FISH-CULTURAL INVESTIGATIONS IN MONTANA, WYOMING, AND TEXAS.

INTRODUCTORY.

The investigations covered by the accompanying reports of Prof. Barton W. Evermann, assistant in the Division of Scientific Inquiry, entitled "A Reconnaissance of the Streams and Lakes of Western Montana and Northwestern Wyoming," and "Report upon Investigations made in Texas in 1891," were undertaken in compliance with instructions from Congress in an act approved March 3, 1891, as follows:

Fish-hatchery in the Rocky Mountain region and Gulf States: For investigation respecting the advisability of establishing a fish-hatching station in the Rocky Mountain region in the States of Montana or Wyoming, and also a station in the Gulf States, one thousand dollars, each; in all, two thousand dollars.

These reports were transmitted to Congress in February, 1892, and were printed as Senate Miscellaneous Document No. 65, Fifty-second Congress, first session. The importance of the information conveyed in them has made it desirable that they should be put in a form that will permit of wider circulation, and they accordingly are presented as articles of the Bulletin.

The direct object of the investigations was for the purpose of determining the best locations for fish-cultural operations in the regions mentioned, but their scope was made more comprehensive for reasons which are obvious. The character of the fish-cultural operations which may be profitably undertaken in any region varies with climatic conditions and with the physical, chemical, and biotic features of its waters. These factors must be more or less accurately known in order to determine the extent and nature of the fish-cultural installation needed and to direct advantageously the stocking of the waters in the interest of which a station is sought to be established.

In Montana and Wyoming the field explorations were begun at Helena, Montana, July 18, 1891, and continued until August 27; in Texas they commenced November 2 and were prosecuted until December 7.

The field of investigation, both in the Rocky Mountain region and in Texas, was limited; it was not practicable, nor was it necessary for the particular purpose to be accomplished, to explore the entire area of the States named. From a knowledge of the conditions to be fulfilled I was able to limit the area to be examined and thus permit a more detailed and careful inquiry than would have been otherwise possible with the limited means available.

Important duties in connection with the operations of the Fish Commission steamer *Albatross* required Prof. Evermann's presence aboard the vessel before he was able to fully complete his studies of the fishes obtained in Texas. As soon as opportunity will permit, a supplementary report on the subject will be presented.

MARSHALL MCDONALD,
Commissioner.

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1.—A RECONNAISSANCE OF THE STREAMS AND LAKES OF WESTERN MONTANA AND NORTHWESTERN WYOMING.

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SUMMARY OF REPORT.

In this paper are presented the results of investigations in Montana and Wyoming made during the summer of 1891 under the direction of the U. S. Commissioner of Fish and Fisheries.

In carrying out the instructions furnished by the Commissioner, it was highly important that a careful study be made of the physical and natural-history features of the streams and lakes of the region. Attention was given to the general characters of the streams and lakes, their size, depth, current; the nature of obstructions, if any, in the streams; the source of water supply, whether from lakes, springs, or melting snow; the temperature of the water at different times and different places; its clearness, and to what extent contaminated by mining operations or heavy rains; the geology of the region through which the stream flows, and the composition and nature of the bottom and banks of each river or lake.

In studying the natural-history features of the streams special attention was given to the kinds of fishes they contain, their abundance, size, condition, and distribution; also to the invertebrate life, such as crustaceans, insects, and mollusks, serving as food for the fishes.

The important question of the geographical distribution of fishes was kept constantly in mind, and attempts were made to trace the limits in the range of certain species, and to determine, if possible, the definite solution of certain difficult problems presented in the distribution of the trout and blob in Yellowstone National Park.

In making my investigations looking toward the selection of a suitable site for a fish-cultural station, visits were made to as many places as our time would permit, or as was necessary for the purposes of the investigation. The station for this region would be devoted almost exclusively to the hatching and rearing of various species of trout and other *Salmonidæ*. The requirements for the successful operation of such a station may be stated briefly as follows:

1. *Pure water:* (*a*) A constant supply of not less than 1,000 gallons per minute. (*b*) The temperature should not at any time exceed 50° or 55°, and would better be under 50°. (*c*) There should be no danger of contamination from any source.

2. *Suitable ground:* (*a*) The amount should be 20 to 30 acres. (*b*) It should lie conveniently near to the source of water supply. (*c*) There should be sufficient fall

between the source of water supply and the hatchery building to permit a gravity supply. (*d*) The ground should lie so as to permit easy drainage of any or all of the ponds.

3. *The location* should be: (*a*) Central with reference to the region to be stocked. (*b*) Such as to afford good railroad facilities.

In the detailed portion of this report I have discussed at length the advantages offered by fourteen of the most promising localities. The one most nearly filling all the natural requirements is Horsethief Springs. These springs, located in Montana, near the northwest corner of the Yellowstone National Park, are among the largest and most remarkable that are to be found anywhere in the United States. Their remoteness from a railroad is apparently the only objection to them.

The springs at Botteler's ranch, just north of the Park, are excellent in every way, as are also the Davies Springs, near Bozeman. Child's bedrock drain near Helena, Cottonwood Creek at Deer Lodge, and Rattlesnake Creek near Missoula are places that should be considered, as each offers advantages of one kind or another.

After considering the advantages offered by each of these various places, I would recommend that the selection be made from the three which are near the Yellowstone National Park, viz, Horsethief Springs, Botteler Springs, and Davies Springs.

BRIEF STATEMENT OF ITINERARY.

I left Washington July 7, 1891, for the West, and, being joined at Terre Haute, Indiana, by Prof. O. P. Jenkins, of Leland Stanford Junior University, and Mr. Burnside Clapham, of Monroeville, Indiana, we proceeded to Leadville, Colorado, where we remained until July 15, when we left for Helena, Montana, where we arrived on the morning of the 18th. Here we began our work by examining the streams of that vicinity. From there we proceeded westward to Elliston, then south to Deer Lodge, Dillon, and Red Rock, carefully examining the waters of that region. Returning, we spent a little time at Silver Bow, then proceeded northwest to Missoula, where we spent three days exploring the streams accessible from that place. From Missoula we went still farther northwest to Ravalli, then by stage across the Flathead Indian Reservation to Flathead Lake, where we took the boat for Demersville, on Flathead River, about 30 miles above the head of the lake. After spending a day at Demersville, we took the steam yacht *Lillian*, which had been placed at our disposal by the owners, Hon. William Muth and Mr. Edward Harwood, and went down the river to the east side of the lake at the mouth of Swan River, where we stopped at the quarters of the Helena Rod and Gun Club for two days, during which time we examined that part of Flathead Lake, the Swan River, and made a trip across the country 7 miles to Swan Lake. Leaving the Flathead Lake region August 4, we returned to Helena, where we spent a day inspecting Hon. W. C. Child's bedrock drain, and then proceeded to Mammoth Hot Springs in the Yellowstone National Park. Here we secured a proper camping outfit, and started out August 7 for a tour of three weeks through the Yellowstone National Park and the little-known region in Wyoming lying south of the Park.

During this expedition we had as our guide Mr. Elwood Hofer, whose energy, intimate acquaintance with the region, and personal knowledge of the work already done by the Commission in the Park, made his services invaluable to us.

The objects of this trip were:

(1) In compliance with our instructions, we desired to visit all the waters of the Park in which plantings of various species of *Salmonidæ* had been made by the Commission in 1889 and 1890, to determine, if possible, the measure of success that has attended that work;

(2) A more thorough study of the streams of the Park than had hitherto been made was necessary to an understanding of the very interesting questions of geographic distribution which are there presented;

(3) It was desirable, as a part of the question of distribution, to visit the region at the headwaters of Atlantic and Pacific creeks, and to determine, if possible, the exact nature of the famous Two-Ocean Pass as a barrier to the distribution of fishes;

(4) We desired to make investigations with a view to discovering if there are not yet other waters in or near the Park that are without fish and the stocking of which might very properly be undertaken by the Commission; and

(5) We wished to examine various streams and springs in and about the Park with reference to the selection of a site for the location of a fish-cultural station, if any suitable could be found in that region.

It may be added here, that these explorations were very satisfactory from both the economic and scientific points of view, the results being among the most important obtained during the summer's work.

We returned to Mammoth Hot Springs at noon, August 25. The afternoon of that day and the day following were spent in examining the streams in that vicinity and at Cinnabar and Horr, just north of the Park line. On the evening of the 26th I went by rail to Bozeman, leaving Prof. Jenkins and Mr. Clapham to examine Botteler Springs, between Cinnabar and Livingston. After spending one day inspecting the streams and springs about Bozeman, I returned to Livingston, where I was again joined by Prof. Jenkins and Mr. Clapham. We decided here to close our investigations for the season.

ACKNOWLEDGMENTS.

In this connection I desire to express the thanks of myself and the other members of my party to the various gentlemen in Montana and Wyoming who assisted us in various ways in our work. Mention should first be made of Senator T. C. Power, who is greatly interested in the efforts of the Fish Commission looking toward increasing the value of the food-fishes of Montana. Senator Power took pains to acquaint the people of the State with the purposes of our visit, and through him we were enabled to meet many of the most prominent citizens, who rendered us assistance in many ways. At Helena numerous courtesies were extended to us by Maj. Robert C. Walker, secretary of the board of trade; also by Hon. William Muth and Hon. W. C. Child. At Deer Lodge we were able to make more thorough and extensive explorations than would have otherwise been practicable through the kindness of Mr. N. J. Bielenberg, Mr. Frank Conley, superintendent of the State prison, and Prof. Frank Traphagen, of the College of Montana. At Missoula we were assisted in visiting the various streams of that region by Hon. W. M. Bickford and Mr. E. A. Winstanley, and were shown favors by other gentlemen of that city.

We were enabled to visit the Swan Lake region through the kindness of Mr. Edward Harwood, of Demersville, and Hon. William Muth, who placed their small

steamer at our disposal. Mr. Harwood accompanied us on all of our trips about this region and assisted us in many ways. I was able to make much more thorough investigations in the vicinity of Bozeman than would otherwise have been possible in the time at my disposal, through the kind and courteous assistance of Hon. O. P. Chisholm, Walter Cooper, esq., and Mr. W. A. Imes. To Capt. George S. Anderson, U. S. Army, acting superintendent of the Yellowstone National Park, we are under special obligations for the loan of blankets and other articles, which added greatly to the comfort of our trip through the Park. Capt. Anderson takes an active and intelligent interest in the efforts of the Commission to stock the Park with valuable food-fishes, and is ever ready to assist it in all proper ways. The opportunity to make the trip from Cañon Hotel to Horsethief Springs was due to the kindness of Mr. R. R. Cummins, who furnished free conveyance to the springs and back again to Mammoth Hot Springs.

REPORT OF THE INVESTIGATIONS.

ITINERARY.

