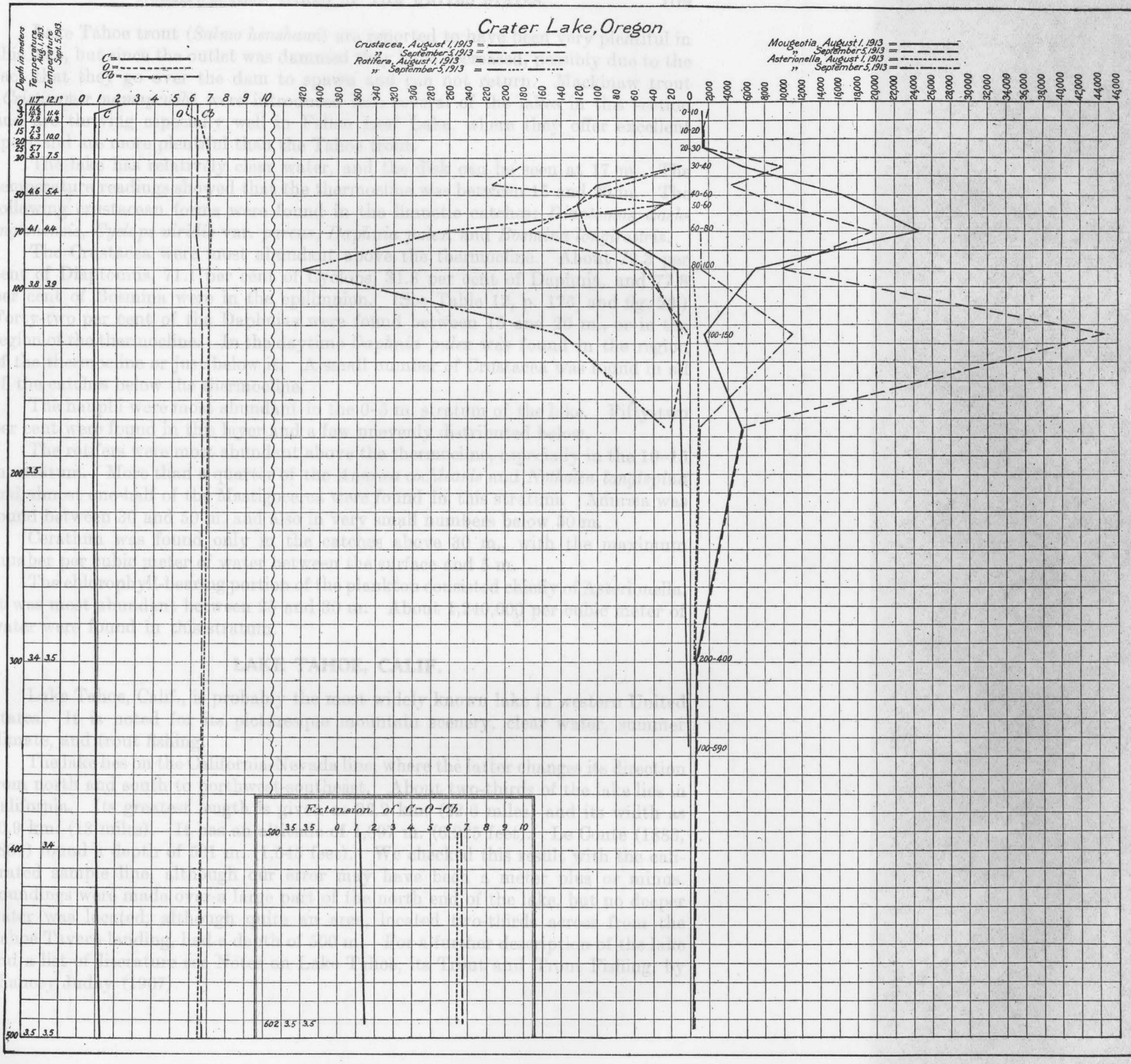

FIG. 19.—Curves for Crater Lake, giving the temperature, dissolved gases, and plankton at various depths. *C*, free carbon dioxide; *Cb*, fixed carbon dioxide; *O*, oxygen; each given in cc. per liter. Plankton numbers are per cubic meter of water.

Lake Tahoe trout (*Salmo henshawi*) are reported to have been very plentiful in this lake, but since the outlet was dammed they have decreased, possibly due to the fact that they go over the dam to spawn and can not return. Mackinaw trout (*Cristivomer namaycush*) were introduced into several of the lakes in this section and are thriving especially well in Fallen Leaf Lake, where they offer excellent sport and are more plentiful than the Tahoe trout.

The lake has relatively clear water, and the disk can be seen at 17 m. The temperature readings showed that the thermocline was between 15 and 20 m. The following crustacean forms were found in the limnetic catches: *Diaptomus washingtonensis*, *Cyclops viridis* var. *parcus*, *Daphnia pulex*, and *Bosmina longirostris*.

The Crustacea were most abundant above the thermocline. About 79.3 per cent of Diaptomus, 71.1 per cent of Cyclops, 31.8 per cent of Daphnia, and 77.8 per cent of Bosmina were in the epilimnion. (See Table 12, p. 126, and fig. 20.) Forty-two per cent of the Daphnias were found between 15 and 20 m., or in the region of the thermocline. In the daytime *Daphnia pulex* was found in the region of the thermocline or just below it. A small number of Crustacea was found in all of the catches below the thermocline.

The nauplii were most abundant in the 0–5 m. stratum of the lake. Fifty-two per cent were found in this layer and a few unevenly distributed below.

The rotifers were most abundant above the thermocline, especially in the 10–15 m. stratum. More than a quarter of the *Anuræa cochlearis* and *Notholca longispina* and almost one-half of the Mastigocerca were found in this stratum. Anuræa was found between 30 and 50 m. and also in very small numbers below 50 m.

Ceratium was found only in the catches above 30 m., with the maximum number per cubic meter of water between the surface and 5 m.

The chlorophyll-bearing portion of the plankton consisted chiefly of Asterionella. It was most abundant between 25 and 30 m. About 1,240,000 per cubic meter of water were found in this stratum.

LAKE TAHOE, CALIF.

Lake Tahoe, Calif., is probably the most widely known lake in western United States. It is noted for its picturesque mountain scenery, clear water, summer climate, and trout fishing.

The lake lies on the California-Nevada line, where the latter changes its direction from north and south to northwest-southeast. About two-thirds of the lake lies in California. Its greatest length is given as 36.2 km. (22.6 miles) and its width as 20.9 km. (13 miles). It has an altitude of 1,897 m. (6,225 feet). Le Conte (1883, 1884) found a depth of 501 m. (1,645 feet). We checked this result with the calibrated sample line, although our error may have been a meter plus or minus. Soundings were made over a large part of the north end of the lake, but no deeper water was located, although quite an area, located two-thirds across from the Tahoe Tavern landing, had a depth of 500 m. For a further description of the lake and a list of literature see Notes on Lake Tahoe, its Trout and Trout Fishing, by Chancey Juday (1907).

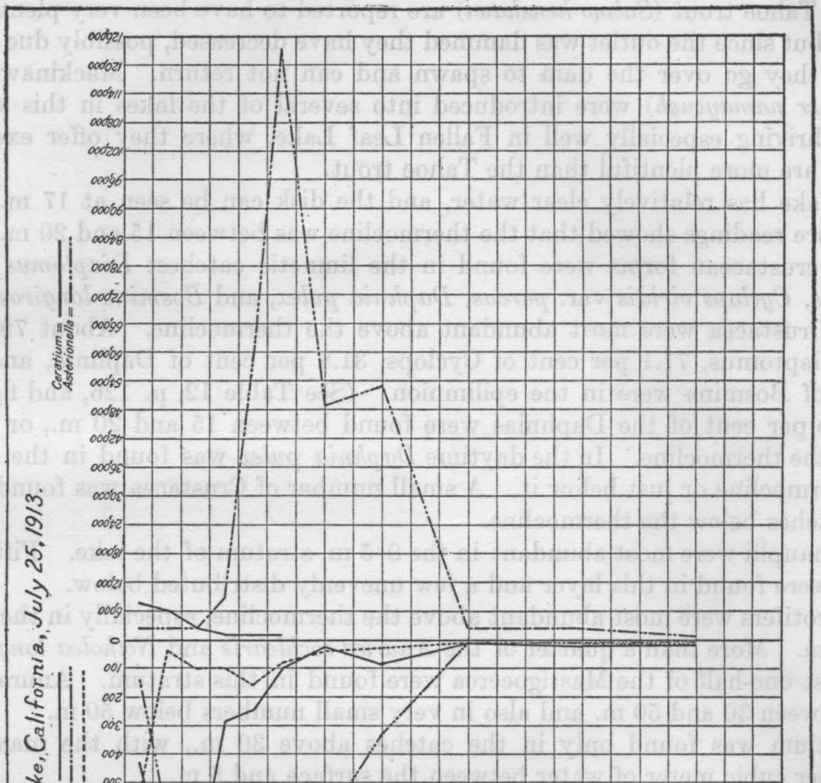

FIG. 20.—Curves for Fallen Leaf Lake, giving the temperature, dissolved gases, and plankton at various depths. *C*, free carbon dioxide; *Cb*, fixed carbon dioxide; *O*, oxygen; each given in cc. per liter. Plankton numbers are per cubic meter of water.

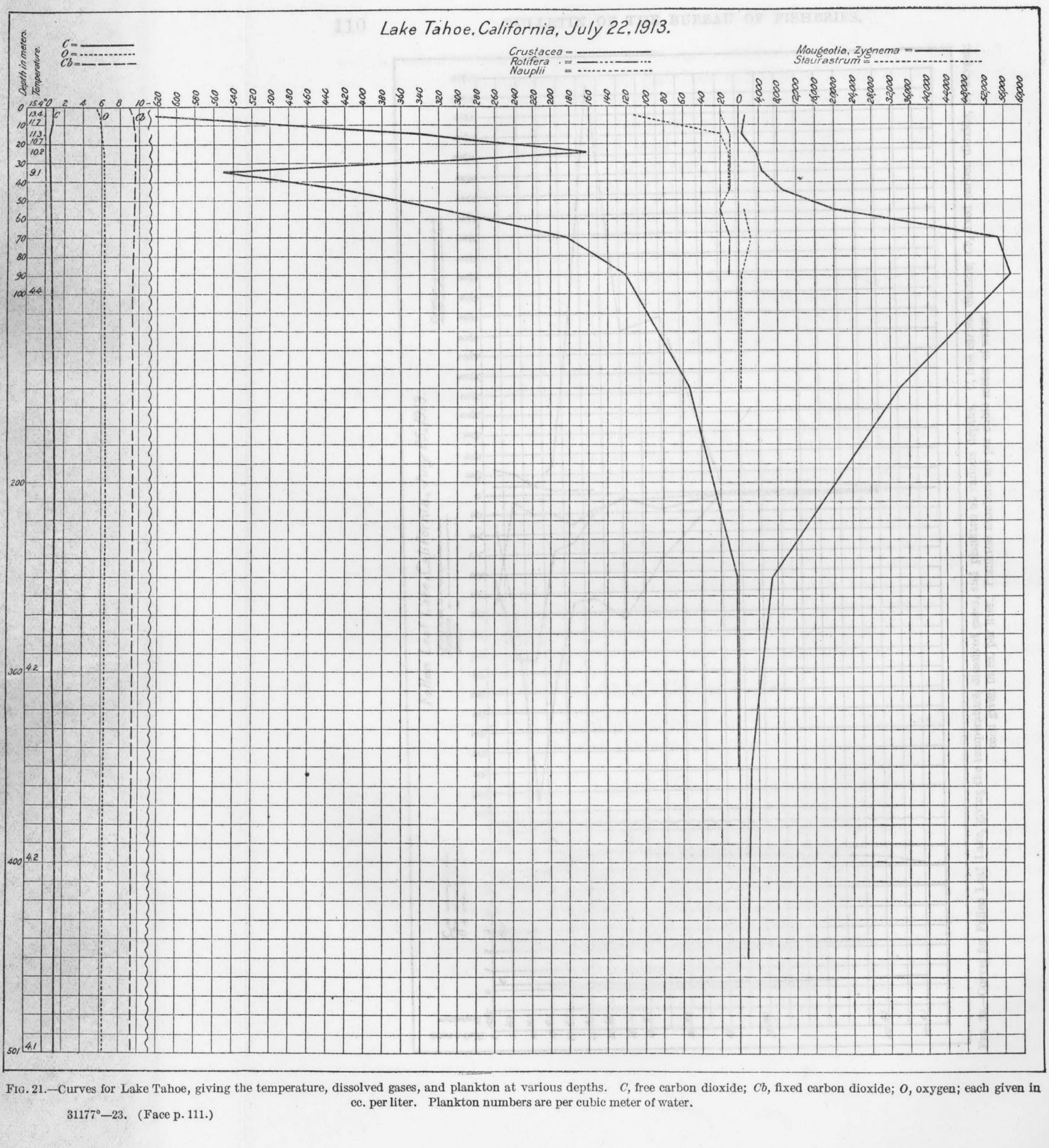

FIG. 21.—Curves for Lake Tahoe, giving the temperature, dissolved gases, and plankton at various depths. *C*, free carbon dioxide; *Cb*, fixed carbon dioxide; *O*, oxygen; each given in cc. per liter. Plankton numbers are per cubic meter of water.

31177°—23. (Face p. 111.)

TEMPERATURES.

Le Conte (1883, 1884) took a very complete series of temperatures of this lake August 11 to 18, 1873. He used a Six self-registering thermometer, which he compared with a standard and applied corrections. Juday (1907) determined the temperature to the depth of 425 feet in June, 1904. These are arranged in Table 8 with our July 22, 1913, set for comparison.

The low surface temperature (15.4° C.) would be expected in a large deep mountain lake with an elevation of 1,897 m. (6,225 feet). The temperature decreases gradually to 100 m., from which point to the bottom the temperature varies only a fraction of a degree. The bottom temperature was 4.1° C., or within 0.1° C. (our limit of error) of the generally accepted temperature of water at its greatest density. Le Conte's (1883, 1884) temperature of the bottom water is 4° C.