July 7. Left Washington, District of Columbia, for Leadville, Colorado; was joined at Terre Haute, Indiana, by Prof. O. P. Jenkins and Mr. Burnside Clapham, and arrived at Leadville July 12.
July 13–14. Spent at the Government hatchery at Evergreen Lakes, near Leadville.
July 15. Left Leadville for Helena, Montana, where we arrived July 18.
July 20. Drove to McClellan and Prickly Pear creeks, east of Helena.
July 21. Went to Elliston, where we seined Little Blackfoot River.
July 22. Went to Deer Lodge; seined Cottonwood Creek and Deer Lodge River.
July 23. Started with teams and saddle horses for the headwaters of Dempsey Creek, returning July 25; examined Tincup Joe, Punch, Dempsey, and Race-Track creeks, and the lakes near Mount Powell, at the head of Dempsey Creek.
July 25. Went to Dillon.
July 26. Mr. Clapham went to Red Rock, where he seined the Red Rock River the next day.
July 27. Prof. Jenkins and I seined the Beaverhead River near Dillon. Went to Silver Bow in the evening and examined Browns Gulch Creek.
July 28. Went to Missoula; drove up Rattlesnake Creek several miles and examined it down to its mouth.
July 29. Drove to Big Blackfoot River.
July 30. Drove to Bitter Root River and Lolo Creek, about 12 miles south of Missoula.
July 31. Went to Ravalli, and drove from there to St. Ignatius Mission, where we examined Mission Creek; returned to Ravalli in the afternoon and seined Jocko River.
August 1. Took the stage for Flathead Lake, where we took the steamer for Demersville, on Flathead River, which we examined in the evening.
August 2. Went on the steam launch down the river to the mouth of Swan River.
August 3. Drove through the woods 7 miles to Swan Lake; examined the lake, river, and Depew Creek.
August 4. Returned to Ravalli and took train for Helena.
August 5. Drove to Mr. Child's ranch.
August 6. Went to Mammoth Hot Springs, Yellowstone National Park.
August 7. Started out from Mammoth Hot Springs equipped for a three-weeks' camping expedition. Traveled about 12 miles and camped at head of Beaver Lake.
August 8. Traveled 18 miles to Cañon Creek, where we camped. Prof. Jenkins and Mr. Hofer made a detour to examine Gibbon River above Virginia Cascade.
August 9. Traveled 9 miles to Nez Percé Creek, Prof. Jenkins and Mr. Clapham making a side trip to the junction of Firehole and Gibbon rivers.
August 10. Rode about 10 miles to Firehole River, just above Old Faithful, where we camped.

August 11. Traveled 16 miles up the Firehole River, across the Divide and to the outlet of Shoshone Lake, where we made our fifth camp.
August 12. Shoshone Lake to Lewis River, below the upper falls, 10 miles.
August 13. Lewis River across Crawfish Creek near Moose Falls to President Camp, on Snake River, 20 miles.
August 14. Crossed Snake River and proceeded southward to Jackson Lake, 12 miles.
August 15. Turned eastward and camped on Pacific Creek, 12 miles from Jackson Lake.
August 16. Followed up Pacific Creek 18 miles, where we again camped.
August 17. Followed on up Pacific Creek 7 miles to Two-Ocean Pass, where we spent the day.
August 18. Followed down Atlantic Creek to its mouth, crossed the Upper Yellowstone River, and camped on Thoroughfare Creek, 12 miles.
August 19. Traveled 18 miles to the mouth of the Upper Yellowstone River, camping near the mouth of Beaverdam Creek.
August 20. Traveled along east side of Yellowstone Lake 10 miles to the mouth of Meadow Creek.
August 21. Followed on down east shore of the lake to the Yellowstone River, crossed over, and went up to Lake Hotel for mail, the rest of the party camping at mouth of Pelican Creek.
August 22. Proceeded down Yellowstone River to the Grand Cañon.
August 23. I left the party here and went across the country to the Norris Basin, from which place I accompanied Mr. R. R. Cummins to Horsethief Springs, about 42 miles west. The rest of the party proceeded down Yellowstone River to the foot of Mount Washburn, where they camped.
August 24. Examined Horsethief Springs and returned to Norris Hotel. The main party traveled on to Blacktail Deer Creek.
August 25. All members of the party reached Mammoth Hot Springs at noon.
August 26. Rode to Reese Creek above Cinnabar. Took the train in the evening, Prof. Jenkins and Mr. Clapham stopping off at Fridley's to examine Botteler Springs, while I went on to Bozeman.
August 27. Examined streams about Bozeman. Returning to Livingston that night, I was joined there by Prof. Jenkins and Mr. Clapham, and we took the train for the east.

PHYSICAL FEATURES OF THE REGION EXAMINED.

The desirability of reaching as many places as possible in the investigations pertaining to the selection of a site for the hatchery required us to cover a much wider area in the season's work than would otherwise have been advisable. Nothing like a thorough survey of the entire region traversed was possible in the time which we had to devote to it.

In the measurement of the streams, the widths and depths given are the average for the distance through which we measured the current. The rate of the current was obtained by timing a floater, and the rate given is usually the average of the results of several tests. Usually the floater was timed for a distance of 50 to 100 feet. The measurements taken were under rather than over; hence the volume determined for each stream is believed to be slightly under the exact amount. The volume given is the number of gallons the stream discharges per minute.

The temperatures were taken with one of Wilder's standard Fahrenheit thermometers, and, unless otherwise stated, the temperature given is that of the water near the surface. The seining was done with two Baird collecting seines, one 15 feet, the other 30 feet long.

According to Dr. Hayden,* Montana is separated into two very unequal areas by the dividing range of the Rocky Mountains, which forms the southwestern boundary from the west line of Wyoming to the intersection of 45° 40′ north latitude and the 114th meridian. Here it suddenly bends eastward for some distance, and then runs north about 20° west to the northern boundary of the State. Extending from

* U. S. Geological Survey of Montana and adjacent Territory, 1871.

the mouth of the Yellowstone to the summit of the Bitter Root Mountains, about two-fifths belong to the mountain region, the remaining three-fifths consisting of broad, open plains lying east of the Rocky Mountain range. The mountain belt, which forms a broad margin along the western end, has probably an average width of 175 miles, running northwest parallel to the western boundary. Besides these two leading ranges and their interlocking spurs on the west slope, there are some minor ranges on the eastern side, which, though comparatively small in extent, are important in respect to the influence they have upon the course of the water drainage and the form and direction of the principal valleys.

In and about the Yellowstone National Park appears to be the great mountain nucleus of this region. Here the Bighorn, Yellowstone, Gallatin, Madison, Jefferson, Snake, and Green rivers have their origin. From this mountain center a number of short ranges run northward, giving direction to a number of streams. Along the southern border the Snow Mountains penetrate Montana for a short distance, compelling the Yellowstone River to make a grand detour in order to sweep around the northern flank. In the central portion are the Belt, Judith, and Highwood mountains, forming an irregular group of short and broken ranges, around which the Missouri sweeps to the northward before entering upon its long eastward stretch. These also have a nucleus where the Musselshell, Judith, Deep, and Shields rivers take their rise.

The mountains of this region, as a rule, are less rugged than those of Colorado. There are some very rough, rocky groups, such as the Grand Tétons, portions of the Main Divide southeast of Flathead Lake, and a number of peaks east of Yellowstone Lake. Instead of the rocky, jagged sides and serrated crests, we usually see here smooth slopes and rounded outlines.

According to Dr. Hayden, the elevation of both mountains and valleys of Montana is less than that of the great mountain belt of Colorado, Wyoming, Utah, Nevada, and New Mexico. The average altitude of the entire State is given as being 2,260 feet lower than that of the other States named, a difference regarded as the equivalent of seven degrees in latitude.

Climate.—Western Montana and northwestern Wyoming are among the most fortunate regions of America as regards rain and snow. According to Prof. Arnold Hague, "snow falls early in October [in the National Park region] and rarely disappears before June, and throughout the winter it is said to lie 6 feet in depth over the plateaus and higher regions of the Park."

A discussion of the forests and other vegetation will be given in detail in connection with the description of each stream or particular locality examined. It may be said here, however, that western Montana and Wyoming constitute a vast region which is for the most part covered with immense coniferous forests on the mountains, while here and there are a few large tracts with little or no timber, such as the plain at the south end of Flathead Lake, constituting the greater part of the Flathead Indian Reservation, and such valleys as those of the Prickly Pear and Deer Lodge. On the mountains the timber line is not far from 9,000 feet above sea level. At this height the dwarfed, scraggy spruce trees are mere bushes, not over a yard in length, and lie pressed flat upon the ground by the heavy snows. The forests are extremely heavy on the Big Blackfoot River, about Swan Lake, below Dempsey Lakes, and the region south and east of the Yellowstone National Park which has recently been added to the Park as a timber preserve by proclamation of President Harrison.

Drainage.—The whole State of Montana and that portion of Wyoming visited by us are drained entirely by the Columbia and the Missouri, the headwaters of those two great rivers having their rise on the Great Continental Divide, near which our investigations were chiefly confined. By far the greater part of Montana, nearly all that portion lying east of the meridian of 112° 30′, lies within the Missouri drainage area. In the northwest part of the State the divide lies more than a degree farther west, and in the southwest the Missouri drainage extends westward to the Idaho State line. The Missouri also drains all of northwest Wyoming excepting the southwest portion of the National Park and part of the region south of the Park. This part of Wyoming belongs to the Columbia River Basin, being drained directly by the Snake River and its tributaries. In general it may be said that the streams of the Missouri system flow in a northeast or northerly direction. Those tributary to Clarke Fork of the Columbia flow to the northwest, while the drainage into the Snake River or Lewis Fork of the Columbia is to the southwest.

Nearly all of these rivers and creeks are, of course, swift mountain streams; most of them have their rise in small lakes of clear, cold water, high up in the mountains—lakes which as yet are difficult of access and but little known. Many of these lakes are known, however, to be well supplied with trout, while others are wholly without any fish life whatever. From these mountain lakes the swiftly flowing, turbulent streams make their descent through rocky gorges and cañons to the valleys below. Ordinarily the beds of the streams are very rocky, but now and then are found more quiet reaches where the streams have sand or gravel beds as they flow through small mountain meadows. Then, at other places, there are rapids and cascades, and in many of the streams are found considerable waterfalls. The best illustrations of this are in the numerous magnificent falls found in the streams flowing from the great volcanic plateau constituting the larger part of the Yellowstone National Park. As the streams leave this immense sheet of rhyolite, they do so in great falls, such as those of the Yellowstone, Gibbon, and Lewis rivers. Others of the same nature are to be found in the country lying to the east of the National Park in the Clarke Fork of the Yellowstone, and other streams of that region. These falls, of course, serve as more or less effective barriers to the distribution of fish, and as a result many of the mountain lakes, though of the most suitable character so far as temperature, purity, and abundance of food-supply are concerned, are wholly barren of fish life of any kind. The larger streams are, as a rule, less swift, and have more sandy and gravelly beds. There are few, if any, sluggish streams in this region, and all are clear unless contaminated by mining operations.

The following is a classified list of the waters examined:

A.—COLUMBIA RIVER BASIN.

I. *Clarke Fork:*
1. Flathead River.
2. Flathead Lake.
3. Swan River.
4. Depew Creek.
5. Swan Lake.
6. Post Creek.
7. Mission Creek.
8. Jocko River.

I. *Clarke Fork*—continued:
9. Missoula River.
10. Bitter Root River.
11. Lolo Creek.
12. Rattlesnake Creek.
13. Hell Gate River.
14. Big Blackfoot River.
15. Little Blackfoot River.
16. Deer Lodge River.

A.—COLUMBIA RIVER BASIN—Continued.

I. *Clarke Fork*—continued:
- 17. Rock Creek.
- 18. Tincup Joe Creek.
- 19. Cottonwood Creek.
- 20. Dempsey Creek; (*a*) Dempsey Lakes.
- 21. Race-Track Creek.
- 22. Peterson Creek.
- 23. Silver Bow River.
- 24. Browns Gulch Creek.

II. *Lewis Fork, or Snake River:*
- 1. Shoshone Lake; (*a*) Heron Creek.
- 2. Lewis River.
- 3. Lewis Lake.
- 4. Aster Creek.
- 5. Crawfish Creek.
- 6. Polecat Creek.
- 7. Jackson Lake.
- 8. Pacific Creek.
- 9. Inness Lake.

B.—MISSOURI RIVER BASIN.

I. *Upper Yellowstone River:*
- 1. Atlantic Creek; (*a*) Jay Creek; (*b*) Senecio Creek.
- 2. Bridger Lake.
- 3. Thoroughfare Creek.
- 4. Escarpment Creek.
- 5. Cliff Creek.
- 6. Mountain Creek.
- 7. Trapper Creek.

II. *Yellowstone Lake:*
- 1. Beaverdam Creek.
- 2. Columbine Creek.
- 3. Meadow Creek.
- 4. Pelican Creek.

III. *Lower Yellowstone River:*
- 1. Blacktail Deer Creek.
- 2. East Fork of Gardiner River; (*a*) Lava Creek.
- 3. West Fork of Gardiner River; (*a*) Glen Creek; (*b*) Indian Creek; (*c*) Beaver Lake; (*d*) Twin Lakes.

III. *Lower Yellowstone River*—continued:
- 4. Reese Creek.
- 5. Botteler Springs.

IV. *Madison River:*
- 1. Horsethief Springs.
- 2. Gibbon River; (*a*) Cañon Creek.
- 3. Firehole River; (*a*) Nez Percé Creek.

V. *Gallatin River:*
- 1. Bozeman Creek.
- 2. Bridger Creek; (*a*) Davies Springs.

VI. *Jefferson River:*
- 1. Red Rock River.
- 2. Beaverhead River.
- 3. Bighole River.

VII. *Prickly Pear Creek:*
- 1. McClellan Creek.
- 2. Child's bedrock drain.

COLUMBIA RIVER BASIN.

STREAMS TRIBUTARY TO CLARKE FORK OF THE COLUMBIA.

Clarke Fork of the Columbia.—This name is of somewhat varied application. It originally meant all of that river having its sources in the numerous small streams coming down from the mountains east and west and uniting into one stream of considerable size in Deer Lodge Valley, and which runs from there north, west, and then northwest, until just beyond the boundary of the United States in longitude 117°30′ west, where it joins the Columbia at Fort Sheperd. Starting as a small stream on the divide near Silver Bow, flowing northward through the beautiful and fertile valley of Deer Lodge, and receiving on its way numerous smaller streams from the mountains between which it flows, it receives the Little Blackfoot River at Garrison, where it turns westward and continues in that general direction to the city of Missoula, 7 miles above which it receives the Big Blackfoot, a large tributary from the north.

All of that portion above the mouth of the Little Blackfoot River is now generally known as the Deer Lodge River. At the mouth of the Little Blackfoot it takes the

name Hell Gate River, which it bears to the mouth of the cañon just above Missoula, where it again changes its name and comes to be known as the Missoula River. The Hell Gate River is sometimes, however, made to include all that portion lying between the mouths of the Little Blackfoot and the Bitter Root, the latter uniting with the main stream just below Missoula; this seems to be the more logical division. For the next 30 miles, or until joined by the Flathead River, it is known as the Missoula River. From the junction of these two streams, it continues northwest for about 80 miles through a well-wooded and magnificent cañon, and it is to this portion that the name "Clarke Fork" is now usually restricted. At the lower end of this cañon the river widens out greatly, forming the beautiful Lake Pend d'Oreille. At the outlet of this lake it begins to flow more slowly and quietly as the Pend d'Oreille River, which name it continues to bear until it joins the Columbia. Some 25 or 30 miles below Lake Pend d'Oreille there is a vertical fall of 8 or 10 feet, known as the Seniakwoteen Falls. Here the river is said to enter a narrow cañon, through which it rushes with such violence as to be wholly unnavigable, and then falls into the Columbia in a final plunge of 15 feet. The streams tributary to this great river are among the most important and most interesting of any of the Rocky Mountain region.

Flathead River.—This is quite a large river and is the outlet of Flathead Lake. It receives numerous small streams from the east, chief among which are Jocko River, Mission, Post, Crow, and Muddy creeks.

Jocko River.—We examined this stream near the railroad station at Ravalli, where it has an average width of about 40 feet and a depth of over 3 feet. The current is very swift—so swift, in fact, that it was with great difficulty that we were able to use the seine. The bottom is of coarse gravel with occasional clusters of large bowlders. There is little or no vegetation in the stream. The banks are lined in most places by quite a heavy growth of willows, alders, cottonwoods, and other bushes. In some places along the stream are small ponds, well filled with various species of *Algæ* and swarming with larval insect life. Frogs and tadpoles were also common, and in one place a number of larval salamanders (*Amblystoma tigrinum*) were taken. The water of the river is clear and cold, the temperature at 5 p. m., July 31, being 58°. The Jocko is a very pretty river, and is regarded by sportsmen as a very good trout stream. We found trout quite abundant, as shown by the fact that we caught as many as a dozen at one haul with the 15-foot seine. Blobs and whitefish were also common—the blobs being large and fine, while only young whitefish were taken. A few small specimens of the long-nosed sucker (*Catostomus catostomus*) were also taken. We were told that salmon trout are also found in the Jocko, but we saw no specimens.

Mission Creek.—This is a clear, cold stream, about 25 feet wide and 2 feet deep, having its rise in the Mission Mountains northeast of Ravalli, and flowing through the reservation to join the Flathead River. We examined it in the vicinity of the Mission of St. Ignatius, where we found trout of small size in considerable numbers. Post, Crow, and Muddy creeks are other small streams crossed by the stage road from Ravalli to Flathead Lake. Each of them is well supplied with trout. From Post Creek, which is somewhat larger than the others, we obtained specimens of the Columbia River sucker. It appears to be common in this stream and is no doubt found in the others of this region. At the Mission we saw several good-sized specimens that had been brought in by the squaws.

Flathead Lake.—This lake, the largest in the State, lies 35 miles northward from Ravalli. It is about 30 miles in length from north to south and averages perhaps 12 miles in width. It is a very beautiful sheet of water, whose shores at the south end are without timber, but toward the north dense forests of pine and other evergreen trees come down to the water's edge. In the northern portion are several small islands tolerably well timbered. This lake lies in what appears to be an immense glacial valley, the lake itself being due to the enormous moraine lying at its lower end and through which the outlet has been cut. It is said to be very deep in many places, but we have no exact data upon that point. The waters are clear and cool.

Flathead Lake is perhaps as well supplied with fish as any body of water in the State. Mountain trout are abundant, grow to a good size, and are readily caught; salmon trout or bull trout are also common and are caught at certain seasons in considerable numbers by trolling. The Columbia River sucker also occurs in the lake, while the two large minnows, the Columbia chub and the "squawfish," are very abundant. At the different landings where our steamer stopped we amused ourselves by fishing for these species with hook baited with pieces of beef. Each species bites very readily and each shows some game qualities. It seems to make but little difference with what the hook is baited. In one instance, a very large "squawfish" was taken with the fly by Mr. Clapham in Swan River, who felt sure he had a very fine trout until it was landed. So abundant are these two species, and so readily do they take the hook, that they often prove quite an annoyance to him who is fishing for nobler game. Whitefish are also found in the lake and, judging from the number of young that we saw, would seem to be common. However, those persons best acquainted with the lake, with whom we talked, did not know of its occurrence there; and, still more curiously, the Oregon chub is known as "whitefish" by those familiar with the lake.

Flathead River.—At its north end, Flathead Lake receives its principal affluent, Flathead River. This is a large stream coming into the United States from British America west of Chief Mountain Lake, flowing through the lake, and then continuing southwest to join the Missoula as already described. We ascended the Flathead River 28 miles to the new town of Demersville, where it is still a very large and very deep stream with a rather swift current. Some 30 miles above Demersville the current becomes more rapid, the head of navigation being at Columbia Falls, near where the three forks of the river unite. The fishes of this part of Flathead River are, so far as we know, the same as found in the lake. At Demersville we found mountain trout, squawfish, and Columbia River chubs quite common. Salmon trout are also caught there, but we saw none.

Swan River.—Nearly east from the mouth of the upper Flathead River is the Swan River. Big Fork, Swan River, Sweating-house River, and Sweating River are different names by which this stream is known on different maps, but it is more generally known to citizens of that part of Montana as Swan River. It rises on the Divide southeast of Flathead Lake, near the head of the Clearwater, a tributary of Big Blackfoot River. It flows about 80 miles northwest and then widens out to form Swan Lake. Narrowing again, it continues northward and then westward for about 20 miles further and then flows into Flathead Lake, only about 3 miles east of Flathead River. Swan River, at the outlet of Swan Lake, is about 75 yards wide and averages about 5 feet in depth. Surface temperature at 3 p. m., August 3, 65°.

The water is very clear and the current quite rapid throughout the greater part of its course between the two lakes. Not far below Swan Lake, and again not far above the mouth of the river, there are very picturesque rapids. The bed of the stream is, of course, very rocky for most of its length. In the more quiet places there is a little water vegetation. The region through which it flows is covered with a very heavy growth of timber, coming down to the water's edge.

Swan Lake is distant from Flathead Lake about 7 miles, though the distance by the river is three times as great. This is a very beautiful lake, 16 miles long and varying from less than a mile to 3 miles in width. This lake, with its clear and sparkling waters, surrounded on all sides by dense evergreen forests, and studded here and there with small, well-wooded islands, rivals in beauty and picturesqueness any that the writer has ever seen; and the beauty of the river from the lake to the outlet is unexcelled. This lake is said to be a favorite resort for swans, ducks, and geese, several pairs of the latter breeding each year upon the small islands.