TABLE 10.—*Temperatures taken at various depths, Lake Tahoe, Calif., 1873, 1904, and 1913.*

Depth.		August, 1873.[1]	June, 1904.[2]	July 22, 1913.	Depth.		August, 1873.[1]	June, 1904.[2]	July 22, 1913.
Feet.	*M.*	*° F.*	*° F.*	*° F.*	*Feet.*	*M.*	*° F.*	*° F.*	*° F.*
0	0	67	60.75	59.8	200	61	48	41.75	....
16	5	....	....	56.1	250	76	47	....	....
23	7	....	....	55.2	300	91	46	41.25	....
25	7.6	....	57	....	330	100	45.5	....	39.9
26	8	....	....	55	400	122	45	40.8	....
29.5	9	....	....	54	425	....	....	40.8	....
32.8	10	....	....	53	480	....	44.5	....	....
50	15	63	55.25	52.3	500	152	44	....	....
65.6	20	....	....	51.3	600	182	43	....	....
75.0	22.8	....	54.75	....	772	244	41 B	....	....
82	25	....	....	50.3	....	300	....	....	39.5
100	30	55	49.75	48.4	....	400	....	....	39.5
125	38	....	46	....	1,506	459	39.2 B	....	....
150	46	50	....	....		501		....	39.4 B

[1] Le Conte (1883, 1884). [2] Juday (1907).

PLANKTON.

Both *Daphnia longispina* var. *hyalina*, form *richardi*, and *Daphnia pulex* were found and comprised the limnetic Cladocera. They did not occur in catches above 50 m. These two forms constituted less than 1 per cent of the total number of plankton Crustacea.

The maximum number of copepods per cubic meter of water was found in the 0–10 m. stratum, where there were more than 6,000 Epischura and Diaptomi per cubic meter of water. Although the lake is more than 500 m. deep, almost one-fourth of the Crustacea (22.6 per cent) were found in the 0–10 m. stratum. There was a decrease in the number of Crustacea in the 10–30 m. stratum, with a rapid increase between 30 and 50 m. Below 50 m. the number decreased rapidly, and below 200 m. only a few were found.

There were very few nauplii found in Lake Tahoe, and they were confined largely to the 0–10 m. stratum. About 67 per cent were in this region of the lake. (See Table 12, p. 133, and fig. 21.) They decreased very rapidly below 10 m., and none was found below 80 m.

The only rotifier found was *Notholca longispina*, which occurred in very small numbers and was confined to the upper 100 m. of the lake.

The phytoplankton consisted of one desmid—Staurastrum—and two filamentous forms—Mougeotia and Zygnema. The Mougeotia, however, comprised the major portion of the limnetic plant life. The maximum number of algæ per cubic meter of water was found between 60 and 100 m. The maximum number of Staurastrum per cubic meter of water was found between 60 and 80 m. This desmid was not found in the catches above 20 m. Below 80 m. the number of Staurastrum decreased very rapidly, and below 200 m. very few were found.

DIURNAL MIGRATION.

On July 23 some observations were made on the diurnal migration of the Crustacea in Lake Tahoe. Plankton catches were taken at 5 a. m., 10 a. m., 4 p. m., and 9 p. m. (See Table 12, p. 133.) At 5 a. m. while it was cloudy and dark the maximum number of copepods per cubic meter of water was found in the 10–15 m. stratum. It remained dark and cloudy all morning, and it was raining at 10 a. m. when the second catch was made. At that time there was a somewhat smaller number of copepods in the 0–5 m. stratum, but the maximum number per cubic meter of water was still between 10 and 15 m.

About noon the sun came out and shone brightly during the afternoon. A third set of catches was made about 4 p. m., which showed a relatively larger number of copepods in the 0–5 m. stratum, with the maximum number per cubic meter of water between 5 and 10 m. With the decreasing amount of sunlight toward evening, the copepods began to move toward the surface, for 21.8 per cent of the number was found in the 5–10 m. stratum. At 9 p. m. the catch showed the maximum number per cubic meter of water to be in the 0–5 m. stratum. About 41 per cent of the copepods were in this layer of the lake, showing a decided upward migration.

The maximum number of nauplii per cubic meter of water was found in the 0–5 m. stratum in every catch. Apparently they showed no diurnal movement.

UPPER KLAMATH LAKE, OREG.

The upper lake lies north of the city of Klamath Falls. Its greatest length is nearly 56 km. (35 miles), and its width varies from 4 (2.5 miles) to 20 km. (12.5 miles). Most of the lake is very shallow. The launches stir up the bottom mud for the greater part of the trip up the lake, although they travel in the deepest water to be found. The deepest place is near Eagle Ridge, where an area of several square kilometers has a depth of 8 m. In the channel between the south end of Bear Island and the shore we found 11 m. of water over a small area.

The lake is noted for its rainbow trout (*Salmo irideus*) fishing, which, considering the very warm water (see p. 120) and the abundant growth of algæ, appeared interesting. Two trout that weighed from 4 to 5 pounds each were caught near Eagle Ridge. They took a small spoon readily (they would not take a fly, but were reported as doing so earlier in the season) and fought well. The flesh seemed hard and firm, but when cooked it had a very marked weedy taste similar to the trout from Henry Lake, Idaho. The best fishing was reported at the mouth of the streams where the colder water occurred.

Because of the shallowness of this lake, the phytoplankton flourishes and tends to decrease very materially the transparency of the water. The Secchi disk disappeared from view at a depth of less than 1 m. The lake was so shallow that the waves kept the water in circulation from top to bottom, and no thermocline had formed.

The largest number of Crustacea per cubic meter of water was found in the bottom stratum of the lake. Fully 70 per cent of the Crustacea at this depth were *Diaphanosoma leuchtenbergianum*. *Diaptomus ashlandi* was most abundant in the 0–2 m. stratum. (See fig. 22.)

Nauplii were most abundant in the 4–6 m. stratum of the lake, about 37 per cent of the total number being found there.

The maximum number of Rotifera per cubic meter of water was found in the 0–2 m. stratum. Forty per cent of the Triarthra, 33.3 per cent of the Mastigocerca, and 46.4 per cent of the *Anuræa cochlearis* were in this layer. (See Table 12, p. 134.) The green and blue-green algæ in Upper Klamath Lake consisted of Microcystis, Aphanocapsa, Staurastrum, Anabæna, and Pediastrum; the maximum number was found between 4 and 8 m. There were over 20,000,000 algæ per cubic meter of water in this region of the lake. The maximum number of diatoms per cubic meter of water, consisting of Cyclotella, Melosira, and Navicula, was found in the 0–2 m. stratum, where there were over 19,000,000 per cubic meter of water.

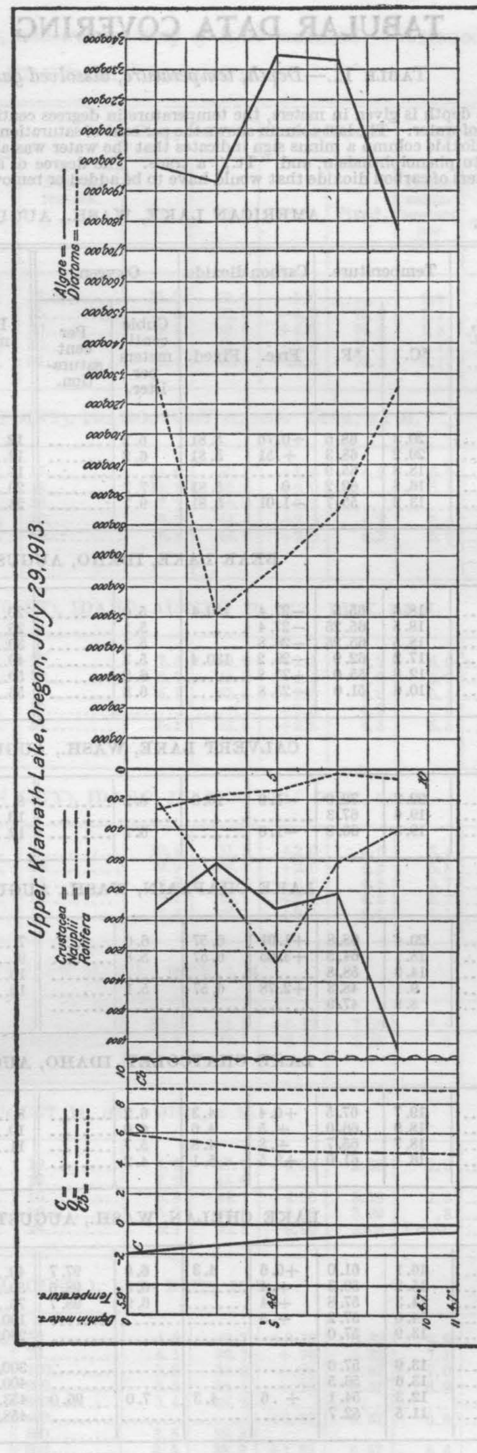

FIG. 22.—Curves for Upper Klamath Lake, giving the temperature, dissolved gases, and plankton at all depths. *C*, free carbon dioxide; *Cb*, fixed carbon dioxide; *O*, oxygen; each given in cc. per liter. Plankton numbers are per cubic meter of water.

TABULAR DATA COVERING ALL LAKES EXAMINED.

TABLE 11.—*Depth, temperature, dissolved gases, and transparency of lakes examined.*

[The depth is given in meters, the temperature in degrees centigrade and Fahrenheit, and the gases in cubic centimeters per liter of water. The last column shows the per cent of saturation of the oxygen for a few of the important lakes. In the free carbon dioxide column a minus sign indicates that the water was alkaline, a plus sign that it was acid, a "neut." that it was neutral to phenolphthalein, and "Tt.," a trace. The degree of alkalinity or acidity is indicated by the number of cubic centimeters of carbon dioxide that would have to be added or removed to make the water neutral.]

AMERICAN LAKE, WASH., AUGUST 29, 1913. DISK, 5.25 M.

Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.		Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.	
	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.		°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	20.3	68.6	+0.76	5.81	6.2		12	10.6	51.0	−1.01	5.81	9.8	
5	20.2	68.3	+.51	5.81	6.2		13	9.1	48.3				
9	18.8	65.9					15	7.8	46.3	+2.02	5.81	6.9	
10	16.8	62.2	0	5.81	7.7		20			+6.83	5.81	1.1	
11	13.2	55.7	−1.01	5.81	9.7		26	6.9	44.4	+8.09	5.81	0	

BEAR LAKE, IDAHO, AUGUST 8, 1912. DISK, 10 M.

Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.		Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.	
	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.		°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	18.6	65.5	−27.4	130.4	5.0		20	8.9	48.0	−25.2		7.0	
5	18.5	65.25	−27.4		5.1		25	7.1	44.9	−24.8	130.4	7.2	
10	18.5	65.25	−26.8		5.1		30	6.1	43.0	−24.8		7.2	
13	17.2	62.9	−26.2	130.4	5.3		40	5.0	41.0	−25.4		7.1	
15	12.8	55.0	−25.8		6.2		50	4.6	40.2	−24.8	130.4	6.9	
17	10.6	51.0	−25.8		6.8		56	4.5	40.1	−26.2	130.4	6.6	

CALVERT LAKE, WASH., AUGUST 23, 1911. DISK, 2 M.

Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.		Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.	
	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.		°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	22.2	72.0	−1.0	26.3	6.2		8	18.9	66.0	Neut.	26.3	5.5	
3	19.6	67.3					10	14.9	58.8	+3.0	26.3	4.1	
5	19.3	66.8	−1.0		6.1		12	14.7	58.5	+10.6	29.6	.5	

LAKE CHAPLAIN, WASH., AUGUST 26, 1913. DISK, 3.5 M.

Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.		Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.	
	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.		°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	20.4	68.8	+1.01	6.57	6.0		7	8.1	46.6	+5.56	6.57	2.0	
3	18.1	64.5	+3.03	6.57	5.8		9			+7.58	7.88	.8	
4	14.9	58.8					10	7.3	45.1				
5	9.1	48.3	+2.78	6.57	5.1		12	6.8	44.2			.2	
6	8.8	47.9											

LAKE CHATCOLET, IDAHO, AUGUST 22, 1912. DISK, 3 M.

Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.		Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.	
	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.		°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	19.7	67.5	+0.4	4.3	6.2		8	14.4	58.0	+5.6	5.3	0.9	
3	18.9	66.0	+.5	4.6	6.0		10	13.3	56.0	+6.8	7.3	.9	
5	18.7	65.7	+.8	4.8	5.7		11	12.2	54.0	+9.4	8.6	.0	
7	16.1	61.0	+2.5	5.1	4.2								

LAKE CHELAN, WASH., AUGUST 10-14, 1911. DISK, 14.25 M.

Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.		Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.	
	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.		°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	16.1	61.0	+0.6	4.3	6.6	97.7	40	10.6	51.0				
5	15.2	59.3	+.4		6.8	98.6	50	9.5	49.1	+0.8		7.4	95.0
10	14.3	57.8	+.4		6.9	98.7	75	7.2	45.0	+.8	4.3	7.6	102.0
15	14.0	57.2	+.5				100	6.7	44.0	+.8		7.5	90.4
20	13.9	57.0					200	5.9	42.6	+.8	4.3	7.6	90.0
22.5	13.9	57.0					300	5.6	42.1	+.8	4.3	7.5	88.0
24	13.6	56.5					400						
25	12.3	54.1	+ .6	4.3	7.0	96.0	453	5.6	42.1	+1.1	4.3	7.5	88.0
30	11.5	52.7					458	5.9	42.7	+1.1	4.4	7.6	90.0

TABLE 11.—*Depth, temperature, dissolved gases, and transparency of lakes examined*—Continued.

CLEAR LAKE, WASH., JULY 27, 1911. DISK, 3.5 M.

Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.	Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.
0	23.1	73.5	−10.6	77.1	6.2		12.5	15.0	59.0	−5.0		2.1	
5	21.9	71.5	−11.6	76.6	6.2		15	12.8	55.0	−4.6	75.8	2.1	
8	15.6	60.0	−9.6		6.2		20	9.8	49.6	+4.3	76.6	1.3	
10	16.9	62.5	−4.6	73.3	2.9		30	9.4	49.0	+6.6	76.6	0.13	
11	16.7	62.0	−5.0		2.5		34	9.4	49.0	+10.4	76.9	0.17	

LAKE COEUR D'ALENE (OFF 3-MILE POINT), IDAHO, JULY 11, 1911. DISK, 3.1 M.

Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.	Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	16.7	62.0	+0.5	4.8	5.5		17	11.6	52.8	+1.8	4.3	5.5	
3	16.1	61.0	+.5	4.8	5.7		18	11.1	52.0	+2.0		5.5	
5	16.0	60.8	+.5	4.3	6.0		30	7.2	45.0	+2.5			
10		60.4			5.7		50	6.9	44.4	+2.5	4.3	5.4	
12	15.7	60.2	+.8	4.3			56	6.8	44.2	+2.5	4.3	5.6	
16	15.0	59.0	+1.0	4.3	5.4								

LAKE COUER D'ALENE (OFF 3-MILE POINT), IDAHO, AUGUST 21, 1912. DISK, 3.5 M.

Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.	Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	19.4	67.0	+0.3	2.5	6.0		20	7.8	46.0	+2.5	4.3	6.0	
5	18.9	66.0	+.3	2.5	6.0		30	6.7	44.0	+2.5	4.3	5.9	
10	16.7	62.0	+.5	3.8	5.8		40	6.1	43.0	+2.5	4.3	5.5	
12	13.3	56.0	+1.0	3.8	5.9		50			+2.5	4.3	5.6	
13	12.2	54.0	+1.3	3.8	6.0		54	6.1	43.0	+2.8	4.3	5.5	
15	10.0	50.0	+1.8	4.0	5.7								

LAKE COEUR D'ALENE (OFF HARRISON CITY), IDAHO, JULY 10, 1911. DISK, 1.25 M.

Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.	Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	15.6	60.0	+0.8	4.8	6.1		9	10.8	51.5	+2.0	4.6	5.4	
3	15.5	59.9	+.8	4.8	6.2		10	9.9	49.8	+2.0	4.3	5.8	
5	15.3	59.5	+1.3	4.8	6.0		13	8.9	48.0	+2.0	4.8	5.7	
7	14.9	58.8		5.0	5.7		16	8.1	46.5	+2.0	4.8	6.2	
8	14.4	58.0	+1.8	4.8	5.8		19	7.8	46.1	+2.0	5.1	6.1	

COTTAGE LAKE, WASH., AUGUST 13, 1913. DISK, 1 M.

Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.	Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	20.3	68.6	+3.03	7.58	6.1		5	10.8	51.5	+6.32	7.58	0.5	
2	19.2	66.5					8	8.6	47.5	+6.32	7.58	.2	
3			+3.03	7.58	3.5								

COW LAKE, WASH., AUGUST 14, 1913. DISK, 5 M.

Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.	Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	20.3	68.6	+0.50	3.29	5.0		10	8.4	47.1	+4.30	3.29	2.6	
5	20.3	68.6	+.50	3.29	4.6		12	7.2	45.0				
6	17.3	63.2	+1.26	3.29	4.8		15	6.8	44.1	+4.30	3.29	2.8	
7	12.6	54.7					20	5.7	42.3	+5.06	3.29	.8	
8	10.0	50.0	+2.53	3.29	2.8		24	5.7	42.3	+6.90	3.03	Trace.	

CRATER LAKE, OREG., AUGUST 1, 1913. DISK, 25 M.

Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.	Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	11.7	53.0	+2.28	6.32	5.8	95.2	50	4.6	40.3	+0.76	6.32	6.9	95.8
3	11.6	52.9					70	4.1	39.3	+.76	6.32	7.1	97.4
5	10.2	50.3	+.76	6.32	5.7	90.5	100	3.8	38.9	+.76	6.57	7.0	95.2
10	7.9	46.3	+.76	6.32	6.5	91	200	3.5	38.4	+.76	6.57	6.9	93.3
15	7.3	45.2	+.76	6.32	6.6	98	300	3.4	38.2				
20	6.3	43.4	+.76	6.32	6.7	97.1	400			+1.01	6.57	6.6	
25	5.7	42.3					500	3.5	38.3				
30	5.3	41.5	+ .76	6.32	7.0	99	602	3.5	38.3	+1.52	6.57	6.4	86.2

TABLE 11.—*Depth, temperature, dissolved gases, and transparency of lakes examined*—Continued.

CRESCENT LAKE, WASH., AUGUST 17, 1913. DISK, 15 M.

Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.	Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.
0	16.4	61.6	+0.76	9.86	6.3	....	22	10.8	51.5	....	....	....	....
5			+.76	9.86	6.4	....	25	9.5	49.1	+0.76	10.11	8.3	....
10	16.4	61.6	+.76	10.11	6.4	....	30	7.9	46.2				
15	16.4	61.6	+.76	10.11	6.3	....	50	6.2	43.2	+1.01	10.11	7.5	....
17	15.0	59.0	....	....	....	....	70	5.9	42.6			7.4	....
18	13.8	56.9	+.76	10.11	7.0	....	100	....	....	+1.01	10.11	7.1	....
19	13.0	55.4	....	....	....	....	150	5.6	42.1	+1.52	10.11	7.3	....
20	12.4	54.4	+.76	10.11	7.4	....	175	5.6	42.1	+2.02	10.37	6.3	....

DEER LAKE, WASH., JULY 29, 1911. DISK, 6.5 M.

0	22.2	72.0	−0.5	7.1	5.9	....	12	12.3	54.2	Neut.	....	7.7	....
5	21.1	70.0	−Tr.	....	6.1	....	15	11.1	52.0	+0.6	6.8	6.9	....
10	16.1	61.0	−Tr.	6.8	8.0	....	20	8.1	46.5	+1.8	7.1	5.5	....
11	13.9	57.0	−Tr.	....	7.7	....	25	5.6	42.0	+6.6	7.6	0.8	....

FALLEN LEAF LAKE, CALIF., JULY 25, 1913. DISK, 17 M.

0	14.9	58.8	+0.25	3.03	5.4	....	20	8.5	47.3	+0.25	2.28	6.4	....
5	14.9	58.8	+.25	2.53	5.3	....	22	7.8	46.0	+.25	2.28	6.7	....
7	14.9	58.8	....	....	....	....	25	6.5	43.7	+.25	2.28	6.8	....
10	14.3	57.7	+.25	2.53	5.1	....	30	5.6	42.1	+.25	2.28	6.9	....
12	13.8	56.9	....	....	....	....	40	5.1	41.1	+.25	2.28	6.8	....
15	12.6	54.7	+.25	2.28	6.1	....	50	4.6	40.3	+.25	2.28	6.7	....
17	11.3	52.4	....	....	....	....	70	4.2	39.6	+.25	2.28	6.7	....
18	11.6	52.9	+.25	2.53	6.2	....	100	4.1	39.3	+.38	2.28	6.5	....
19	9.8	49.6	....	....	....	....	110	4.1	39.3	+.51	2.28	6.2	....

FISH TRAP LAKE, WASH., SEPTEMBER 1, 1912. DISK, 1.8 M.

0	17.9	64.2	+1.8	23.8	2.7	....	7	17.8	64.0				
5	17.9	64.2	+1.8	23.8	2.5	....	8	17.8	64.0	+2.0	23.8	2.4	....

LAKE GOODWIN, WASH., AUGUST 27, 1913. DISK, 3.75 M.

0	19.8	67.6	+0.51	3.29	5.8	....	9	15.4	59.8	+3.29	3.29	2.7	....
5	19.8	67.6	+.76	3.29	5.9	....							

GREEN LAKE, WASH., AUGUST 9, 1913. DISK, 1 M.

0	21.4	70.6	−1.52	9.35	6.4	....	4.5	21.1	70.0	−1.01	9.35	5.8	....

HAYDEN LAKE, IDAHO, JULY 7, 1911. DISK, 7.0 M.

0	16.9	62.5	+0.8	6.1	6.0	93.8	15	7.8	46.1	+0.8	5.3	7.3	94.5
3	16.9	62.5	+.5	5.3	5.3	83.0	20	6.1	43.0	+1.0	5.3	7.3	90.3
8	16.7	62.1	+.5	5.3	5.8	90.4	30	5.9	42.6	+1.0	5.8	6.6	81.5
10	11.4	52.5	+.5	5.6	7.1	99.5	50	4.8	40.6	+2.0	5.6	6.7	80.4
12	10.6	51.0	+.5	5.3	7.3	101.0	57	4.7	40.5	+5.1	5.8	2.8	33.6

HAYDEN LAKE, IDAHO, AUGUST 26, 1911. DISK, 10.5 M.

0	19.9	67.9	+0.3	5.7	5.8	96.0	20	7.6	45.6	+0.4	....	7.7	98.5
3	19.7	67.5	+.4	5.7	5.7	94.5	30	5.4	41.8	+1.5	....	7.3	89.0
5	19.6	67.3	+.6	5.6	....	....	40	5.0	41.0	+2.0	....	7.0	84.4
8	19.6	67.3	+.5	....	5.7	94.8	50	4.7	40.5	+2.0	....	6.5	78.0
11	19.1	66.4	+.5	....	7.5	121.7	56	....	....	+3.3	5.6	5.2	62.0
13	13.1	55.6	+.4	5.6	7.8	111.8	57	4.6	40.3	+5.8	5.8	1.9	22.7
15	10.3	50.5	+.4	....	7.8	106.3							

TABLE 11.—*Depth, temperature, dissolved gases, and transparency of lakes examined*—Continued.

Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.		Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.	
	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.		°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
HAYDEN LAKE, IDAHO, AUGUST 25, 1912.													
0	20.0	68.0	+0.3	5.6	5.8		20	6.7	44.0	+0.8		7.9	
5	20.0	68.0	+.3		5.8		30	5.3	41.5	+1.9		6.5	
10	19.9	67.9			5.8		40			+1.9	5.6		
11	15.0	59.0	+.3	5.6	6.8		50			+2.8	5.6	5.4	
12	13.3	56.0	+.4		7.8		54			+4.0	5.6	3.1	
15	8.3	47.0	+.5		8.3		56	4.5	40.1	+4.2	5.6	1.4	
HENRY LAKE, IDAHO, AUGUST 12, 1912. DISK, 1 M.													
0	17.7	63.9	−1.0	22.2	5.2	98.8	1.5	17.3	63.2	−1.0	22.5	5.1	
LAKE KI, WASH., AUGUST 27, 1913. DISK, 6.25 M.													
0	19.9	67.8	+0.76	1.26	6.0		10	9.1	48.3	+2.28	1.26	6.0	
5	19.4	66.9	+.76	1.26	5.8		15	7.6	45.6	+4.05	1.26	3.9	
7	17.3	63.1					19			+4.55	1.26	3.6	
8	14.0	57.1	+1.01	1.26	6.6		20	7.3	45.2	+6.07	1.26	3.2	
9	10.2	50.4											
LIBERTY LAKE, WASH., JULY 31, 1911. DISK, 1.25 M.													
0	23.2	73.8	−1.0	3.8	5.8		8	18.6	65.5	+3.5	4.3	4.1	
3	21.6	70.9			5.8								
LOON LAKE, WASH., JULY 28, 1911. DISK, 8.5 M.													
0	22.2	72.0	−0.0	13.9	5.8		15	10.3	50.5	+0.3		7.5	
5	21.9	71.5	−1.0		5.8		20	7.5	45.5	+1.5		7.0	
10	18.4	65.2	−1.0	13.7	7.4		25	6.7	44.0	+3.0		5.2	
12	15.8	60.5	Neut.		7.1		30	5.8	42.5	+5.6	14.2	3.3	
13	13.3	56.0	Neut.		7.2		32	5.6	42.0	+5.3	14.2	2.6	
LOWER TWIN LAKE, IDAHO, AUGUST 2, 1911. DISK, 1.2 M.													
0	21.0	69.9	−2.0	3.0	6.9		10	10.3	50.6	+0.8	3.0	4.6	
3	20.7	69.2					12	9.4	49.0	+1.8	3.0	4.2	
5	16.6	61.9	−1.0		6.7		16			+8.3	4.0	.1	
8	13.0	55.4	−.5	3.0	5.7		19	8.8	47.8	+8.3	4.0	.1	
9	12.1	53.8	Neut.	3.0	5.0								
LUNA LAKE, WASH., AUGUST 24, 1913. DISK, 3 M.													
0	19.3	66.7	−5.06	10.87	6.9		10	6.1	43.0	+6.07	10.62	1.2	
3	19.1	66.4					15			+5.56	10.62		
5	17.2	62.9	−3.34	11.12	7.4		20	4.6	40.2	+6.07	11.12	.7	
6	11.6	52.9					25			+6.07	12.39	Trace.	
7	8.5	47.3	+4.80	11.12	4.2		28	4.6	40.2	+9.10	14.16	0	
8	8.4	47.1											
LAKE MARTHA, WASH., AUGUST 25, 1913. DISK, 5 M.													
0	20.7	69.0	+0.76	1.26	5.6		6	12.7	54.8	+1.01	1.26	7.1	
3	20.2	68.4					7	11.0	51.8	+1.01	1.26	8.1	
4	19.3	66.7	+1.01	1.26	5.9		8	10.1	50.1				
5	17.0	62.6	+.76	1.26	6.1		9	7.4	45.4	+4.55	1.26	4.0	

TABLE 11.—*Depth, temperature, dissolved gases, and transparency of lakes examined*—Continued.

MEDICAL LAKE, WASH., SEPTEMBER 2, 1912.

Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.	Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.
0	15.6	60.0	−99.0	424.7	2.2		8	11.1	52.0	−115.2	426.7	0.9	
3	15.3	59.5					9	9.7	49.5				
4			−129.4	434.8	2.4		10	8.9	48.0	−101.2	478.6	.4	
6	15.3	59.5					14	8.3	47.0	−101.2	410.5	.3	
7	15.3	59.5	−123.4	429.8	1.6								

NEWMAN LAKE, WASH., AUGUST 25, 1911. DISK, 4 M.

Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.	Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.
0	19.9	67.9	+0.4	4.2	6.0		8	16.9	62.5	+3.5		3.5	
3			+.6	4.0	5.9		9	13.3	56.0	+7.1	4.6	.5	
5	19.7	67.5	+.8	4.0									

LAKE PADDEN, WASH., AUGUST 21, 1913. DISK, 3 M.

Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.	Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.
0	18.8	65.9	+1.52	3.54	5.7		7	14.7	58.4				
3	18.3	64.5					8	11.6	52.9				
5	17.0	62.6	+1.26	3.54	5.2		9	10.8	51.4	+7.33	6.57	0.2	

PARADISE LAKE, WASH., AUGUST 13, 1913.

Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.	Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.
0	17.2	63.0	+0.76	8.34	6.9		5	9.0	48.1	+7.58	8.09	0.3	
3	12.7	54.9					8	7.0	44.5	+12.64	11.38	0	

PAYETTE LAKE, IDAHO, AUGUST 15, 1912. DISK, 6 M.

Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.	Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.
0	19.2	66.5	Trace.	2.0	5.5		20	5.8	42.5	+1.5		5.7	
4	18.9	66.0	+0.3	2.0	5.5		30	4.9	40.9		1.5	5.6	
6	14.2	57.5	+.3	2.0	5.5		40			+1.5		5.8	
7	12.2	54.0	+.3		6.3		50	4.4	39.9	+1.3		5.6	
8	10.6	51.0	+.5	2.0	6.6		60			+1.8	2.0	4.8	
10	9.4	49.0	+.5		6.3		67	4.3	39.8	+2.8	2.5	4.2	
15	7.2	45.0	+1.3	2.0	6.1								

LAKE PEND OREILLE, IDAHO, JULY 17, 1911. DISK, 7.5 M.

Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.	Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.
0	22.5	72.5	+2.3	17.2	6.3	108.0	30	7.8	46.0	+1.5			
3	16.9	62.4	+.5	16.9	7.0	109.0	50	5.6	42.1	+1.8	16.4	7.9	96.0
5	16.1	61.0	+1.0	16.7	7.0	107.0	100	4.5	40.1	+1.8	17.2	8.0	95.0
10	14.3	57.8	+1.1	16.2	7.0	103.0	200	4.2	39.6	+3.3	17.4	7.9	92.8
15	13.1	55.5	+1.3	16.4	7.0	101.0	300	4.0	39.2	+2.0	17.2	7.7	90.0
20	11.1	52.0	+1.3	16.2	7.3	101.0	360	4.0	39.2	+2.0	17.2	7.5	88.0
25	8.8	47.8	+2.0	16.7	7.9	103.0	368	4.0	39.2	+2.5	17.4	7.4	86.5

LAKE PEND OREILLE, IDAHO, AUGUST 28, 1912. DISK, 10 M.

Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.	Depth, meters.	Temperature. °C.	Temperature. °F.	Carbon dioxide. Free.	Carbon dioxide. Fixed.	Oxygen. Cubic centimeters per liter.	Oxygen. Per cent saturation.
0	17.2	63.0	+0.3	16.4	6.0	94.1	30	7.2	45.0	+1.3	15.9	7.5	94.5
5			+.3	16.4	6.0		50	5.3	41.5	+1.3	16.2	7.9	95.0
10	16.4	61.5	+.3	16.4	6.1	93.8	100	4.4	40.0	+1.3	16.4	7.8	91.0
15	14.1	57.5	+1.0	16.2	6.6	97.0	200	4.0	39.2	+1.1	16.6	6.0	70.0
17	13.1	55.5					300	4.0	39.2	+1.1	16.6	6.2	72.5
18	12.2	54.0					365	4.0	39.2	+2.0	16.9	6.8	79.5
20	10.6	51.0	+1.5	15.7	6.9	94.4	366	4.0	39.2	+2.0	16.7	6.8	
25	8.6	47.5	+1.3	15.7	7.3	94.0							

TABLE 11.—*Depth, temperature, dissolved gases, and transparency of lakes examined*—Continued.

PRIEST LAKE, IDAHO, AUGUST 17, 1911. DISK, 13.25 M.

Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.		Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.	
	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.		°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	19.8	67.6	+0.5	4.8	5.9		40	5.6	42.1	+1.0		7.3	
3	19.4	67.0	+.4		5.8		60	5.0	41.0	+1.0	4.8	7.5	
5	19.3	66.7	+.4		6.0		80	4.6	40.3	+1.0	4.8	7.5	
8	18.4	65.2	+.4	4.8	6.1		100	4.4	40.0	+1.0	4.8	7.5	
10	16.0	60.8	+.5		6.3		108.5			+1.5	4.8	7.4	
12	13.1	55.6	+.5	4.8	6.3		112.5		39.8				
15	10.6	51.0	+.8		7.1								

LAKE SAMISH, WASH., AUGUST 21, 1913. DISK, 3.5 M.

0	19.0	66.2	+0.76	3.29	6.2		12	9.0	48.1	+3.79	3.29	3.1	
5	17.6	63.7	+.51	3.29	6.2		15	7.3	45.1	+5.56	3.29	2.0	
8	16.7	62.9	+1.52	3.29	4.6		20	7.1	44.7	+6.83	3.79	0.3	
9	14.0	57.1					21	7.1	44.7	+6.83	3.79	0.3	
10	11.9	53.4	+3.29	3.29	4.1								

LAKE SAMMAMISH, WASH., AUGUST 13, 1913. DISK, 3.33 M.

0	20.4	68.7	−1.01	6.57	6.5		11	10.6	51.0				
5	20.2	68.3	−1.01	6.57	6.6		12	9.2	48.6	+1.01	6.57	5.9	
9	18.8	65.9	+.51	6.57	6.6		15	7.9	46.2	+2.78	6.32	5.2	
10	13.6	56.4	+.51	6.57	6.7		19	7.2	45.0	+4.30	6.32	4.0	

SILVER LAKE, SPOKANE COUNTY, WASH., JULY 28, 1911. DISK, 1 M.

0	22.2	72.0	−10.6	74.3	6.1		11	12.8	55.0				
4	21.7	71.0	−9.1	74.6	6.1		12	12.8	55.0	+4.3	74.6	0.7	
7	20.0	68.0	−8.1		4.7		15	10.3	50.6	+3.8		.6	
9	18.6	65.5	−.5		.6		20	10.0	50.0	+4.3	75.1	.5	
10	15.8	60.4	Neut.	71.3	.5		24	9.4	49.0	+7.1	75.3	.1	

SILVER LAKE, WASH., AUGUST 25, 1913. DISK, 3.5 M.

0	22.4	72.3	+0.51	1.77	5.6		7	10.6	51.0	+2.53	1.77	5.3	
3	20.2	68.4	+1.01	1.77			8	9.8	49.7				
5	17.1	62.8	+1.26	1.77	5.7		10	8.8	47.9	+4.05	1.77	3.5	
6	13.5	56.3					14	7.1	44.7	+5.81	1.77	1.4	

LAKE SPANAWAY, WASH., AUGUST 29, 1913. DISK, 1.33 M.

0	21.4	70.6	+0.51	8.60	6.6		7	14.4	57.9	+11.3	11.12	0.3	
5	17.5	63.5	+3.03	8.85	4.5								

SPIRIT LAKE, IDAHO, AUGUST 3, 1911. DISK, 5 M.

0	21.4	70.5	+0.8	2.5	5.6		12	8.6	47.4	+1.3		6.1	
3	21.0	69.8					14	6.3	43.4	+3.0	2.5	5.6	
5	20.8	69.5	+.5	2.5	5.8		20	6.0	42.9	+2.3	2.8	5.8	
8	14.8	58.6	+1.8	2.5	5.9		25	5.7	42.3	+3.3	2.8	4.7	
9.5	10.0	50.0	+1.0	2.5	6.5								

LAKE STEILACOOM, WASH., AUGUST 29, 1913. DISK, 4 M.

0	20.4	68.8	+0.51	6.57	4.9		6	15.0	59.0	+2.02	7.08	7.4	
3	19.2	66.5											

TABLE 11.—*Depth, temperature, dissolved gases, and transparency of lakes examined*—Continued.

LAKE STEVENS, WASH., AUGUST 28, 1913. DISK, 2.5 M.

Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.		Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.	
	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.		°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	19.9	67.8	+0.51	2.53	6.1		15	7.2	45.0				
5	18.7	65.6	+.76	2.53	5.9		20	6.2	43.2	+2.53	2.78	6.1	
6	17.1	62.8	+2.02	2.78	5.7		30	5.6	42.1	+2.53	2.78	5.7	
7	15.0	59.0	+2.78	2.78	4.5		40					1.4	
8	10.8	51.5	+3.29	2.78	4.7		45	5.3	41.5	+6.1	2.78	1.4	
10	8.4	47.1	+2.53	2.78	5.2								

SULLIVAN LAKE, WASH., AUGUST 5, 1911. DISK, 6 M.

Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.	Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	19.7	67.5	+0.8	11.4	6.1		20	6.0	42.8	+1.3		7.3	
5	18.1	64.5	+.8	11.1	6.2		40	4.4	39.9	+1.8		7.2	
7	15.6	60.0	+1.0	11.1	6.3		60	4.2	39.5	+1.5	11.4	7.0	
8	13.4	56.1	+1.0	10.9	6.8		80	4.1	39.4	+2.3		6.4	
10	11.0	51.8	+1.3	11.4	6.4		90			+2.3		6.2	
15	8.1	46.8	+1.0	10.9	7.0		95	4.1	39.4	+3.3	11.9	5.9	

SUTHERLAND LAKE, WASH., AUGUST 18, 1913. DISK, 7 M.

Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.	Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	17.6	63.7	+0.76	13.40	6.7		12	11.6	52.8	+0.51	13.40	10.0	
5	17.5	63.5	+.76	13.40	6.7		13	9.8	49.6				
9	16.9	62.4	+.51	13.40	8.6		15	8.3	46.9	+1.26	13.65	7.9	
10	14.3	57.7	+.51	13.40	9.3		20	6.8	44.2	+2.53	13.65	5.1	
11	12.2	54.0					26	5.9	42.7	+5.56	14.16	0.6	

SWAN LAKE, WASH., AUGUST 14, 1913. DISK, 3.5 M.

Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.	Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	19.3	66.7	+0.76	2.53	5.0		9	10.2	50.3				
5	18.1	64.6	+.76	2.53	5.0		10	8.2	46.8	+1.77	2.53	5.3	
6	15.2	59.3					15	5.7	42.3	+4.55	2.53	2.6	
7	14.1	57.4	+.76	2.53	6.0		20	5.6	42.1	+6.57	2.53	0.9	
8	12.1	53.7					22	5.6	42.1	+6.83	2.53	1.1	

LAKE TAHOE, CALIF., JULY 22, 1913. DISK, 28 M.

Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.	Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	15.4	59.8	+0.76	8.85	5.4	96.5	25	10.2	50.3	+.51	9.60	6.3	100.0
5	13.4	56.1	+.76	9.35	5.8	99.0	30	9.1	48.4				
7	12.9	55.2					100	4.4	39.9	+.76	9.35	6.4	89.0
8	12.8	55.0					200			+1.01	9.35	6.5	
9	12.2	54.0					300	4.2	39.5	+.76	9.35	6.4	88.6
10	11.7	53.0	+.76	9.35	5.9	97.4	400	4.2	39.5	+1.26	9.35		
15	11.3	52.3	+.51	9.60	6.0	98.0	501	4.1	39.4	+1.26	9.35	6.4	88.4
20	10.7	51.3	+.51	9.60	6.1	98.2							

LAKE TAPPS, WASH., AUGUST 19, 1913. DISK, 0.5 M.

Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.	Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	18.9	66.0	+1.77	4.30	5.7		10	11.6	52.8	+3.03	4.30		
3	16.2	61.2					12	9.5	49.1				
5	14.5	58.1			5.1		15	7.6	45.6	+3.27	4.30	4.0	
7	13.7	56.7					20	6.0	42.8			3.9	
8	13.2	55.7					24	5.7	42.2	+5.06	4.55	4.3	

UPPER KLAMATH LAKE, OREG., JULY 29, 1913. DISK, 0.9 M.

Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.	Depth, meters.	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
0	23.1	75.5	−2.02	8.85	5.9		10	18.8	65.9	−0.51	8.85	4.7	
3	19.2	66.6					11	18.8	65.8	−.51	8.85	4.7	
5	18.8	65.9	−1.01	8.85	4.8								

TABLE 11.—*Depth, temperature, dissolved gases, and transparency of lakes examined*—Continued.

Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.		Depth, meters.	Temperature.		Carbon dioxide.		Oxygen.	
	°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.		°C.	°F.	Free.	Fixed.	Cubic centimeters per liter.	Per cent saturation.
UPPER PRIEST LAKE, IDAHO, JULY 22, 1911. DISK, 9 M.													
0	18.1	64.5					10	12.6	54.6	+1.3	8.8	7.1	
5	15.9	60.6	+0.8	8.8	6.9		15	9.6	49.2	+1.0	9.1	6.7	
6	15.4	59.8					25	7.6	45.7	+2.3	9.4	6.5	
7.5	13.1	55.5	+.8	9.6	7.0		32	7.5	45.5	+2.0	9.4	6.1	
UPPER TWIN LAKE, IDAHO, AUGUST 2, 1911. DISK, 1.2 M.													
0	21.2	70.2	−2.0	3.0	6.7		4	20.4	68.8				
3	20.4	68.8	−2.0	3.0	6.7		5.5	17.2	63.0	+0.8	3.0	3.6	
LAKE WASHINGTON, WASH., AUGUST 9, 1913. DISK, 4 M.													
0	21.4	70.6	Neut.	6.57	5.9	93.5	13	11.7	53.0				
5	20.6	69.1	+0.25	6.57	5.9	90.8	15	10.6	51.1	+2.02	6.57		
8	20.5	68.9	+.25	6.57	5.8	89.0	20	8.9	48.0	+1.52	6.57	6.5	75.0
9	18.2	64.7					30	7.3	45.2	+1.77	6.57	6.8	
10			+.76	6.57	5.4		40	6.7	44.0	+1.77	6.57	6.5	75.0
11	14.8	58.7					50	6.3	43.3	+1.77	6.57	6.6	75.4
12	13.7	56.7	+1.77	6.57	5.1	69.0	60	6.2	43.2	+2.02	6.57	6.2	71.4
LAKE WHATCOM, WASH., AUGUST 20, 1913. DISK, 5 M.													
0	19.3	66.7	+0.76	3.78	6.1	92.0	20	10.6	51.0	+1.52	3.78	6.2	81.0
5	17.6	63.7	+.76	3.78	6.2		22	9.5	49.1				
10	17.3	63.2	+.76	3.78	6.2		25	7.6	45.7	+1.52	3.78	6.9	
15	15.6	60.0	+1.01	3.78	5.9		30	6.8	44.2	+1.26	3.78	6.0	
16	14.8	58.7					50	5.7	42.3	+1.52	3.78	7.3	
17	13.2	55.7					80	5.4	41.7	+1.52		7.6	
18	12.2	54.0					96	5.4	41.7	+1.52	4.05	7.2	81.0
19	10.6	51.0											
LAKE WILDWOOD, WASH., AUGUST 24, 1913. DISK, 6 M.													
0	19.5	66.9	+0.51	11.65	6.2		8	7.3	45.2				
3	19.2	66.5					10	6.0	42.8	+2.53	11.65	7.3	
5	16.7	62.0	+.76	11.88	6.4		15	5.1	41.1	+4.05	11.65	4.7	
6	10.6	51.0					20			+9.60	15.17	0	
7	8.1	46.5	+1.26	11.65	8.0		22	4.4	39.9	+11.38	15.67	0	
WILLIAMS LAKE, WASH., AUGUST 23, 1911. DISK, 5 M.													
0	19.7	67.4	−0.5	25.8	5.8		10	19.4	67.0	Tt.		6.0	
3	19.6	67.2					11	19.0	66.2	Neut.		5.7	
5	19.5	67.1	−.5	25.8	6.1		12	13.6	56.5	Neut.	25.5	4.1	
8	19.5	67.1					15	11.8	53.2	+4.8	27.6	.6	
WRIGHT LAKE, IDAHO, AUGUST 24, 1912. DISK, 4 M.													
0	20.0	68.0	+0.5	6.1	6.2		7	13.3	56.0	+6.6	7.6	0.4	
5	18.3	65.0											

TABLE 12.—*Analysis of net plankton of lakes examined.*

The results indicate the number of individuals in 1 cm.³ of water.