Depew Creek.—Just below the foot of Swan Lake the river receives from the right a small stream known locally as Depew Creek. This little creek rises in springs and runs through very dense pine forests for its entire course, a distance of about 8 miles. It has a flow of less than 2,000 gallons per minute. The water is very clear and pure, with a temperature of 48° at 11 a. m., August 3. The fishes of Swan Lake and Swan River are, so far as known, the common trout, salmon trout, whitefish, Columbia chub, squawfish, blob, and the Columbia River sucker. We obtained specimens of all of these except the salmon trout.

Swan River, between the two lakes, is noted as one of the best trout streams in Montana, the greater part of the entire distance being exceedingly well suited for trout fishing.

Rattlesnake Creek is a stream about 20 miles long, rising in the mountains north of Missoula and flowing through a rocky but well-wooded cañon to the Missoula River at the town of that name. It is said to have its source in two small lakes, near a third lake which is drained by Clearwater Creek into Big Blackfoot River. The "divide" between this third lake and the two others is said to be of such a character that, with very little work, a ditch could be cut across which would result in bringing the surplus water of the third lake into those drained by the Rattlesnake, thus greatly increasing the volume of that stream. This is a very clear, cold stream flowing with a rapid current over a very rough bed of gravel and larger rocks, and containing very little water vegetation. The banks are lined with a heavy growth of trees, bushes, and vines, but this promises not to remain very much longer. The larger timber is being cut off rapidly for wood, which is floated down the stream. At the time of our visit, at least 3 miles of the stream was literally filled with an immense jam of cordwood which had been started down, and still above this we saw a constant line of sticks floating by to augment the large amount already in the jam. From the best information we could gain, all of this timber is being cut from Government land, and, whether by Government permission or not, it is certainly to be very greatly deplored.

We examined this stream throughout the last 10 miles of its course, and took measurements just above Missoula. Temperature, 54° at 5 p. m., July 28. Width, 30 feet; depth, $1\frac{3}{8}$ feet; current, $2\frac{1}{2}$ feet per second. This would give over 56,000 gallons per minute. This creek flows its entire course through Government land, except the

last 2 miles. The city of Missoula gets its water supply from this stream, taking it out less than 2 miles above the mouth.

There seems to be an abundance of suitable fish food, many species of insect larvæ, etc., being seen at all places examined. The species of fishes found were the common trout, salmon trout, and blob. All of these were quite common, the salmon trout being, perhaps, the most abundant.

Big Blackfoot River.—This is one of the largest tributaries of the Hell Gate River, into which it flows at a point about 7 miles above Missoula. We examined it for the last 6 miles of its course. It is at least 100 yards wide and is very deep, so deep that the water, which is clear, appears very blue. Temperature at noon, July 29, 63°.

At Bonner, a mile or so above the mouth, is a very large sawmill, and the river for 3 or 4 miles above the mill is literally filled with logs which have been cut from the heavily timbered country through which the river flows and which were being floated down to the mill. Above this jam of logs the stream is open, but so deep and swift as to render seining wholly impossible except in occasional nooks and shallow places. This stream flows through a rocky gorge most of the way, there being but little bottom land. The mountains on either side are of highly metamorphic sandstone, and in most places densely timbered, but at the present rate of destruction it will not be many years until these magnificent forests are wholly destroyed, the mountains made barren, and the volume and beauty of the streams greatly diminished. An abundance of insect larvæ was found in several places, and the river is said to be a most excellent trout stream. We obtained specimens of the common trout, whitefish, blob, and one species of minnow (*Rhinichthys dulcis*). Frogs were not rare along the shore in suitable places.

Little Blackfoot River.—Examined on July 21, just above the town of Elliston. Temperature at 4 p. m., 55°; air, 71°. Width, 25 feet; depth, 2½ feet; current, 3 feet; volume, 84,375 gallons per minute. This is a good-sized stream, rising on the "divide" west of Helena and flowing westward to Garrison, where it joins the Deer Lodge to form Hell Gate River. The current is very swift, the bottom strewn with rocks of various sizes, and the banks are lined with willows, cottonwoods, and other small bushes. Below Elliston the water is muddied by mining operations, but above that place it is pure and clear.

Near the railroad bridge above town a small creek, averaging, near its mouth, 10 feet wide and 1 foot deep, flows into the Little Blackfoot. Its water is not so clear and is warmer (59°). In this we found an abundance of a small mollusk (*Limnæa palustris*) as well as various larval insects. In the river we found blobs and young whitefish abundant, and also took a few trout; while in the small creek we found trout of good size quite plentiful, a few whitefish, and an abundance of blobs, suckers (*Catostomus catostomus*), and minnows (*Rhinichthys dulcis*). Though we obtained no specimens, there is no doubt that the salmon trout also occurs in this river. Persons who have fished it frequently described to us two species of trout which they had taken here, one of which was quite certainly the salmon trout (*Salvelinus malma*). Frogs were not uncommon about the creek.

Cottonwood Creek.—Examined July 22 for the last 3½ miles of its course. Width, 20 feet; depth, 1½ feet; current, 3 feet; volume, 40,394 gallons per minute. Temperature at 3 p. m., 54°; air, 77°. This is a clear stream of considerable size rising in the

mountains some 15 miles east of Deer Lodge. Flowing through rocky gorges in the upper part of its course, and through rather rough meadow land in the lower portion, it unites with the Deer Lodge River at the city of that name. The bed of the stream is throughout very rough and rocky, but the banks are lined with a heavy growth of cottonwoods, alders, and other small trees and bushes. It seems to be well supplied with insect larvæ and other suitable food for fish, and is a most excellent trout stream. The seining that we did here was very unsatisfactory, owing to the roughness of the bottom and the extreme swiftness of the current; however, we took over 30 trout and a great many blobs. Quite a number of trout were also taken with the fly. None of the trout taken weighed over half a pound.

In some very small ponds along the creek we found a great many frogs, and insect larvæ literally swarmed in these pools. A few snakes (*Eutænia* sp.?) were seen here. Quite a good deal of the water from Cottonwood Creek is used for irrigation, and the city of Deer Lodge receives its water supply from this stream. Up to the present time a little mining has been carried on along the upper course, but it has practically ceased now, and there is no great probability that the water of this creek will ever be in danger of contamination from that source.

Deer Lodge River.—This river has its origin in numerous small streams in the hills, chiefly to the westward of Butte City and on the divide, upon which also rise many of the affluents of Jefferson Fork of the Missouri. Flowing northward through a very beautiful and rich agricultural valley, it joins the Little Blackfoot River at Garrison, about 45 miles north of Silver Bow. We examined the Deer Lodge River throughout the greater part of its course. At Deer Lodge we found it to be 57 feet wide, 3 feet deep, and to have a current of 4 feet per second; this gives a flow of 307,800 gallons per minute. The temperature of the water at 10 a. m., July 23, was 59°; that of the air, 78°.

Throughout most of its course it has a very swift current. The bed of the stream is chiefly of coarse gravel and larger rocks. In some portions where the current is less swift the bed is made up of a constantly shifting mass of fine silt-like material, probably from the concentrators and reduction works at Anaconda and Butte. Throughout the entire length of this river the water is full of this solid matter in suspension. The amount of solid matter carried down by the Deer Lodge River from this source must be very considerable, and of course proves fatal to all kinds of fish life. We seined the river very thoroughly in the vicinity of Deer Lodge and did not find any fish whatever.

This stream is said to have been well supplied with trout and other fish, but none have been seen since the concentrators began operations. Other life was also scarce; no living mollusks or crustaceans and but few insect larvæ were seen. Upon a sandbar, below the town of Deer Lodge, we found a few dead shells of *Margaritana margaritifera* Linn., but careful search failed to discover any living specimens. The banks, usually low, are covered with a pretty heavy growth of alders, willows, and other small bushes. Except this fringe of trees along the streams, most of the Deer Lodge Valley is more or less rolling prairie or meadow land. In suitable places along the stream frogs were quite plentiful.

In its course from Silver Bow to Garrison the Deer Lodge River receives a great number of small streams from the mountains on each side of the valley. From the east come Browns Gulch, Silver Bow, Peterson, Cottonwood, and Freeze-out creeks;

while from the west the number is much greater, including Willow, Warm Spring, Lost, Modesty, Race-Track, Dempsey, Punch, Tincup Joe, and Rock creeks. Although these are all comparatively small streams, they are, with few exceptions, well filled with trout. Warm Spring and Silver Bow creeks are ruined by mining operations, and perhaps others are somewhat contaminated.

Rock Creek, which flows into Deer Lodge River near Garrison, is a good stream, rising in a large lake. A large reservoir has been made upon this creek about 12 to 15 miles above Garrison, and this is said to be full of trout.

Tincup Joe is a good-sized creek, coming in not far from Deer Lodge.

Dempsey Creek is perhaps the most interesting one of this region. This stream rises in several small lakes lying near Mount Powell, flows about 20 miles or more, and joins the Deer Lodge River about 8 miles above the city of that name. Through the kindness of Messrs. N. J. Bielenberg and Frank Conley, of Deer Lodge, we were able to make a trip to the lakes at the head of this creek. In company with these gentlemen and Prof. Frank W. Traphagen, of the College of Montana, and Mr. Thomas Morgan, of Deer Lodge, we made a three days' trip to these lakes. The first day we drove about 18 miles southwest from Deer Lodge and camped on Dempsey Creek, perhaps 15 miles above its mouth. That portion of the creek lying between our camp and the valley is very rocky and very swift. There are a few short, quiet reaches, but most of the course is made up of rapids and small cascades which make it a very picturesque stream. In the vicinity of our camp there are some small mountain meadows, and the creek is more quiet as it flows through them. Its average width here was about 12 feet, the depth 2 feet, and the current not over 1 foot per second. The water was, of course, very clear and cold, and well suited to trout. A little time devoted to fishing with the fly in the evening near our camp resulted in a string of about twenty very nice fish.

The next day we took saddle horses and followed on up the creek to the lakes at its head, a distance of 5 or 6 miles. This ride was a very difficult one, through dense, almost impenetrable pine forests, over rough, rocky ridges almost too steep for a horse to climb, and across marshy meadows in whose soft mud our animals were in danger of miring. The first lake we reached was about 5 miles from our camp; a few hundred yards to the right was a second one, and about the same distance to the left a third lake. Each of these contains perhaps three sections or less. About them the country is quite rocky, great bowlders and angular fragments of stone from the cliffs above being scattered here and there through the pine forests in which the lakes are set. These lakes are fed in great part from melting snows. Lying as they do around the base of the rocky peak of Mount Powell, they receive a multitude of little rivulets from a number of snow banks which linger in the gorges and cañons above until very late in summer, or even remain throughout the year. Indeed, right upon the shore of the third one of these lakes, we found a considerable bank of snow at the time of our visit, July 24. The lakes are in most places very deep, and the water clear and extremely cold. We neglected to take a thermometer with us on this trip, and consequently had no means of determining the temperature exactly, but it could not have been much above 40°.

In the first of these lakes we saw several trout, but though we fished quite a while they bit very poorly and we caught only a few. In the second lake we employed different methods with better success. At the lower end of the lake is the small stream which serves as an outlet to the lake. The beginning of this outlet is widened

into a miniature bay, which has a fine pebbly bottom, and in which the water is not over a foot deep. A line of rocks has been made by some one so as to separate this corner from the lake proper. One or two places had been left open, thus permitting the fish to pass through. We found a great number of good-sized trout in this little bay, but nearly all ran out into deep water upon our approach. Withdrawing only a short distance we had to wait but a few minutes until they began to return. Very soon the spot was literally alive with trout, when we hurriedly closed the few openings in the dam. When thus shut in it was an easy matter to capture all we wished with a small seine which we had. In this way we soon caught about thirty very fine specimens, which constituted but a small portion of the number in the cove.

This little cove is evidently used as a spawning ground, and our visit was at the height of the spawning season. Nearly all the females were ripe with spawn. In several instances the eggs came freely from the fish as we handled them, and a great number of eggs were seen lying around among the fine granite gravel. The testes of the males were in many cases greatly distended with milt, and both the males and females were very brilliantly colored.

In the third lake, already mentioned, we found trout most abundant. As a result of less than two hours' fly fishing, we took about one hundred and twenty-five, each weighing a half pound or less. Quite contrary to our experience with the trout in the other lakes, we found them to bite freely, even voraciously, in this lake. It seemed to matter very little what was used for bait, whether artificial fly, a real fly, trout eye, or parts of bright-colored flowers. Several good catches were made with bright-colored leaves of a species of painted cup (*Castilleia*). All these fish were caught in shallow water along the shore, but the best fishing was always at the mouths of the little streams flowing into the lake. The fish were all in excellent condition, their stomachs were well filled with insect larvæ and insects; in a few cases I found a number of small bivalve shells. In several instances the stomachs contained quite a lot of fine gravel or sand, probably the broken-down cases of caddis worms. Wherever examinations were made, suitable food for trout was found in abundance.

Besides the three lakes which we visited, there are said to be eight others lying about the base of the peak of Mount Powell. So far as we are able to learn, these lakes have not received separate names, but are known collectively as Dempsey Lakes. They all lie at an elevation of about 9,000 feet above the sea, and most of them are drained by Dempsey Creek. The elevation of Mount Powell is about 11,000 feet.

Dempsey Creek, though a rapid stream, does not contain any falls that trout can not ascend, and the difficulty of reaching the lakes is, fortunately, so great that they are not likely to become fished out very soon.

Race-Track Creek is also an excellent trout stream. About two miles from its mouth we found it about 30 feet wide, 2 feet deep, and with a 3-foot current.

Browns Gulch Creek.—This is a small stream in Browns Gulch, near Silver Bow. We spent some time examining it about a mile north from the railroad station. We found it here to be not over 6 feet wide, 2 feet deep, and with a rather swift current. The water was not very cold, about 63°, and was somewhat muddy, owing to recent rains. The stream is lined by a good growth of willows, and runs through a narrow strip of meadow land bordered by low hills. A few trout and a great many suckers (*Catostomus catostomus*) and *Rhinichthys dulcis* were obtained here, and it was from

this stream that we obtained the types of *Leuciscus gilli*. Small mollusks (*Limnæa palustris*), insect larvæ, and frogs were abundant.

This little creek flows into Silver Bow Creek near the railroad junction of that name. Silver Bow Creek is simply the name applied to the upper portion of Deer Lodge River. This comes down from the vicinity of Butte City, and its water has the consistency of thick soup, made so by the tailings which it receives from the mills at that city. No fish could live in such a mixture, and the fish in Browns Gulch are for the time being practically confined to that short stream.

The other tributaries of the Deer Lodge River are all small, but, with the exceptions already noted, are excellent trout streams.

Bitter Root River.—This is a fine large stream, reminding me very much of the beautiful Tippecanoe River, but it is about twice as large. It rises in the Bitter Root Mountains near the line between Idaho and Montana, flows north through the beautiful Bitter Root Valley, and empties into the Missoula River about 3 miles below the town. It is at least 75 miles long, its waters are clear and moderately cold, and the lower part of its course at least is over a bottom of sand and gravel covered toward the shores with a heavy growth of *Algæ* and other water vegetation. This stream is apparently quite deep and flows with a steady, moderate current. The banks are usually low and well wooded. Several bayous or small ponds were noticed along the west bank, and these are invariably filled with *Algæ*, a species of *Ranunculus*, and other aquatic plants.

Owing to the too great depth of the water we were not able to do any seining in the Bitter Root. Quite a number of specimens of *Mylocheilus caurinus* and *Ptychocheilus oregonensis* were obtained, however, by use of hook and line. These two species are evidently abundant in this river. Trout and "salmon trout" are also reported common, "salmon trout" weighing 12 to 14 pounds having been taken at the mouth of the river, according to Mr. E. A. Winstanley, of Missoula.

Lolo Creek.—This stream, also spelled "Lou-Lou," has its origin in the Bitter Root Mountains, on the Idaho State line, and flowing eastward for about 40 miles joins the Bitter Root River about 10 miles above its mouth, or about 12 miles southwest of Missoula. Like all other streams of this region the Lolo's waters are pure, clear, and cold. A mile or so above its mouth it was found to be about 35 feet wide, averaging perhaps 2½ feet deep, and flowing with a very rapid current. Temperature at noon, July 30, 56°. We examined it throughout the last mile but one of its course. Here it flows over gravelly bottom and between gravelly banks which are covered with a dense growth of alders, willows, and cottonwoods, with here and there a mossy patch or a stretch of meadow land. The stream, in some places along here, is broken up into several streams flowing in different channels, but they soon come together again. There are also a number of bayous, or more properly small ponds, occupying detached portions of former old channels of the stream. These were invariably filled with a species of *Ranunculus* (most probably *R. aquatilis trichophyllus*). They were often very deep, and the extremely muddy bottom rendered seining them a matter of no little difficulty.

The Lolo is one of the very best trout streams in western Montana. During the time we seined we obtained numerous fine trout, also a good many blobs and young whitefish. In the ponds we found *Catostomus catostomus* and *Ptychocheilus oregonensis* very common.

As already stated, the stream formed by the junction of the Deer Lodge and the Little Blackfoot is called Hell Gate River. It bears this name to the mouth of the cañon just above Missoula River, or sometimes to the mouth of the Bitter Root, where it becomes known as the Missoula River, by which latter name it is known for 30 miles or more, or until it is joined by the Flathead River.

Hell Gate River (and its continuation, the Missoula) being composed largely of the muddy waters of the Deer Lodge and the lower Little Blackfoot, is, of course, a rather muddy stream. By the time Missoula is reached the amount of solid matter in suspension is probably not enough to prove wholly destructive to fish, though there is no doubt that the number of fish in the river even here is very greatly reduced on account of this contamination. It is greatly to be regretted that something can not be done to prevent such destruction of these fishing streams. The Hell Gate River flows through a very rough, rocky cañon (whence the name) and is quite a large stream. The mouth of the cañon is just above Missoula; below there the stream flows through a broad valley.

So far as we were able to determine, there are no natural obstructions anywhere above Lake Pend d'Oreille in this river system—the Clarke Fork of the Columbia and its tributaries—which interfere seriously with the free movement of fishes. There are certainly no falls in the larger streams, and we know of none of any importance in any of the smaller ones; and the only artificial obstructions are those already mentioned, the great drifts of cordwood in the Rattlesnake and sawlogs in the Big Blackfoot. The contamination of the Silver Bow, Deer Lodge, the lower Little Blackfoot, the Hell Gate, and the Missoula by the mills at Butte and Anaconda tends to drive fish from these streams. It is quite certain, however, that Seniakwoteen Falls, below Lake Pend d'Oreille, and the falls at the mouth of Clarke Fork interfere with the further ascent of salmon, and it is possible that they prevent it altogether.

STREAMS TRIBUTARY TO LEWIS FORK OF THE COLUMBIA.

Snake River.—This is the name now usually applied to what was once known as Lewis Fork of the Columbia; it is, however, on many maps, called the Shoshone River. This river is more than 900 miles long, and is one of the most important of the Pacific coast streams. The only waters of this basin that we examined are in the southwest corner of the Yellowstone National Park and the region immediately south of the Park—the extreme upper courses—the very beginnings of the Snake River. About one-fourth of the area of the Park is drained by streams which unite to form the Snake River. Most all of these have their origin in several picturesque lakes which rest on, or are surrounded by, the great bed of rhyolite which forms the floor of this plateau region. Among the most important of these lakes are Shoshone, Lewis and Heart, the first two of which were visited by us.

Shoshone Lake.—We reached this lake from the Upper Geyser Basin, from which it is distant about a dozen miles to the southeast, across the "Great Continental Divide." The trail crosses the Divide much nearer the lake than the Geyser Basin, and from the crest the lake can be plainly seen to the south. The elevation of this lake is 7,740 feet. Its shape is somewhat like that of the letter T, the upright and the cross-pieces being each pretty heavy, and the letter being inclined very greatly to the right. The portion corresponding to the upright part of the T is very much

constricted at the upper end. According to Mr. Gannett, topographer of the U. S. Geological Survey, the greatest length of Shoshone Lake is 6½ miles, the greatest width 4½ miles, while the constricted portion is but half a mile across, and its area is about 12 square miles. There are but few streams flowing into this lake, and they are all small. At the western end is Shoshone Creek, a small stream running through the Shoshone Geyser Basin, a cluster of hot springs and geysers discovered in 1872 by Dr. C. Hart Merriam and others of the U. S. Geological Survey. At the north end there is a small stream called Heron Creek, which drains a considerable area on the south slope of the "Divide," lying immediately north from this part of the lake. At the time of our visit, August 11, this stream was very small, not over 3 feet wide and 1 foot deep at the outlet, but back a little distance it widens out a good deal, and there is scarcely any current. This creek runs for the last few miles of its course through low, somewhat marshy meadow land. The water is clear, but not very cold. the temperature at 3 p. m., August 11, being 63.5°.

From the mouth of Heron Creek we traveled down the east shore of the lake (*i. e.*, across the top of the T) to the outlet. The distance is about 5 miles through the heavy evergreen forest which covers the bold, in places precipitous, shores to the water's edge. The view of the lake from this trail is a most charming one, for Shoshone Lake is certainly one of the gems of the Rocky Mountains, and the setting could scarcely be improved. (See Pl. VI.) Its shores, nearly everywhere bold and commanding, are densely wooded; the beach is of very clean gravel, and the water is clear and pure. The temperature at the surface near shore was 66°, at 3 p. m.