The following abbreviations have been used for the different forms found in the net plankton:

CLADOCERA:
- B=Bosmina.
- C=Ceriodaphnia.
- Ch=Chydorus.
- D=Daphnia.
- Dh=*Daphnia hyalina.*
- Di=Diaphanosoma.
- Dp=*Daphnia pulex.*
- H=Holopedium.
- L=Leptodora.
- P=Polyphemus.

COPEPODA:
- C=Cyclops.
- Ca=Canthocamptus.
- D=Diaptomus.
- E=Epischura.
- L=Limnocalanus.

ROTIFERA:
- A=Anuræa.
- As=Asplancha.
- B=Brachionus.
- C=Conochilus.
- M=Mastigocerca.
- N=Notholca.
- P=Polyarthra.
- Pe=Pedalion.
- Pl=Plœsoma.
- R=Rattulus.
- S=Synchæta.
- T=Triarthra.

PROTOZOA:
- A=Actinosphærium.
- C=Ceratium.
- D=Dinobryon.
- E=Epistylis.
- M=Mallomonas.
- U=Uroglena.
- V=Vorticella.

BLUE-GREEN ALGÆ:
- An=Anabæna.
- Ap=Aphanocapsa.
- Aph=Aphanizomenon.
- Coe=Cœlosphærium.
- G=Glœocapsa.
- Gl=Glœotrichia.
- L=Lyngbya.
- M=Microcystis.
- N=Nostoc.
- O=Oscillatoria.

GREEN ALGÆ:
- G=Gonatonema.
- M=Mougeotia.
- P=Pediastrum.
- S=Staurastrum.
- U=Ulothrix.
- Z=Zygnema.

DIATOMS:
- A=Asterionella.
- C=Cyclotella.
- F=Fragilaria.
- M=Melosira.
- N=Navicula.
- S=Synedra.
- T=Tabellaria.

AMERICAN LAKE, WASH., AUGUST 29, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
	D 820	C 610	....	....	....	An 101,200	....	....
0–5	Di 4,900	E 1,220	4,480	....	....	M 12,650	....	....
	B 820	C 1,830	....	....	....	An 189,750	....	....
5–10	D 200	E 1,220	1,220	....	....	Ap 12,650	....	....
	Di 2,440	....	....	....	....	M 12,650	....	....
	D 200	C 2,860	....	N 8,360	....	An 75,900	....	....
10–15	Di 200	E 2,850	2,850	P 200	....	Ap 12,650	....	C 25,300
	....	....	....		....	M 12,650	....	....
	D 410	C 9,800	....	A 2,650	....	An 12,650	....	C 25,300
15–20	....	E 1,220	12,650	N 1,420	....	M 25,300	....	M 63,250
	....	....	....	P 610	....	....	....	....
	....	....	....	T 200	....	....	....	....
	....	C 11,430	....	A 1,020	....	....	....	....
20–25	....	E 200	1,220	N 610	....	M 12,650	....	M 50,600
	....	....	....	P 200	....	....	....	....
	....	....	....	T 2,440	....	....	....	....

TABLE 12.—*Analysis of net plankton of lakes examined*—Continued.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
BEAR LAKE, IDAHO, AUGUST 8, 1912.								
0–5		E 1,190						
5–10		E 2,260	260	P 130	C 15,690	Coe 7,850		F 7,850
10–15		E 2,910	800	P 390				
20–25		E 400	130					
27½–32½		E 1,060	260					
42½–47½		E 530						
50–55		Ca 1,190						
		E 660	2,790					
CALVERT LAKE, WASH., AUGUST 23, 1911.								
0–2	176,000	67,500	111,860		1,560,000	[1] 3,372,000		
6–8	90,900	27,300	106,500		215,500	[1] 2,743,000		
10–12	6,400	9,300	41,500		201,300	[1] 6,000,000		
LAKE CHAPLAIN, WASH., AUGUST 26, 1913.								
0–3	B 2,720	C 5,440	7,480	N 340		An 42,200		C 63,300
	D 670	E 1,010		P 23,810				
	Di 670							
	H 340							
3–6	B 340	C 3,400	23,000	N 4,060	M 84,400	M 63,300		A 21,100
	D 670			P 5,770				
6–9		C 1,010	41,840	A 1,010	M 105,500	M 42,200		
				N 670				
				P 670				
9–12			340					C 42,200
								N 84,400
LAKE CHATCOLET, IDAHO, AUGUST 22, 1912.								
0–5	Di 530	C 4,770	2,390	As 130	C 25,300	An 126,500		A 354,000
		D 17,770		M 2,390	D 126,500	Aph 126,500		F 50,000
	Dh 400			P 3,450		M 430,000		T 76,000
5–10 [2]		C 660	8,980	A 260		M 405,000		F 50,000
		D 4,770		As 130				T 50,000
	Dh 300			M 130				
				N 260				
				P 5,440				
LAKE CHELAN, WASH., AUGUST 10, 1911.								
0–5	1,500	2,800	4,300		4,400	[1] 137,200		
5–10	400	14,200	200		9,200	[1] 1,080		
10–15	900	18,600	400		4,300	[1] 1,600		
25–30	100	9,100	2,100			[1] 360		
40–50	200	5,900	10,000					
90–100		800	1,500					
190–200								
290–300		700	700					
390–400								
450–458								
LAKE CHELAN, WASH., AUGUST 11, 1911.								
0–5	140	600	800		814,000	[1] 300		
5–10	800	13,800	500		22,300	[1] 60,500		
10–15	1,500	19,600			20,400	[1] 72,000		
15–20	1,400	25,200			5,700	[1] 53,300		
25–30	700	10,500	3,400		200	[1] 700		
35–40	3,800	3,200			100	[1] 100		
75–80	200	1,200	300		200	[1] 400		

[1] Includes both blue-green and green algæ.

[2] Also 660 Corethra larvæ.

TABLE 12.—*Analysis of net plankton of lakes examined*—Continued.

LAKE CHELAN, WASH., AUGUST 14, 1911.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–5	140	1,200	9,700		3,700	[1] 139,000		
5–10	1,000	20,000	200		1,300	[1] 61,500		
10–15	2,000	26,200			2,100	[1] 185,000		
15–20	2,100	14,700	300		3,200	[1] 36,400		
25–30	1,400	11,300	1,400		140	[1] 58,900		
35–40	700	5,100	1,800					700
45–50		800	200					
55–60	100	500	600					
65–70		500	200					
75–80		500	700					
90–100	100	200	300					
190–200		140						
340–350		140						
450–458								

LAKE CHELAN, WASH., SEPTEMBER 11, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–10	B 200 D 300	C 1,130 D 6,530			C 63,300			A 25,320
10–20	B 200 Ch 100 D 200	C 920 D 4,280	200		C 37,980			
20–30	B 100 D 100	C 1,330 D 1,730	100		C 37,980			
30–40	D 100	C 820 D 2,050	400		C 12,660			A 25,320
40–50	B 100 D 100	C 400 D 720	400					A 12,660 M 12,660
50–60		C 100 D 100	100					A 12,660 M 6,330
60–100	Ch 50 D 40	C 100 D 130	30		C 1,580	M 3,160	S 1,580	A 1,580 M 1,580
100–150		C 20 D 70	20					M 2,520
150–200	Ch 550	C 40 D 80	120					M 3,780
200–300		C 10 D 10			C 630			M 5,040
300–400		C 10 D 10						M 1,800

LAKE COEUR D'ALENE, IDAHO, JULY 10, 1911.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0	2,800	1,400				[1] 3,100		
3	5,300	5,000	1,200			[1] 6,900		
5	1,200	5,100	200			[1] 49,500		
7	5,500	12,000	8,000		5,000			
8	500	3,900	5,800			[1] 5,300		
9	300	5,800	6,100			[1] 56,000		
10	100	500	900			[1] 4,400		
13		1,000	700			[1] 6,200		
16	800	2,400	800			[1] 146,000		
19		1,500	700			[1] 14,500		

LAKE COEUR D'ALENE, IDAHO, AUGUST 21, 1912.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–5	Di 5,300 B 930	C 9,970	1,850	M 1,720				A 30 T 500
5–10	B 130 D 2,230	C 2,120	1,590	M 1,460				A 110 T 50
10–15	B 1,060 D 260	C 3,050	3,970					A 740 T 80
15–20	B 1,060	C 3,050	2,520					
20–25	B 1,060	C 3,050	1,060					
25–30	B 800	C 2,450	800					
30–35	B 530	C 1,850	530					
35–40	B 990	C 1,460	2,120					
40–45	B 1,460	C 1,060	3,710					
45–50	B 1,790	C 990	2,780					
50–55	B 2,120	C 930	1,850					A 390

[1] Includes both blue-green and green algæ.

TABLE 12.—*Analysis of net plankton of lakes examined*—Continued.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
COTTAGE LAKE, WASH., AUGUST 13, 1913.								
0–2	Di 24,490	E 10,710	16,830	A 4,080	C 31,130	An 217,910		C 31,100
				N 6,120	D 62,260	Ap 93,390		
				P 2,040	E 31,130			
2–5	Di 340	C 3,730	5,780	M 340		An 105,500		A 31,100
				N 70,080				
5–7	Di 1,220	C 610	610	N 19,380	D 62,260	An 93,390		A 93,390
COW LAKE, WASH., AUGUST 14, 1913.								
0–4	B 5,100	E 260	4,340	As 1,520				A 15,800
	D 1,270			P 81,630				
4–8	B 1,270	C 260	4,080	As 760	C 15,800			
	D 510			P 40,820				
8–12	D 260	C 260	4,080	A 260	C 15,800			
				C 260	D 15,800			
				M 260				
				P 1,020				
12–16	D 50	C 260	1,520	A 1,270				
				N 510				
				P 1,520				
16–20			100	A 1,020				
				N 510				
20–24		C 510	1,520	A 1,020				
				N 510				
CRATER LAKE, OREG., AUGUST 1, 1913.								
0–10							M 12,660	
10–20							M 12,660	
20–30							M 12,660	
30–40				As 100			M 56,970	
40–60	D 70			As 910			M 164,320	
				N 100				
60–80	D 810			A 100			M 246,480	
				As 1,330				
				N 300				
80–100	D 140			As 460			M 69,520	A 3,160
				N 50				
100–590	B 20							
100–150				N 20			M 15,120	A 7,560
150–200				As 160			M 55,440	A 10,080
				N 50				
200–400							M 4,800	A 1,920
400–590							M 1,650	
CRATER LAKE, OREG., SEPTEMBER 5, 1913.								
0–10							M 18,990	
10–20							M 12,660	
20–30							M 12,660	
30–40	D 100			As 1,840			M 100,280	
40–50	D 1,020			As 2,140			M 44,310	
50–60	D 1,230			As 210			M 94,950	
60–80	D 1,120			A 100			M 195,920	A 12,640
				As 2,500				
				N 100				
80–100	D 450			As 3,470			M 97,960	A 12,640
				N 720				
100–150	D 90			A 100			M 447,300	A 110,880
				As 960				
				N 310				
150–200				A 60			M 55,440	A 10,080
				As 160				
				N 60				
200–400							M 4,800	A 1,920
400–590							M 1,650	

TABLE 12.—*Analysis of net plankton of lakes examined*—Continued.