The outlet of Shoshone Lake is called Lake Fork or Lewis River. This is a very pretty stream of clear, pure water flowing with a rather rapid current for 3 miles in a direction a little east of south, and then expanding into Lewis Lake.

Lewis Lake.—This is another beautiful sheet of water, 20 feet lower than Shoshone Lake. It is, however, much smaller, its length being but 3 miles and its width not greater than 2 miles. It is essentially the same kind of lake as Shoshone, and, like it, was totally without fish life of any kind until stocked by the U. S. Fish Commission in 1890 with Loch Leven and lake trout. We camped the night of August 11 at the outlet of Shoshone Lake, where we seined the lake and the river repeatedly, but found no fish, though plenty were found at the upper end of the lake, as stated elsewhere in this report. The river at its beginning is about 50 feet wide, 1⅔ feet in average depth, and has a 2-foot current. Temperature at 8 a. m. was 59.5°; air, 56°.

From our camp at the foot of Shoshone Lake we rode through the heavy woods around the east shore of Lewis Lake, to a point on Lewis River just below the mouth of Aster Creek, where we camped again. Just above our camp are the Lewis Falls. These falls are very beautiful. There is first a vertical descent of about 20 feet, then a very steep rapid or cascade of 50 or 60 feet. It does not seem possible that fish could ever get up these falls. Lewis River here is about 75 feet wide, averages 1¼ feet deep, and flows with a 2-foot current. Its temperature at 8 a. m., August 13, was 65.5°, the air being 66°.

Aster Creek is but a small stream, 12 feet wide, ¾ foot deep, and having a current of nearly 2 feet per second. It rises in the Red Mountains west of Heart Lake and flows nearly due west. Its temperature was 58°.

We seined Lewis River from the falls downstream for some distance, but found no fish of any kind. Mr. Hofer whipped the stream very thoroughly for a mile or

more, but not a trout rose to the fly. We also seined Aster Creek from its mouth upstream several rods, but saw no evidence of the presence of any fish. It is quite certain there are none here, and it is equally certain that it is not these falls that keep fish from entering Lewis and Shoshone lakes. These facts led us to make an attempt to reach a fall lower down the river, the existence of which had been reported by hunters, but about which little or nothing seemed to be certainly known. Next day we traveled on southward, Prof. Jenkins and Mr. Hofer making a detour to the left of the trail and following more closely down the right bank of the river. They found the cañon of Lewis River in this part of its course very wild and picturesque. (See Pl. XVII.) The walls are in many places quite high and vertical. About halfway between the Upper Falls and the mouth of Crawfish Creek, they came upon a very beautiful fall of considerable size. The stream is divided by a small island into two parts, the larger portion of the water flowing around to the right of the island. This part was estimated to be at least 50 feet wide and to fall almost perpendicularly at least 30 feet, then descend about 20 feet more in a very steep rapid, in which the stream widens out very much. That part of the stream passing around to the left of the small rocky island is about 8 feet wide, and it comes down in a series of very steep cascades and two principal falls, each apparently vertical. Both Prof. Jenkins and Mr. Hofer regard it as highly improbable that fish can ever ascend these falls. Mr. Hofer fished with the fly a short time just below these falls and found trout abundant. In a few minutes he landed six very fine fish, the largest measuring 14 inches in total length. A great many smaller ones were seen. So it may be considered as settled that these lower falls of Lewis River are the first impassable barrier that the fish meet in their efforts to ascend to Lewis and Shoshone lakes.

Crawfish Creek.—A few miles below the Lower Falls, Lewis River receives from the right a good-sized tributary known as Crawfish Creek. This stream rises on the Pitchstone Plateau, flows perhaps a distance of 10 to 15 miles southeast, and joins Lewis River just before that stream unites with Snake River. This is just inside the southern boundary of the Park. Where the trail crosses, Crawfish Creek is 27 feet wide, 1 foot in average depth, and has a slow current—100 feet in 1 minute. The water is very warm—81° at noon, August 13. There must be warm springs somewhere along its upper course. The water is clear and seems to be pure. The banks here and for some distance above the ford are low and marshy in some places. The bed of the stream is gravelly, the rocks generally being coated with *Algæ*. Water vegetation was abundant in places. Just below the ford, Crawfish Creek becomes very rapid and continues so to its mouth, about 1½ miles away. The banks are steep and rocky and covered with a heavy pine forest. A short distance below the ford are Moose Falls, where the creek falls in one vertical plunge a distance of at least 30 feet. We examined the creek very carefully both above and below the falls. No fish were found above the falls but trout were taken below. The bed of the stream below the falls is extremely rocky, rendering the use of the seine almost impossible.

Crawfish (*Astacus gambelli*) were found to be very common both above and below the falls. Crawfish were not found in any other stream of the entire region explored by us, except in Snake River and Jackson Lake south of this place.

Polecat Creek.—This is a stream much the same size as Crawfish Creek, and not unlike it in other particulars. It rises just within the Park limits, flows south across the line, and empties into Snake River at President Camp.

Snake River.—The old Sheridan trail, the trail we followed from the Upper Geyser Basin, crosses Snake River at what has come to be known as the "President's Camp." This is about 2 miles south of the south line of the Park. The river here flows through a wide meadow, grassy and open on the right side, on the other covered with a heavy growth of chapparal. It is a beautiful river with clear water and gravelly bottom. At the camp, the bank is 3 or 4 feet high, but a little lower down the shores are low and composed of gravel and sand. In the main stream the current was pretty strong, but there were some quiet nooks and coves where the water was filled with various species of *Algæ*. The water was 62.5° at 9 a. m., August 14.

Fish were found to be abundant in the river here. Many fine trout were taken, mostly with the hook. Blobs, young whitefish, suckers (*Catostomus ardens* J. & G.), and minnows (*Leuciscus atrarius*, *Leuciscus hydrophlox*, and *Rhinichthys dulcis*) were found, the whitefish, Utah chub, and suckers being especially abundant. Most of these were gotten from a deep, quiet nook filled with *Algæ* right at the camp, and nearly all were found covered with small dark specks, probably a parasitic protozoan. Crawfish were found to be common here.

Jackson Lake.—From President Camp we crossed Snake River and traveled south about 12 miles to Jackson Lake. This is a fine body of water about 15 miles long by 3 or 4 miles wide. Below our camp a short distance is Marymere, the mountain home of Mr. John D. Sargent. Across the lake to the southwest are the Téton Mountains, rising from the margin of the lake and their rugged peaks piercing the clouds. These peaks are very rough and wild. The pinnacles are very steep and storm-splintered; beds of snow that never disappear, and which may be glaciers, fill the gorges. There is no grander mountain group in America than the Grand Téton with the peaks which environ it.

Snake River flows into Jackson Lake at its upper end and out again below. About the upper end of the lake there is a good deal of low-lying meadow land. On the left it is bordered by low hills, while on the right the shore is precipitous and rocky. Near the upper end a small creek flows into it, in which we found suckers, minnows, blobs, trout, and crawfish. This creek, where we crossed it, is 6 or 8 feet wide and 2 or 3 inches deep. It has but little current. There are some very deep holes in which fish were common. The water was not cold, 67.5° at noon, August 14. The lake is rather shallow on the eastern side, but is said to be very deep on the west. The temperature at the surface was 62° at 9 a. m., August 15.

In the Tenth Annual Report of the Director of the U. S. Geological Survey, Capt. C. E. Dutton says, in writing of Jackson Lake and Snake River, which drains it:

> The present area is not far from 40 square miles, while its watershed is between 750 and 800 square miles.
>
> Snake River at low stages carries more than 3,000 second-feet of water. Its sources in Yellowstone Park and in the Téton and Wind River ranges are regions of large precipitation, which yield many perpetual streams. Emerging from the mountains the Snake flows out into an immense plain, 250 miles in length and from 50 to 100 miles in width. A large portion of this plain has been overflowed, in comparatively recent geological times, by extravasations of basaltic lava, much of which is still an expanse of barren rock, while some of it is imperfectly buried in drifted sand and soil. (Part II, p. 106.)

According to Mr. Sargent, Jackson Lake literally swarms with suckers in the spring, and trout are also abundant. We were not able to take any suckers or trout; nor did we think it worth while to use the seine in the lake. We fished some time

with hooks, however, and caught nine large Utah chubs (*Leuciscus atrarius*). Crawfish were also found here.

Pacific Creek.—From Jackson Lake we traveled across the mountains eastward about 12 miles to Pacific Creek. Our first camp on this creek was about 8 miles above its mouth. It is here a good-sized creek, 37 feet wide, 14 inches deep, and with a very swift current (5 feet per second). The bed of the stream is very rocky, being made up of water-rounded glacial bowlders of small size. The banks are low and level, covered with a fair growth of bushes, and further back a good growth of pines. Trout were found to be quite abundant, no less than thirty very fine ones being taken with the fly in a short time. Most of these ranged in length from 10 inches to 17 inches; one very fine specimen, 19 inches in total length, was taken by Prof. Jenkins. Several very young trout and a few very small blobs were taken with the seine. Fish food seemed abundant. Numerous caddis-worm cases formed of bright-colored granite pebbles were found. No crawfish or mollusks were seen. The water is clear and cold, the temperature at 4 p. m., August 15, being 62°; at 8 the next morning, when the air was 50°, the water was 49°.

The next day we followed up the narrow valley of Pacific Creek for about 18 miles and camped about a mile above Inness Lake. We found Pacific Creek here very much reduced in size, it being not over 10 feet wide, 6 inches deep, and having a 2-foot current. Temperature at 5 p. m.: water, 59°; air, 66°; at 6:30 a. m. the air was 38°; at 9:15 the air had warmed to 62°, while the water was 50°. A small branch at our camp was somewhat colder, the thermometer indicating 48° when the air was 62°. About 2 miles below this camp Pacific Creek is joined by Mink Creek, which, being the larger of the two, should be regarded as the main stream. Trout were found to be abundant in Pacific Creek here, but all individuals seen were small. Insect larvæ and other suitable food for fish were common.

Inness Lake is the somewhat uncertain name of a peculiar lake lying near Pacific Creek, about 1 mile below this camp. So far as I can learn, no name has been given to this lake by the U. S. Geological Survey, but "Inness Lake" is the name by which it is known to Mr. Hofer. It is about 3 miles long and ½ mile wide. It seems very deep in two crater-like depressions, but is rather shallow elsewhere. One shallow area was noticed near the center. A part of the bed of the lake and a portion of the shore at least are of limestone rock. The lake is surrounded on most sides by low marshy meadow. Its outlet is into Pacific Creek. Trout are very abundant in this lake. There was scarcely a moment when we were passing from one end to the other that one or more trout were not seen rising to insects upon the surface of the water.

The mountains about here are, in most part, covered with heavy coniferous forests. There are, however, among the ridges and upon the sides of some of the mountains, small but very beautiful grassy mountain meadows. The journey from Jackson Lake up Pacific Creek, while rather rough and difficult, is not attended with any hardships or danger. The chief difficulty is in getting through the fallen timber.

TWO-OCEAN PASS.

The next day, August 17, we traveled 6 miles farther up Pacific Creek and came to the famous Two-Ocean Pass. The importance of this pass justifies more than a brief notice. I have therefore collected all the published data regarding it that I could find. The first printed reference to this pass seems to be that made by Capt. W. F. Reynolds in his report of the exploration of the Yellowstone in 1868, page 11. Capt. Reynolds says:

> Bridger also insisted that immediately west of where we made our final attempt to penetrate this singular valley [Yellowstone] there is a stream of considerable size which divides and flows down either side of the watershed, thus discharging its waters into both the Atlantic and Pacific oceans. Having seen this phenomenon on a small scale in the highlands of Maine, where a rivulet discharges a portion of its waters into the Atlantic and the remainder into the St. Lawrence, I am prepared to concede that Bridger's "Two-Ocean River" *may* be a verity.

Capt. Jones, of the U. S. Engineers, in his report of a Reconnaissance of northwestern Wyoming, published in 1875, gives a description of the pass. He seems to have been the first to describe this interesting place from actual observation. He says:

> At this divide occurs a phenomenon, probably the one referred to by the early trappers as the "Two-Ocean Pass." Marching at the head of the column where the trail approached the summit I noticed that the ribbon of meadow, in which the stream lay we had been following, suddenly dropped away in front of us with a contrary slope. I could still see the stream threading it and for a moment could scarcely believe my eyes. It seemed as if the stream was running up over this divide and down into the Yellowstone, behind us. A hasty examination in the face of the driving storm revealed a phenomenon less startling perhaps, but still of remarkable interest. A small stream coming down from the mountains to our left I found separating its waters in the meadow where we stood, sending one portion into the stream ahead of us and the other into the one behind us, the one following its destiny through the Snake and Columbia Rivers back to its home in the Pacific; the other through the Yellowstone and Missouri, seeking the foreign waters of the Atlantic by one of the longest voyages known to running water. On the Snake River side of the divide the stream becomes comparatively large at once, being fed by many springs and a great deal of marsh.

Capt. Jones gave a map of the pass, a copy of which I give in Fig. 1, Pl. II.

In October, 1878, Dr. Hayden visited the pass, an account of which he gave in Article XV, Bulletin 2, U. S. Geological and Geographical Survey of the Territories, as follows:

> This pass is located about longitude 110° 00′, and latitude 44° 05′. Atlantic Creek is a branch of the Upper Yellowstone River. The party with which the writer was connected passed up the east side of the Yellowstone Lake to the mouth of the Upper Yellowstone River, and thence up the valley of that stream about 30 miles to what may be called the Three Forks, near Bridger's Lake. The east [west] fork bears the name of Atlantic Creek.
>
> From the Three Forks the party passed up the valley of Atlantic Creek to the southwest, for the most part over a grassy valley, which was inclosed between vertical walls of volcanic breccia 1,000 to 1,200 feet in height. This valley is purely one of erosion. The breccia itself is of very modern age, probably quaternary date, and the wearing out of this great groove must have been an exceedingly modern event. So far as can be seen from the summit of the mountains on either side no divide can be observed. The erosion seems to have produced a gentle slope on either side of the watershed. At the summit, not over 10 miles from the junction of Atlantic Creek with the Upper Yellowstone, the elevation, 8,081 feet, is not more than 150 feet above the valley of the main stream. The valley is at first quite narrow, but it gradually expands into an open, grassy meadow, which, near the pass, becomes one-third of a mile in width, and gradually closes up again into a cañon on the Pacific slope. So obscure is the drainage that we camped the night of October 3, 1878, within a fourth of a mile of the water divide, but did not perceive it until we commenced our march the following morning.

The conditions are as follows: The summit of the pass for a distance of about half a mile is so nearly level that a marsh is formed, which in times of high water becomes a small lake. A portion of the waters from the surrounding mountains accumulates in the marshy meadows and gradually gravitates from either side into two small streams, one of which flows to the northeast, the other to the southwest. On the east side of the divide there is a depression or gorge in the mountain, which is occupied by a small stream that at the time of our visit flowed in a well-marked channel toward the northeast into Atlantic Creek.

This is the well-known Two-Ocean Creek. At the base of the mountain side (*c*), a small stream rises from a sink hole or spring, which at the time the writer saw it (October 4) was nearly dry, and but little water was running in Two-Ocean Creek (*a*). This spring hole was not separated from the latter creek more than 6 feet, and a small dry channel connecting it with *a* showed that in times of high water a portion of the water that started down the mountain channel (*a*) broke over the side into the spring hole (*c*), and flowed thence through channel *c* to the Pacific. Lower down in the Two-Ocean channel are two places (shown by dotted lines), where there are two old channels connecting in time of high water with channel *c*, showing that a portion of the waters that started down the mountain side for the Atlantic was diverted toward the Pacific. On the opposite side of the pass there is a similar depression in the breccia wall, down which, at the time of the melting of the winter's snows, much water flows.

The points *b* and *d* are close together, and the waters of the grassy meadows, which lie between them, probably separate, a part taking one direction and a part the other. The little lake or marsh in the center, of course, furnishes a supply or reservoir for both. (See Dr. Hayden's map, Fig. 2, Pl. II.)

In September, 1884, Two-Ocean Pass was visited by Mr. Arnold Hague, of the U. S. Geological Survey, but he was prevented by a severe snowstorm from making any detailed observations. In Powell's Sixth Annual Report, p. 56, Mr. Hague says:

I determined, however, to follow up Pacific Creek and take as direct a course as possible to its sources in the meadows described by Dr. Hayden. From the information I had gathered and the erroneous character of the maps I was prepared for a difficult bit of travel. I found, to my surprise, with the exception of 1 or 2 miles of rough country, that the stream could be followed without any serious hinderance to its source in the broad meadows high up in the mountains. From this same meadow a small stream, known as Atlantic Creek, flows eastward and empties its waters into the Upper Yellowstone.

Unfortunately, we were caught on the summit in a severe snowstorm, although early in the month of September. Snow to the depth of 15 inches covered the ground. This not only caused a delay, but prevented us from determining accurately the conditions governing the supply and discharge of the waters. It is probable that the divide between Atlantic and Pacific creeks is but a few inches in height.

The conditions observed here are not unlike those seen in many places in flat, plateau-like country, the difference being that here they are on a grander scale and more than usually striking and impressive. The place is one of great beauty. If the Park limits should be extended to the 44th parallel, Two-Ocean Pass will be within the reservation.

From the above it appears that this interesting pass was evidently known to the famous guide, Jim Bridger; that the first account written by one who had seen it is that given by Capt. Jones, who visited it during a driving storm September 3, 1873; that the next to visit it was Dr. Hayden, in October, 1878, who, like Capt. Jones, approached it from the Yellowstone side; and that it was again visited by Mr. Hague, in September, 1884. Mr. Hague reached the pass from Jackson Lake by way of Pacific Creek at a time when the pass was covered with snow. Besides those who have published accounts of their visits, Two-Ocean Pass has been visited several times by our guide, Mr. Elwood Hofer, within the last few years. The route traveled by our party was essentially the same as that followed by Mr. Hague. We arrived at the pass on Monday morning, August 17, and remained until 10 o'clock the next morning. This gave us ample time to make a careful examination of the remarkable conditions which

obtain here. Reference to the frontispiece and the accompanying diagram (Fig. 3, Pl. II), from sketches made on the ground, will assist very much in understanding the description which follows.

Two-Ocean Pass is a nearly level piece of meadow land, surrounded by rather high hills except where the narrow valleys of Atlantic and Pacific creeks open out from it. Running back among the hills to the northward are two small cañons; on the opposite side is another cañon of the same character. Down these cañons come the three main streams which flow through the pass. The extreme length of the pass from east to west can not be much less than a mile, while the width from north to south is perhaps three-fourths of a mile. From our camp at *4*, just on the border of the meadow, an excellent view of the pass and its surroundings could be had. Just in front was Pacific Creek. Following it upstream for more than a mile above our camp, we found it to head west of the pass, then follow down a rocky cañon in a general northerly direction before finally turning somewhat abruptly to the southward just before entering the pass. The course is then southward across the western border of the meadow until a short distance to the right of our camp, when it turns suddenly west and leaves the pass through a narrow, grassy valley.

Atlantic Creek was found to have two forks entering the pass. At the north end of the meadow is a small wooded cañon down which flows the North Fork of Atlantic Creek. This fork hugs the border of the flat very closely, and at *3* turns rather abruptly to the east. At *c* we found a small tributary stream coming into Pacific Creek from across the meadow. Following up this stream we found it to start in a spring at *5;* but above this spring and connected with it we found a well-marked, dry channel, with gravelly bottom and distinct banks. This we followed to its source and found it to branch off from the North Fork at *3*. Very recently a green pine tree had fallen across this channel right at its origin in such a way as to completely dam it, thus throwing all the water back into Atlantic Creek. Only a little effort was needed to clear away the tree and the rubbish that had accumulated against it, and very soon a good portion of Atlantic Creek was flowing down the old channel to Pacific Creek. The distance from *3* to the spring, *5*, is about 1,000 feet, and the slope is very gentle. This, together with the fact that the ground throughout most of the distance was quite dry and took up water rapidly, caused the water diverted into the old channel to travel very slowly, and not until the next morning had it reached and connected with the running water at the spring. Mr. Elwood Hofer, our guide, traveled through this pass in September, 1890, at which time he says there was a continuous stream of water from point *3* to Pacific Creek by way of this old channel.

The South Fork of Atlantic Creek comes down a cañon to the right, skirting the brow of the hill a little less closely than does the North Fork. The phenomenon discovered on the north side was found to be repeated on this. At *1* an old channel was found branching from the South Fork and running toward Pacific Creek. It had also been dammed by a dead tree falling across right at its place of branching from the main stream, turning all its water back into Atlantic Creek. Putting a few rocks in the main stream and clearing away some of the rubbish resulted in sending at least 30 miner's inches down the old channel to *2*. This old channel runs along pretty close to the main stream for some distance, at one place, *d*, coming within a few feet of it. Across this narrow strip is another old bed through which water would be made to flow by a rise of a very few inches in Atlantic Creek. The old channel, beginning

at *1*, was found to connect with the one from the other fork at *2*, and by the next morning a good-sized stream was flowing from the South Fork of Atlantic Creek into Pacific Creek. The lower portion of this channel contained a little seepage water, and it is certain a live stream had been flowing through it earlier this season.