CRESCENT LAKE, WASH., AUGUST 17, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0-10		E 1,940	1,630	N 1,020			G 145,590	
				P 4,080				
10-20		E 1,020		C 160	D 12,660		G 493,740	
				N 3,160				
				P 1,830				
20-30	D 100	E 720		C 100		Ap 6,330	G 37,980	
				N 1,230				
				P 2,140				
30-40		E 720		C 310		Ap 18,990	G 139,260	
				N 3,470			Z 6,330	
				P 1,230				
40-50		E 720		C 310			G 50,640	
				N 1,230				
				P 510				
50-60		E 720		C 200			G 6,330	
				N 720				
				P 100				
60-100		E 250	100	N 100				
				P 100				
100-160		E 30		N 30				

DEER LAKE, WASH., JULY 29, 1911.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0-2	3,900	54,500	1,300		89,600	[1] 3,051,000		1,300
1-6	4,300	39,200	700		41,900	[1] 1,078,000		1,400
6-11	300	26,600	5,700		9,000	[1] 655,000		7,500
11-16	300	29,500	21,900			[1] 318,000		17,500
16-21	200	42,500	18,000			[1] 1,330,000		12,400
20-25	8,600	10,700	500			[1] 803,000		

FALLEN LEAF LAKE, CALIF., JULY 25, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0-5		C 1,020		M 200				
		D 3,260	5,510	N 1,220	C 75,900			A 25,300
5-10	B 1,630	C 3,660	410	A 2,040	C 63,250			A 25,300
	D 410	D 2,640		M 820				
				N 3,460				
10-15	B 1,220	C 5,100	1,020	A 5,710	C 25,300			A 25,300
	D 200	D 1,830		M 2,040				
				N 7,750				
15-20	B 200	C 1,220	1,020	A 3,660	C 12,650			A 88,550
	D 820	D 610		M 820				
				N 4,900				
20-25	B 410	C 1,420	1,630	A 1,220	C 12,650			A 607,300
	D 410	D 200		M 610				
				N 3,660				
25-30	B 200	C 610	820	A 1,440				A 1,239,700
	D 40	D 200		N 3,860	C 12,650			
30-40	D 20	C 310	420	A 5,100				A 493,740
		D 100		N 1,220				
40-50	D 20	C 100	310	A 2,980				A 531,720
		D 730		N 310				
50-70		D 100	100	A 100				A 25,280
70-90		C 150	100	A 100				A 25,280
		D 50						
90-110		C 150	150	A 50				A 9,480

LAKE GOODWIN, WASH., AUGUST 27, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0-3	B 340	C 3,400	2,720	M 2,720		An 147,700	P 14,700	
	D 670	E 340				Gl 4,100		
	Di 8,170					M 865,100		
3-6	D 340	C 3,730	21,080	M 1,010		An 400,900		
	Di 670	E 340		N 670		Gl 43,000		
						M 1,160,500		
6-9	Di 670	C 3,060	4,060	A 340		An 63,000		
		E 340		M 1,010		Gl 4,800		
						M 633,000		

[1] Includes both blue-green and green algæ.

TABLE 12.—*Analysis of net plankton of lakes examined*—Continued.

GREEN LAKE, WASH., AUGUST 9, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0-2	D 2,040	C 2,550	31,620	P 26,530	C 124,520	An 8,685,270		A 373,560
						Coe 124,520		F 62,260
						M 124,520		T 62,260
						N 778,250		
2-4	B 610	C 2,550	5,610	A 610	C 62,260	An 5,167,580		A 93,390
	Di 2,040			P 18,360		Coe 186,780		C 62,260
	D 1,020					N 435,800		F 31,130
								M 62,260
								T 62,260

HAYDEN LAKE, IDAHO, JULY 7, 1911.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0		500	1,000		8,000			3,500
3	2,000	1,600	1,600		14,000			400
8	800	2,400	4,000		22,200			1,200
10	400	1,600	3,200		8,000			1,200
12	2,000	10,500	2,000		9,000			2,000
15	500	8,500	6,000		2,000			500
20	3,200	6,000	40,400		3,600			3,600
40		4,000	32,500		8,000			1,500
50		2,000	15,500		7,500			2,500

HAYDEN LAKE, IDAHO, AUGUST 26, 1911.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0-5	2,200	2,800	5,700		992,000			3,600
5-10	6,600	15,100			208,000			3,600
10-15	6,100	35,600	5,400		46,100	[1] 3,900		5,400
15-20	2,300	24,100	43,500		3,900	[1] 10,000		18,000
20-25	1,800	25,500	54,000		7,900	[1] 5,700		19,400
25-30	1,800	24,100	32,400		3,200	[1] 5,300		11,100
35-40	1,000	7,500	12,900		3,600	[1] 1,400		3,900
40-45	1,000	5,000	10,800		10,400			1,800
52-57	2,700	7,200	3,600		17,600			3,200

HAYDEN LAKE, IDAHO, AUGUST 27, 1911.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0-5	66,000	10,500	1,100		1,001,000	[1] 13,100		7,500
5-10	6,800	5,400	2,800		80,000	[1] 34,800		
10-15	8,200	33,200	2,080		42,000	[1] 2,800		3,200
15-20	8,000	27,200	19,800		10,400	[1] 2,080		4,600
25-30	1,000	44,000	26,600		11,800			4,600
35-40	4,400	9,000	16,900		7,500			1,800
45-50	2,080	2,500	7,200		13,300			2,800
52-57	2,800	3,600	33,300		10,800			2,500

HAYDEN LAKE, IDAHO, AUGUST 25, 1912.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0-5	B 530	C 3,710	1,070	N 260	C 2,150			
	Di 2,520							
	Dh 2,260							
5-10	B 130	C 5,040	530		C 1,790			
	Di 2,780							
	Dh 3,710							
10-15	B 130	C 14,460	1,070		C 290			
	Dh 2,650							
15-20	B 200	C 11,270	11,410		C 200			
	Dh 1,920							
20-25	B 260	C 8,090	21,750	N 4,380	C 110			
	Dh 1,190							
25-30		C 6,760	11,410	N 2,450	C 110			
	Dh 860							
30-35		C 5,430	16,840	A 130	C 110			
	Dh 530			N 530				
35-40		C 4,650	10,800		C 160			
	Dh 530							
40-45		C 3,850	4,770		C 210			
	Dh 530							
45-50		C 3,860	3,320		C 120			
	Dh 400							
50-55		C 5,700	1,860		C 30			M 30
	Dh 260							T 30

[1] Includes both blue-green and green algæ.

TABLE 12.—*Analysis of net plankton of lakes examined*—Continued.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
HENRY LAKE, IDAHO, AUGUST 10, 1912.								
0-2	Di 9,970	C 330	990					A 39,600
	Dh 330	D 330				M 19,800		
LAKE KI, WASH., AUGUST 27, 1913.								
0-4	Di 760	C 2,290	1,270	A 2,800	D 15,800			M 15,800
	H 2,800	E 760		P 1,270				
4-8	B 760	C 2,550	2,100	A 1,020	D 15,800			
	Di 1,020	E 760		N 3,570				
	H 260			P 1,020				
8-12		C 12,650	3,310	A 250			S 15,800	
		E 760		N 2,290				
				P 1,780				
12-16		C 10,510	12,910	N 4,340				
		E 510		P 5,100				
16-20		C 3,570	10,710	N 3,810				C 47,400
				P 1,020				
LIBERTY LAKE, WASH., JULY 31, 1911.								
0-1	7,000	101,000	3,000		4,200	[1] 158,200,000		
2-3	2,400	65,600	28,200			[1] 8,860,000		
3-5	500	17,700	13,500		2,300	[1] 1,555,000		772,000
5.5-7.5	800	47,200	108,000		10,400	[1] 5,700,000		80,200
LOON LAKE, WASH., JULY 29, 1911.								
1-6	1,500	15,800	800		53,800	[1] 585,000		1,200
6-11	2,100	22,700	8,700		59,000	[1] 632,000		2,200
11-16	3,300	30,800	41,200		46,200	[1] 854,000		28,500
16-21	2,800	15,000	35,000		2,500	[1] 1,075,000		33,100
26-31	8,300	9,300	31,500		200	[1] 413,000		36,600
LOWER TWIN LAKE, IDAHO, AUGUST 2, 1911.								
0-1	25,000					[1] 87,700,000		
2-3	21,000	14,000				[1] 29,550,000		
5-6	4,000	13,000				[1] 6,690,000		
8-9	8,400	1,400	14,000			[1] 1,873,000		
11-12	2,000		4,000			[1] 1,975,000		
18-19	2,500	800				[1] 3,210,000		
LUNA LAKE, BLAKELY ISLAND, WASH., AUGUST 24, 1913.								
0-4	B 3,040	C 1,520	5,100	A 1,520	C 15,800			
				As 7,650				
				C 1,520				
				M 26,020				
				P 5,610				
				T 42,350				
4-8	B 1,020	C 1,020	7,140	A 3,040	C 15,800		S 31,600	A 15,800
		D 1,020		As 1,520				
				M 12,150				
				N 1,020				
				P 1,520				
				T 37,240				
8-12		C 1,520	760	M 4,340				
		D 250		N 760				
				P 1,020				
				T 6,120				
12-20		C 13,390	260	A 640				
				As 130				
				M 640				
				T 1,530				
20-28		C 2,040		A 260				
				M 260				
				P 130				
				T 640				

[1] Includes both blue-green and green algæ

TABLE 12.—*Analysis of net plankton of lakes examined*—Continued.

LAKE MARTHA, WASH., AUGUST 25, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–3	B 3,400	E 1,360	4,090	A 340	C 21,000		S 21,000	
	Di 340			C 670				
	H 2,370			M 1,010				
				N 340				
				P 670				
3–6	B 670	E 340	1,010	P 670	C 21,000		S 21,000	
	Di 60							
	H 60							
6–9			1,700	A 1,010				
				N 670				
				P 340				

MEDICAL LAKE, WASH., SEPTEMBER 2, 1912.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–4[3]	C 330	D 34,970	3,640	B 2,320	C 70	M 860	S 70	M 100
	Dh 2,150			Pe 2,320				
	Dp 1,320							
4–8[3]	C 160	D 22,850	11,590	B 5,130		M 660	S 30	M 230
	Dh 1,120			Pe 24,510				
	Dp 990							
8–12[3]		D 1,490	3,310	B 830		M 70	S 30	M 30
	Dh 160			Pe 660				

NEWMAN LAKE, WASH., AUGUST 25, 1911.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–1	61,000	28,000	32,900		249,000	[1] 8,851,000		39,600
4–5	6,500	9,400	16,400		201,000	[1] 13,530,000		338,000
7–8	6,500	5,600	98,700		58,500	[1] 32,230,000		400,000
8–9	11,200	13,600	12,200		15,000	[1] 7,390,000		22,400

LAKE PADDEN, WASH., AUGUST 21, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–3	B 670	D 22,800	15,300	As 15,970	C 3,966,800	An 4,051,200		A 7,006,600
	Ch 670			C 1,010				
	Di 15,000			M 9,860				
	D 3,730			P 6,120				
3–6	Di 2,030	D 2,030	1,010	As 2,720	C 844,000	An 1,055,000		A 13,926,000
				M 2,720		Coe 126,600		
				N 1,360				
				P 1,360				
6–9		D 670	340	M 670	C 84,400	An 168,800		A 2,447,600
				P 340				

PARADISE LAKE, WASH., AUGUST 13, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–2	D 17,340	C 6,120	28,570	A 23,970	D 996,160	An 5,292,100		A 4,140,290
		E 20,410		C 1,530	M 155,650	Aph 5,105,320		C 93,390
				N 20,410				
				P 34,690				
2–4	D 5,610	C 1,530	9,690	A 9,730	D 1,058,420	An 311,300		A 2,739,440
		E 2,040		As 510	M 186,780	Ap 124,520		
				C 1,530		Aph 62,260		
				P 15,810		M 311,300		
4–6	D 610	C 1,020	1,020	N 5,610	D 747,120	An 249,040		A 809,380
				P 5,610	M 311,300	Aph 124,520		
						M 93,390		
6–8		C 610			D 155,650	An 217,910		A 373,560
					M 31,130			

PAYETTE LAKE, IDAHO, AUGUST 15, 1912.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–5	B 400	C 4,110		A 260	C 1,270		S 1,060	A 60
	Di 6,900	D 28,120			D 480			F 160
	Dh 3,450							T 210
5–10	B 660	C 5,300		A 660	C 110		S 530	A 60
	Di 400	D 5,170			D 160			F 60
	Dh 7,960							T 260
10–15	B 800	C 1,860		A 660	C 210		S 530	A 60
		D 1,720			D 160			F 30
	Dh 1,990							T 210
15–20	B 530	C 1,520						F 30
		D 1,390						T 140

[1] Includes both blue-green and green algæ.

[3] Also 330 Corethra larvæ.

TABLE 12.—*Analysis of net plankton of lakes examined*—Continued.

PAYETTE LAKE, IDAHO, AUGUST 15, 1912—Continued.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
20–25	B 260	C 1,190	130	T 2,120	D 30	L 30	S 30	F 30
		D 1,060						T 60
25–30	B 130	C 130	130	P 130		Aph 30		T 30
		D 930		T 530				
30–35		C 200		P 130				
		D 800		T 600				
35–40		C 230		P 200				
		D 530		T 700				
40–45		C 400		A 130		L 60		F 30
		D 260		M 130				
				N 130				
				P 260				
				T 800				
45–50		D 190		A 130				
				T 1,000	C 30			
50–55		D 130		A 130	D 60		S 110	A 30
				T 1,190				T 30
55–60				T 1,060				
60–65		C 530		T 930	C 30		S 160	T 60

LAKE PEND OREILLE, IDAHO, JULY 17, 1911.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–5	6,400	20,400	12,800					
10–15	14,700	38,800	58,100		100			
20–25	1,100	4,600	15,300			[1] 1,100		
25–30	500	500	10,200			[1] 900		
45–50	200	300	1,200			[1] 3,300		
95–100	100	200				[1] 500		
195–200						[1] 200		
295–300	700	200	200			[1] 200		
300–365								

LAKE PEND OREILLE, IDAHO, AUGUST 28, 1912.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–10		C 200	1,850			O 31,600		
	Dh 12,790	D 9,070						
10–20		C 530	790	N 70		O 227,700		
	Dh 1,990	D 2,860						
20–30		C 260	70					
	Dh 70	D 330						
40–50		C 200						
	Dh 130	D 130						
70–80		C 70						
90–100		C 70	70					
190–200		D 200	70					

PRIEST LAKE, IDAHO, AUGUST 17, 1911.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–5	2,700	10,800	1,900		78,200	[1] 6,900		
5–10	10,000	9,000	2,500		15,700	[1] 3,100		
15–20	800	5,300	8,900		2,500	[1] 14,400		
25–30	1,000	10,900	3,800			[1] 4,300		
45–50	1,000	13,100	4,100		700	[1] 300		
75–80	100	150	700					
90–100		1,400	500					
101–111	1,400	2,100	4,200					

LAKE SAMISH, WASH., AUGUST 21, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–4	Di 1,870	C 1,730	610	M 2,540		Ap 20,540		
		E 250		N 100		Aph 1,580		
				P 200		M 6,320		
						N 3,160		
4–8	Di 810	C 1,530	1,020	M 1,830		Ap 14,220		
		E 150		N 150		M 4,740		
						N 3,160		
8–12	Di 100	C 720	1,530	M 1,270		Aph 1,580		C 1,580
		E 50		N 100		M 1,580		
				P 50				
12–16		C 200	1,580	M 410		Ap 4,740		
		E 100		N 200		M 3,160		
16–20		C 460	1,940	N 100		M 3,160		C 3,160

[1] Includes both blue-green and green algæ.

TABLE 12.—*Analysis of net plankton of lakes examined*—Continued.

LAKE SAMMAMISH, WASH., AUGUST 13, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0-3	B 1,010	C 12,240	3,060	M 1,010	C 42,200	An 21,100	S 21,100	A 21,100
	Di 4,080	E 35,710		N 340		Ap 42,200		F 63,300
				P 340		M 42,200		
						N 42,200		
3-6	Di 670	C 4,080		M 340	C 21,100	M 21,100		A 21,100
		E 5,780		P 340				F 42,200
6-9	B 340	C 3,060		M 1,010	C 21,100	M 21,100	S 21,100	A 42,200
	Di 340	E 4,420		N 340		N 42,200		F 63,300
9-12	B 670	C 8,840	6,460			M 105,500		F 21,100
		E 8,840						C 21,100
9-18				N 340				
12-15	B 340	C 2,040	640			M 21,100		F 21,100
		E 2,720						C 21,100
15-18	Di 340	C 4,420				N 21,100	S 42,200	F 21,100
		E 1,360						C 21,100

SILVER LAKE, WASH., JULY 28, 1911.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0-5	1,350,000				187,100	[1] 8,025,000		
5-10	99,000				10,080	[1] 7,450,000		
10-15	2,500					[1] 720,000		
16-21	11,100					[1] 371,000		
19-24	7,100					[1] 6,110,000		

SILVER LAKE, WASH., AUGUST 25, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0-5	D 200	E 1,220	2,440	A 1,020	C 21,100	An 21,100		A 21,100
	Di 2,030			C 2,440				F 21,100
				M 410				
				N 1,630				
				P 3,250				
5-10	D 200	C 3,450	7,950	A 410	C 42,200			A 21,100
	Di 410			N 5,300	M 126,600			
				P 5,710				
10-14		C 2,300	20,410	A 2,040	M 31,600			
				N 3,060				
				P 7,140				

LAKE SPANAWAY, WASH., AUGUST 29, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0-2	B 510	E 2,550	6,120			M 31,130	U 249,040	
	Di 1,020							
2-4	Di 510	E 1,020	2,040	N 1,530	M 62,260	M 31,130	U 62,260	
4-7		E 340	2,030	A 670				M 21,100
				N 670			U 42,200	

SPIRIT LAKE, IDAHO, AUGUST 3, 1911.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0-1	4,600	24,400	41,500					
4-5	9,400	34,800	5,600					21,600
8-9	1,800	24,400	4,700					19,700
10-11	5,600	25,400	15,000					900
19-20	18,800	21,600	54,500					
25-26	10,300	15,900	7,500					3,700

LAKE STEILACOOM, WASH., AUGUST 29, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0-2	B 4,080	E 12,140	7,140	N 1,020		An 7,408,940		
	C 4,080							
	Di 1,020							
2-5	B 1,360	E 3,730	1,010	N 340			M 588,000	
	C 670							
	D 340							

[1] Includes both blue-green and green algæ.

TABLE 12.—*Analysis of net plankton of lakes examined*—Continued.

LAKE STEVENS, WASH., AUGUST 28, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–5	Di 1,220	C 1,830	6,530	M 3,870		Ap 101,200		M 25,300
		E 6,730		N 6,530		M 75,900		
				P 1,420				
				T 200				
5–10		C 4,070	8,580	A 2,860		Ap 177,100	S 126,500	
		E 1,830		M 1,220		M 25,300		
				N 1,020				
				P 1,020				
10–15		C 2,240	40	A 1,420		Ap 126,500	S 50,600	
				M 200		M 12,650		
				N 1,220				
15–20	D 200	C 3,260	610	A 1,020		Ap 63,250	S 12,650	A 12,650
				N 410				
20–25		C 1,830	1,020	A 400		Ap 37,950	S 50,600	
				M 200		M 37,950		
25–35	D 100	C 810	310	A 720		Ap 44,310	S 12,660	
				M 100		M 6,330		
				T 100				
35–45	D 3,160	C 1,200	13,470	A 4,480		Ap 18,990		
				M 200		M 25,320		
				N 200				
				T 310				

SULLIVAN LAKE, WASH., AUGUST 5, 1911.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–1	7,500	5,600			971,000	[1] 2,582,000		
4–5	5,100	17,600	2,000		15,300	[1] 8,830,000		
7–8	7,000	28,200	31,900		63,500	[1] 222,000		
10–11	4,200	11,700	19,700		30,500	[1] 6,252,000		
11–15	2,900	8,600	34,500		15,800	[1] 2,033,000		16,200
15–20	1,200	7,300	22,900		8,000	[1] 1,049,000		7,600
55–60		400	200			[1] 1,856,000		200
75–80		300				[1] 632,500		
90–95	100	500	100			[1] 2,842,000		

SUTHERLAND LAKE, WASH., AUGUST 18, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–4	B 1,020	C 12,400	760	A 27,550	C 726,800	An 221,200		A 442,400
	D 1,020	D 4,590		As 760	D 300,200	Aph 31,600		F 505,600
	Di 34,180			N 510				M 63,200
				P 9,180				
4–8	B 760	C 3,320	510	A 6,480	C 331,800	An 94,800		A 94,800
	D 250	D 760		N 250	D 126,400			F 205,400
	Di 5,610			P 1,270				M 31,600
8–12	B 510	C 8,160	2,290	A 10,000	C 63,200	An 126,400		A 237,000
	Di 6,630	D 2,550		N 510	D 410,800	Aph 31,600		F 94,800
				P 250	M 189,600			
12–16	B 510	C 5,610	7,650	A 10,710	C 47,400	An 15,800	S 15,800	A 47,400
	D 1,520	D 510			D 252,800			F 47,400
	Di 260				M 63,200			M 31,600
16–20	B 8,160	C 13,520	8,420	A 15,560	C 63,200	An 15,800		F 221,200
	D 510			N 1,270	D 47,400			M 15,800
	Di 1,780			P 1,270	M 15,800			
20–26	B 1,530	C 9,180	1,020	A 4,760				C 21,080
				N 340				F 347,820
				P 1,870				

SWAN LAKE, WASH., AUGUST 14, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0–3	Di 6,740	C 8,840	4,760	A 670	C 42,200	An 21,100	S 21,100	
		E 2,380		C 1,700	D 21,100			
				M 1,360				
				N 670				
				P 1,360				
3–6	Di 1,360	C 2,370		M 340	C 42,200	N 168,800		
		E 1,360		N 1,360	D 63,300	M 168,800		
				P 2,030				
6–9		C 1,700	3,060	M 340	C 21,100	M 42,200		
				N 1,700				
				P 1,700				

[1] Includes both blue-green and green algæ.

TABLE 12.—*Analysis of net plankton of lakes examined*—Continued.

SWAN LAKE, WASH., AUGUST 14, 1913—Continued.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
9-12		C 6,120		C 670	D 21,100	M 211,000		
		E 670	29,230	M 670				
				N 3,060				
				P 2,380				
12-15		C 4,420	23,470	A 670	C 42,200	M 42,200		
				M 1,360				
				N 1,700				
				P 670				
15-18		C 1,010	5,100	M 670	C 21,100	M 42,200		
				N 670		N 21,100		
				P 3,060				
18-21		C 3,730	27,210	A 2,050	C 21,100	M 63,300		
				M 670				
				N 1,010				
				P 5,100				

LAKE TAHOE, CALIF., JULY 22, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0-10		E 6,220	1,120	N 200			M 12,660	
10-20		E 3,370	200	N 100			M 6,330	
20-30		E 1,630	100	N 100	C 6,330		M 25,320	
							S 6,330	
							Z 6,330	
30-40		E 5,500	100	N 100			M 50,640	
40-50		E 4,180	100	N 100			M 94,950	
50-60	D 100	E 3,060		N 200			M 196,230	
							S 12,660	
							Z 6,330	
60-80	D 50	E 1,780	50	N 50			M 549,840	
							S 25,280	
80-100		E 1,210		N 50			M 575,120	
							S 6,330	
100-200	D 20	E 510					M 338,940	
							S 5,040	
							Z 2,520	
200-300	D 10	E 10					M 68,670	
300-400		E 10					M 25,200	
							S 630	
400-500							M 17,120	

LAKE TAHOE, CALIF., JULY 23, 1913.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
0-5, 5 a. m.		E 2,650	2,040					
0-5, 10 a. m.		E 2,060	1,020					
0-5, 4 p. m.		E 9,580	2,040					
0-5, 9 p. m.		E 15,310	1,220					
5-10, 5 a. m.		E 4,690	410					
5-10, 10 a. m.		E 5,920	200					
5-10, 4 p. m.		E 13,800	1,020					
5-10, 9 p. m.		E 7,980	410					
10-15, 5 a. m.		E 4,880	200					
10-15, 10 a. m.		E 6,530	410					
10-15, 4 p. m.		E 11,020	820					
10-15, 9 p. m.		E 2,440	200					
15-20, 5 a. m.		E 3,270	200					
15-20, 10 a. m.		E 3,470	200					
15-20, 4 p. m.		E 9,800	1,430					
15-20, 9 p. m.		E 3,670	200					
20-25, 5 a. m.		E 2,240	200					
20-25, 10 a. m.		E 2,860	200					
20-25, 4 p. m.		E 10,000	820					
20-25, 9 p. m.		E 2,240	200					
25-30, 5 a. m.		E 1,630	200					
25-30, 10 a. m.		E 2,240	200					
25-30, 4 p. m.		E 4,690	610					
25-30, 9 p. m.		E 1,630	200					
30-40, 5 a. m.		E 1,840	100					
30-40, 10 a. m.		E 4,280	300					
30-40, 4 p. m.		E 3,770	300					
30-40, 9 p. m.		E 1,740	200					
40-50, 5 a. m.		E 2,440	100					
40-50, 10 a. m.		E 3,570	100					
40-50, 4 p. m.		E 3,470	100					
40-50, 9 p. m.		E 2,240	200					

TABLE 12.—*Analysis of net plankton of lakes examined*—Continued.

Depth, meters.	Cladocera.	Copepoda.	Nauplii.	Rotifera.	Protozoa.	Blue-green algæ.	Green algæ.	Diatoms.
LAKE TAPPS, WASH., AUGUST 19, 1913.								
0-4	D 4,830	C 250	5,610	A 2,040	C 600,400	An 63,200	S 63,200	A 884,800
		D 1,270		N 1,020	D 31,600	Aph 1,200,800		
				P 510		M 1,580,000		
4-8	D 250	C 250	510	A 760	C 110,600	An 31,600		
		D 250		As 510	D 15,800	Aph 537,200		
						M 821,600		
8-12	D 250	C 510	760	A 510	C 63,200	An 31,600		A 142,200
				P 760		Aph 474,000		
						M 505,600		
12-16	D 250	C 250	510	A 250	C 94,800	An 47,400	S 31,600	A 126,400
				N 250	D 15,800	Aph 363,400		
				P 510		M 916,400		
16-20		C 510	510	A 760	C 15,800	An 94,800		A 31,600
				As 510		Aph 316,000		
				P 250		M 268,600		
20-24	D 250	C 510	6,380	A 1,270	C 15,800	An 15,800		
		D 4,320		As 510		Aph 126,400		
				N 510		M 142,200		
				P 1,020				
UPPER KLAMATH LAKE, OREG., JULY 29, 1913.								
0-2	Di 2,040	D 7,140	4,080	A 1,300	C 2,179,100	An 933,900	P 2,054,580	C 9,961,600
				M 1,000		Ap 123,520	S 373,560	M 13,572,680
				T 400		M 2,801,700		N 622,600
						N 155,650		
2-4	Di 3,060	D 3,060	7,140	A 700	C 496,160	An 1,089,550	P 1,307,460	C 2,992,640
				M 800		Ap 124,520	S 373,560	M 16,000,820
				T 300		M 1,245,200		N 435,820
						N 280,170		
4-6	Di 6,120	D 3,060	12,750	A 400	C 747,120	An 1,556,500	P 622,600	C 4,856,280
				M 800		Ap 249,040	S 747,120	M 19,425,120
				T 200		M 871,640		N 435,820
						N 622,600		
6-8	Di 7,140	D 1,020	6,120	A 100	C 1,494,240	An 1,245,200	P 249,040	C 8,098,000
				M 100		Ap 124,520		M 19,425,120
				T 100		M 622,600		N 155,650
						N 373,560		
8-10	Di 17,340	D 1,020	4,080	A 300	C 404,690	An 1,369,420	P 747,120	C 11,642,620
				M 300		Ap 61,260		M 15,565,000
						N 311,300		N 186,780
UPPER PRIEST LAKE, IDAHO, JULY 22, 1911.								
0-5	13,300	12,800	8,050		40,400	[1] 41,000		
5-10	26,300	67,000	7,900		99,200	[1] 506,000		
10-15	12,800	10,100	7,400		3,100	[1] 173,500		
27-32	3,000	6,400	9,700		1,100			
UPPER TWIN LAKE, IDAHO, AUGUST 2, 1911.								
0-1						[1] 137,500,000		
4.5-5.5						[1] 42,600,000		
LAKE WASHINGTON, WASH., AUGUST 9, 1913.								
0-5	B 2,040	C 2,650	1,230	N 410		An 50,600	S 12,650	A 12,650
	Di 2,860	E 43,590						C 12,650
5-10	B 3,680	C 5,920	2,650	A 210	C 12,650	An 12,650	S 12,650	
	Di 3,270	E 20,400		N 820		Aph 50,600		
10-15	B 6,730	C 1,230	6,130	M 410		An 12,650	P 12,650	C 25,300
		E 2,860						
15-20	B 1,630	C 410	2,860					
		E 4,090						
15-30							S 37,950	C 37,950
20-25		C 610	2,450					
		E 1,430						
25-30	B 410	C 610	1,030					
		E 2,460						

[1] Includes both blue-green and green algæ.

TABLE 12.—*Analysis of net plankton of lakes examined*—Continued.

Depth, meters.	Cladocera.		Copepoda.		Nauplii.	Rotifera.		Protozoa.		Blue-green algæ.		Green algæ.		Diatoms.	
LAKE WASHINGTON, WASH., AUGUST 9, 1913—Continued.															
30-40	B	100	C	1,120	810										
			E	1,630											
40-50	B	100	C	1,840	410										
			E	1,320											
30-50												P	12,650	C	12,650
												S	12,650		
50-60			C	2,240	510	N	340					P	12,650		
			E	810											
LAKE WHATCOM, WASH., AUGUST 20, 1913.															
	B	610	C	820	2,640	N	200	C	25,300	Ap	25,300			A	12,650
0-5	D	200	E	4,680		P	820			M	25,300				
	Di	410													
	B	820	C	3,050	2,230	C	1,830	C	12,650	An	12,650			A	12,650
5-10	D	610	E	2,030		P	1,220			Ap	12,650				
	Di	610								M	12,650				
	B	200	C	820	1,220	C	200			Ap	12,650			A	12,650
10-15	D	200	E	200		N	410								
						P	410								
15-20	D	40	C	1,420	4,070	N	410							A	12,650
						P	200								
20-30	D	100	C	1,630	3,980	N	100								
			E	200		P	200							C	6,330
30-40			C	1,320	610	N	200			M	6,330			C	6,330
						P	100								
40-50			C	1,320	310	N	200	C	3,160					C	6,330
50-70			C	360	100			C	3,160						
70-95			C	970	120	N	40	C	2,530						
						P	40								
LAKE WILDWOOD, WASH., AUGUST 24, 1913.															
	D	1,010	C	4,420	5,450	A	340	C	21,100					M	21,100
0-3			D	1,010		C	340	D	42,200						
						M	340								
						T	1,360								
	D	1,680	C	4,420	3,400	A	670	C	147,700					A	21,100
			D	1,010		C	670								
3-6						M	1,010								
						P	5,100								
						T	670								
	D	1,110	C	1,360	9,520	M	340	C	21,100			S	21,100	A	21,100
6-9						P	2,720								
						T	1,700								
			C	2,380	4,420	A	1,010	C	21,100					A	21,100
						M	340								
9-12						N	1,700								
						P	4,760								
						T	11,570								
	D	400	C	2,350	7,140	A	810					An	12,650	A	12,650
12-17						As	200	C	25,300						
						P	8,160								
						T	2,150								
17-22	D	200	C	610	610	P	1,430	C	12,650					A	12,650
						T	1,430								
WILLIAMS LAKE, WASH., AUGUST 23, 1911, 10 A. M.															
0-2		124,800							24,951,000						1,648,000
3-5		42,200		500	500				9,550,000						1,413,000
9-11		5,400		500					7,530,000						74,000
13-15		1,040			500				89,700						6,500
WRIGHT LAKE, IDAHO, AUGUST 24, 1912.															
0-6	Di	220	C	990	1,770	C	1,430	C	2,100	An	10,500			M	2,100
	Dh	3,420	D	1,540		N	770			Gl	20,000				

Table 13.—*Geographical distribution of plankton Crustacea in lakes examined.*

Species.	Bear Lake, Idaho, Aug. 8, 1912, 10 a. m.	Henry Lake, Idaho, Aug. 10, 1912, 10 a. m.	Stanley Creek, 3 p. m.	Marsh, 11 a. m.	Payette Lakes, Idaho, Aug. 15, 1912, 2.30 p. m.	Lake Coeur d'Alene, Idaho, Aug. 21, 1912, 9 a. m.	Lake Chatcolet, Idaho, Aug. 22, 1912, 10 a. m.	Marsh, 1 p. m.	St. Maries River, at St. Maries, Idaho, Aug. 24, 1912.
Bosmina longirostris var. brevicornis O. F. Muller 1785		x			x	x		x	
longirostris var. cornuta O. F. Muller 1785									x
Camptocercus rectirostris Schoedler 1862						x			
Canthocamptus northumbricus var. americanus Herrick	x								
Ceriodaphnia pulchella Sars 1862								x	
quadrangula O. F. Muller 1785		x							
Chydorus sphæricus O. F. Muller 1785								x	x
Cyclops bicolor Sars 1863					x	x			
bicuspidatus Claus 1857							x		
serrulatus Fischer 1851		x	x					x	
viridis Jurine 1820				x					
viridis var. parcus Herrick 1882						x			
sp. (no mature females)									x
Daphnia longispina O. F. Muller 1785		x	x	x					
longispina var. hyalina Leydig 1860	x				x	x	x	x	
Diaphanosoma brachyurum Lieven 1848					x	x	x		
leuchtenbergianum Fischer 1850		x						x	
Diaptomus ashlandi Marsh 1893							x		
leptopus Forbes 1882		x							
shoshone Forbes 1893								x	
sp. (no mature males)					x				
Epischura nevadensis Lilljeborg 1889	x								
Eurycercus lamellatus O. F. Muller 1785		x	x	x					
Gammarus limnæus Smith 1871		x							
Hyalella knickerbockeri Bate 1862		x							
Polyphemus pediculus Linné 1761		x	x	x					
Scapholeberis mucronata O. F. Muller 1785								x	x
Simocephalus vetulus O. F. Muller 1785									x

Species.	Marsh.	Hayden Lake, Idaho, Aug. 25, 1912, 10 a. m.	Wright Lake, Idaho, Aug. 25, 1912, 2 p. m.	Lake Pend Oreille, Idaho, Aug. 27, 1912, 10 a. m.	Medical Lake, Wash., Sept. 2, 1912, 11 a. m.	Spring.	Little Medical Lake, Wash., Sept. 2, 1912.	Clear Lake, Wash., Sept. 2, 1912, 9 a. m.	Fish Trap Lake, Wash., Sept. 1, 1912, 11 a. m.
Alona costata Sars 1862						x			
guttata Sars 1862	x								
Bosmina longirostris var. brevicornis O. F. Muller 1785		x							
Ceriodaphnia pulchella Sars 1862	x				x			x	x
quadrangula O. F. Muller 1785							x		
Chydorus sphæricus O. F. Muller 1785	x					x			
Cyclops bicuspidatus Claus 1857	x	x		x				x	x
serrulatus Fischer 1851	x								
Daphnia longispina var. hyalina Leydig 1860		x	x	x					x
pulex De Geer 1778					x	x	x	x	
Diaphanosoma leuchtenbergianum Fischer 1850		x							
Diaptomus ashlandi Marsh 1893				x					
leptopus var. piscinæ Forbes 1893			x						
sicilis Forbes 1882					x				
signicauda Lilljeborg 1889									x
tenuicaudatus Marsh 1907							x		
female (probably oregonensis)						x			
Epischura nevadensis Lilljeborg 1889		x		x					
Eurycercus lamellatus O. F. Muller 1785	x							x	
Leydigia quadrangularis Leydig 1860					x				
Simocephalus vetulus O. F. Muller 1785	x								

TABLE 13.—*Geographical distribution of plankton Crustacea in lakes examined*—Continued.

Species.	Lake Union, Wash., Dec. 7, 1896. (Aug. 10, 1913, 2 p.m.[1]).	Lake Washington, Wash., Nov. 24, 1896. (Aug. 9, 1913, 4 p.m.[1]).	Alturus Lake, Wash., July 23, 1896.	Crater Lake, Oreg., Aug. 21, 1896. (Aug. 1, 1913, 11 a. m.[1]).	Tsiltcoos Lake, Oreg., Dec. 1, 1896.	Lake Tahoe, Calif., July 22, 1913, 9 a.m.	Marsh. July 23, 1913, 4 p.m.	Truckee River, July 23, 1913, 5 p.m.
Acroperus angustatus Sars 1863								x
harpæ Baird 1835		(2)						
Alona affinis Leydig 1860	(2)	(2)						
costata Sars 1862	(2)	(2)						
quadrangularis O. F. Muller 1785								x
Bosmina longirostris var. brevicornis O. F. Muller 1785				x				
longispina Leydig 1860	(2)	(2)		(2)				
Camptocercus rectirostris Schoedler 1862	(2)	(2)						x
Ceriodaphina recticulata Jurine 1820	x (2)							
Chydorus sphæricus O. F. Muller 1785	(2)	(2)		(2)			x	
Cyclops albidus Jurine 1820				(2)				
bicolor Sars 1863		(2)						
bicuspidatus Claus 1857				x				
viridis var. americanus Marsh 1893			x					x
Daphnia longispina var. hyalina Leydig 1860	x	x	x	x	x	x		
pulex De Geer 1778						x		
pulex, probably middendorffiana				(2)				
Diaphanosoma brachyurum Lieven 1848		x						
leuchtenbergianum Fischer 1850		(2)						
Diaptomus ashlandi Marsh 1893		x (2)						
sp. (no mature males)			x			x		
Drepanothrix dentata Sars 1861		x						
Epischura nevadensis Lilljeborg 1889		x (2)		x	x	x		
Eurycercus lamellatus O. F. Muller 1785	(2)	(2)						x
Graptoleberis tustudinaria Fischer 1848		(2)						
Hyalella azteca knickerbockeri Bate 1862				(2)				
Oxyurella tenuicaudis Sars 1862				(2)			x	
Pleuroxus denticulatus Birge 1877	(2)							x
procurvatus Birge 1878	(2)	(2)						
striatus Schoedler 1863	(2)							
Polyphemus pediculus Linné 1761			x					
Scapholeberis mucronata O. F. Muller 1785	(2)							
Sida crystallina O. F. Muller 1785	(2)							

Species.	Fallen Leaf Lake, Calif., July 25, 1913, 10 a. m.	Upper Klamath Lake, Oreg., July 29, 1913, 3 p. m.	Green Lake, Wash., Aug. 9, 1913, 11 a. m.	Paradise Lake, Wash., Aug. 13, 1913, 11 a. m.	Lake Sammamish, Wash., Aug. 13, 1913, 10 a. m.	Cottage Lake, Wash., Aug. 13, 1913, 4 p. m.	Swan Lake, Wash., Aug. 14, 1913, 10 a. m.	Cow Lake, Wash., Aug. 14, 1913, 2 p. m.	Lake Crescent, Wash., Aug. 17, 1913, 9 a. m.
Alona quadrangularis O. F. Muller 1785			x						
Bosmina longirostris O. F. Muller 1785	x							x	
longispina Leydig 1860			x						
obtusirostris Sars 1861					x				x
Cyclops bicuspidatus Claus 1857			x	x	x	x			
modestus Herrick 1883								x	
viridis var. parcus Herrick 1882	x						x		
Daphnia longispina O. F. Muller 1785				x				x	
longispina var. hyalina Leydig 1860			x						x
pulex De Geer 1778	x								x
Diaphanosoma leuchtenbergianum Fischer 1850		x	x	x	x	x	x		
Diaptomus ashalndi Marsh 1893		x							
oregonensis Lilljeborg 1889			x	x					
washingtonensis Marsh 1907	x								
Epischura nevadensis Lilljeborg 1889				x	x	x	x	x	x
nevadensis var columbiæ Forbes 1893									x
Scapholeberis mucronata O. F. Muller 1785					x				

[1] Record of specimen for date in parentheses in boxhead. [2] Record of specimen for a different date.

TABLE 13.—*Geographical distribution of plankton Crustacea in lakes examined*—Continued.

Species.	Lake Sutherland, Wash., Aug. 18, 1913, 9 a. m.	Lake Ta pps, Wash., Aug. 19, 1913, 2 p. m.	Lake Whatcom, Wash., Aug. 20, 1913, 2 p. m.	Lake Samish, Wash., Aug. 21, 1913, 11 a. m.	Lake Padden, Wash., Aug. 21, 1913, 2 p. m.	Lake Wildwood, Wash., Aug. 24, 1913, 10 p. m.	Luna Lake, Wash., Aug. 24, 1913, 2 p. m.	Silver Lake, Wash., Aug. 25, 1913, 1.30 p. m.	Lake Martha, Wash., Aug. 25, 1913, 3 p. m.
Bosmina longirostris O. F. Muller 1785	x					x	x	x	
longispina Leydig 1860			x		x				x
Ceriodaphnia quadrangula O. F. Muller 1785		x							
Chydorus sphæricus O. F. Muller 1785					x				
Cyclops bicolor Sars 1863		x							
bicuspidatus Claus 1857			x	x		x	x	x	
prasinus Fischer 1850	x								
Daphnia longispina var. hyalina Leydig 1860	x	x	x		x	x	x	x	
Diaphanosoma brachyurum Lieven 1848	x				x				
leuchtenbergianum Fischer 1850			x	x			x	x	x
Diaptomus eiseni Lilljeborg 1889		x							
oregonensis Lilljeborg 1889					x	x	x		
tyrelli Poppe 1888	x								
Epischura nevadensis Lilljeborg 1889		x	x	x				x	x
Holopedium gibberium Zaddach 1885									x
Pleuroxus uncinatus Baird 1850							x		
Scapholeberis mucronata O. F. Muller 1785	x								

Species.	Lake Chaplain, Wash., Aug. 26, 1913, 11 a. m.	Lake Goodwin, Wash., Aug. 27, 1913, 11 a. m.	Lake Ki, Wash., Aug. 27, 1913, 10 a. m.	Lake Stevens, Wash., Aug. 28, 1913, 11 a. m.	Lake Steilacoom, Wash., Aug. 29, 1913, 2 p. m.	Lake Spanaway, Wash., Aug. 29, 1913, 4 p. m.	American Lake, Wash., Aug. 29, 1913, 10 a. m.	Lake Chelan, Wash., Sept. 11, 1913, 1 p. m.
Acroperus angustatus Sars 1863								x
Alona affinis Leydig 1860								x
Bosmina longirostris O. F. Muller 1785					x	x	x	
longispina Leydig 1860	x							x
Ceriodaphnia recticulata Jurine 1820					x	x		
Chydorus sphæricus O. F. Muller 1785								x
Cyclops bicuspidatus Claus 1857	x	x	x	x				x
viridis var. americanus Marsh 1893							x	
Daphnia longispina O. F. Muller 1785			x					
longispina var. galeata Sars 1864					x	x		
longispina var. hyalina Leydig 1860	x	x					x	x
pulex De Geer 1778								x
Diaphanosoma leuchtenbergianum Fischer 1850	x	x	x	x	x	x	x	
Diaptomus oregonensis Lilljeborg 1889					x		x	
female (probably oregonensis)								x
Epischura nevadensis Lilljeborg 1889	x	x	x	x	x	x	x	x
Holopedium gibberium Zaddach 1885	x		x					x
Macrothrix laticornis Jurine 1820								x
Sida crystallina O. F. Muller 1785								x

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