Besides the old channels already mentioned there are evidences of several others which, during even ordinary water, would connect the two creeks. As already stated, the pass is a nearly level meadow, covered with a heavy growth of grass and many small willows 1 to 3 feet high. While it is somewhat marshy in places, it has nothing of the nature of a lake about it. Of course, during wet weather the small springs in the meadow would be stronger, but the important fact is that neither Atlantic nor Pacific Creek rises in the meadow. Atlantic Creek, in fact, comes into the pass as two good-sized streams from two different directions and leaves it by at least four channels, thus making an island of a considerable portion of the meadow.

Pacific Creek is a strong stream long before reaching the pass, and its course through the meadow is well fixed, but not so with Atlantic Creek, The west bank of each fork is liable to break through almost anywhere and thus send a part of its water across to Pacific Creek. It is probably true that one or more branches connect the two creeks under ordinary conditions, and that in times of high water a very much greater portion of Atlantic Creek flows across to the other. At any rate, it is certain that there has been, and usually is, a free waterway through Two-Ocean Pass of such a character as to permit fishes to pass easily and readily from the Snake River over to the Yellowstone—or in the opposite direction. Indeed, it is possible, barring certain falls, for a fish so inclined to start at the mouth of the Columbia, travel up that great river to its principal tributary, the Snake, continue on up through the long, tortuous course of that stream, and, under the shadows of the Grand Tétons, enter the cold waters of Pacific Creek, by which it could journey on up to the very crest of the Great Continental Divide, to Two-Ocean Pass; through this pass it may have a choice of two routes to Atlantic Creek, where it begins the journey downstream; soon it reaches the Yellowstone River, down which it continues through Yellowstone Lake, then through the lower Yellowstone out into the turbid waters of the Missouri; for many hundred miles it may continue down this mighty river before reaching the Mississippi, the Father of Waters, through which it may finally reach the Gulf of Mexico—a wonderful journey of over 5,800 miles, by far the longest possible fresh-water journey in the world.

Standing upon the bank of either fork of Atlantic Creek, just above the place of the "parting of the waters," we tossed chips, two at a time, into the stream. Though the two chips would strike the water within an inch or so of each other, not infrequently one would be carried by the current to the left, keeping in Atlantic Creek, while the other might be carried a little to the right and enter the branch running across the meadow to Pacific Creek; the one beginning a journey which will finally bring it to the Gulf of Mexico, the other entering upon a long voyage, in the opposite direction, to the Pacific. Where Pacific Creek leaves the pass it is about 6 feet wide and will average 2 or 3 inches deep, though it is much deeper in many places—in some places forming pools 1 to 2 feet deep. Just inside the pass, from *a* to *b*, the current flowed 268 feet at the rate of 1½ feet per second. The two forks of Atlantic Creek come together near the east margin of the pass and form a stream much like Pacific

Creek in size and general features. There are relatively deep pools in each of these forks, particularly in the lower parts.

We seined all of these creeks quite carefully and found plenty of small trout everywhere on each side. We took specimens in each arm of each of the Y's of Atlantic Creek and in such places as would have easily permitted them to pass from one side to the other, and there is no doubt whatever that trout can and do pass over this divide at will.

As is well known, Yellowstone Lake is abundantly supplied with trout, while Shoshone and Lewis lakes, two very similar bodies of water, were wholly without any fish life. The absence of fish from Shoshone and Lewis lakes is readily explained by the presence of vertical falls in Lewis River. But the much greater falls in the Lower Yellowstone River would certainly prove as effective a barrier in preventing fish from ascending to Yellowstone Lake from the Missouri. Evidently, Yellowstone Lake and the Upper Yellowstone River were stocked from the west, and almost certainly via Two-Ocean Pass. The probability that the outlet of Yellowstone Lake at one time was toward the Pacific, as claimed by geologists, only strengthens this solution of the problem. But while this explains the origin of the trout of Yellowstone Lake, it leaves another equally interesting problem without any explanation, viz, the presence of the blob (*Cottus bairdi punctulatus*) in Pacific Creek and its absence from Atlantic Creek and the entire basin of Yellowstone Lake.

We caught four blobs in Pacific Creek in the pass, but though we seined carefully in Atlantic Creek, only a few yards away, we did not find a single blob; nor were we able to find any further down Atlantic Creek or in any of the streams tributary to Yellowstone Lake. This fish could surely get across just as easily as the trout, and the four we caught would have had to travel upstream but a few rods through a channel filled with an abundance of water in order to be on the Atlantic side.

The water of Atlantic Creek and the Upper Yellowstone River does not seem to differ in any way from that of Pacific Creek, and the conditions there seem just as favorable to blobs. At present I am wholly unable to account for their absence; the matter needs further investigation.

During the night that we camped in Two-Ocean Pass (August 17–18), ice froze half an inch thick in a basin at our camp, and nearly as thick on the creek near by. The temperature of the air at 6:30 a. m. was 33°; of the water at 8 a. m., 42°; at 11 a. m., 55°. According to the U. S. Geological Survey, the elevation of Two-Ocean Pass above sea level is about 8,200 feet.

The "Lake sheet" of the map of the Yellowstone National Park by the U. S. Geological Survey includes Two-Ocean Pass, but it needs changing in some particulars. All of the line representing Pacific Creek *above* the pass should represent the South Fork of Atlantic Creek, and should be connected with the North Fork at the east edge of the pass; and Pacific Creek should be made to come into the pass from the northwest. (See diagram, Fig. 3, Pl. II.)

MISSOURI RIVER BASIN.

Atlantic Creek.—On August 18 we followed Atlantic Creek down to where it flows into the Upper Yellowstone River. We seined it about a mile above its mouth and found a few young trout. At this point the creek is about 36 feet wide, ¾ foot deep, and has a 3-foot current. The temperature of the water at noon was 57°. Less than 2 miles below the pass the trail crosses Jay Creek, a few rods above where it joins Atlantic Creek. At the ford, Jay Creek was 20 feet wide, 8 inches deep, and had a current of 2½ feet per second. The water at 10:30 a. m. was 47°. About 2 miles further down, we crossed Senecio Creek about one-fourth of a mile above its mouth. This is a stream much like Jay Creek, but considerably smaller.

The Upper Yellowstone River.—We came upon the Upper Yellowstone at a point about 20 miles in a direct line above the lake, or 2 miles above Bridger Lake. Crossing it at this point, we traveled down the right bank to its mouth. This river is of good size and flows through a broad valley of meadow land which, in many places, has marshes bordering the river.

According to Mr. Arnold Hague, the Upper Yellowstone River "rises in an immense snow field on the north side of an isolated peak, about 25 miles south of the southern boundary of the Park. The peak attains an elevation of over 12,250 feet above sea level, and has been long recognized as a prominent point by all topographical survey parties. Although never visited, it has been designated as Yount Peak, after a trapper who lived for a long time along the banks of the Yellowstone. Three rivers—the Yellowstone, Gray Bull, and Buffalo Fork of Snake River—find their sources upon the abrupt slopes of this peak. To the southward and not far distant rises the Wind River. The region is an uncommonly rough one, with profound gorges penetrating far into the mountains and separated from each other by mere knife-edges of rock. The entire country is made up of volcanic material, for the most part andesitic breccia."*

We saw a great many young trout where we forded the river, and again near the mouth, where large fish were also abundant. A little time devoted to fly fishing here resulted in the capture of six very fine trout, 14 to 18 inches long, every one of which, however, was infested with the parasitic worm *Dibothrium cordiceps*. The temperature of the river near its mouth at 3:30 p. m. was 57°; air, 68°. Throughout most of its course the Upper Yellowstone River has a clean, gravelly bottom and flows with a good, strong current.

Bridger Lake lies just outside the original Park boundary and between the Yellowstone River and Thoroughfare Creek. This is a pretty little lake, about a mile long by half a mile wide, and is well filled with trout.

Thoroughfare Creek.—This is the largest tributary of the Upper Yellowstone River. At our camp, just at the Park line, it is fully 100 feet wide, 2 feet deep, and flows 3 feet per second. Temperature of water at 5 p. m., August 18, 60°; at 7:30 a. m., the next day, 45°; temperature of air at 6:30 a. m., 31°. We seined this stream very thoroughly, but found nothing except numerous very young trout. A good deal of fly fishing did not result in a single catch. The water is clear and pure and full of fish food of various kinds.

* Hague, in Powell's Ninth Annual Report, page 93.

On the way down to the lake we crossed numerous small creeks, Escarpment, Cliff Mountain, and Trapper. The largest of these is Mountain Creek, it being 18 feet wide and a foot deep. These are all clear, cold streams, coming down from the heavily timbered mountains to the east, and all were found full of young trout.

Beaverdam Creek.—This stream flows into the lake just to the right of the mouth of the Upper Yellowstone River. Near its mouth, where we crossed, it is 20 feet wide, about 18 inches deep, and with a pretty swift current. Temperature of water at 10:30 a. m., August 20, 50°. The bed of the stream is very rocky, and there is little or no vegetation in the water. Fish food seemed scarce and no fish were observed, though we made several hauls with the seine. Near the mouth of this creek are several old beaver dams, from which doubtless the stream received its name.

From here our path led us down the east shore of Yellowstone Lake to the outlet. This is one of the most heavily timbered districts in the United States. The trees are of good size and so close together that it is no easy matter to find one's way along the game trails—the only trails found here. The lake is in sight most all the way and the views are very beautiful. (See Pl. VII.) We crossed Columbine Creek, a small stream of mineral water containing no fish, and camped at the mouth of Meadow Creek, another very small, sluggish stream, but full of young trout. In places this creek was 12 feet wide, a foot or more deep, and had a somewhat muddy bottom These were really pools, with scarcely any current. In other places the stream was not so wide nor deep, but swift and rocky. Temperature of water at 3 p. m., August 20, 57°; at 8:30 next morning, air, 57°; water, 51°. Young trout were very abundant in this little creek.

Pelican Creek.—This is a fair-sized stream, flowing into Yellowstone Lake near the outlet. Near its mouth it is about 35 feet wide, 1½ feet deep, and flows with a moderately swift current. The temperature at the mouth at 6 p. m. August 21 was 52°. Along this stream are numerous springs, many of them of mineral water. The stream is full of young trout. From here we traveled down the Yellowstone River to the ford, where we crossed to the left bank, and then followed the Government road to the Mammoth Hot Springs Hotel.

Yellowstone Lake and the streams below it have already been well described by Dr. Jordan in his report on the Yellowstone National Park. (Bulletin IX, U. S. Fish Commission, pp. 41–63, 1891.) The following from Mr. Hague, Powell's Ninth Report, pp. 92 and 93, concerning Yellowstone Lake, should be added:

> In comparison with its size the drainage area is small. This is readily accounted for by its great altitude above sea level and the very favorable conditions of the surrounding country for receiving a heavy snowfall throughout eight months of the year. Over a great part of this area these snows are protected by the forests from the dry westerly winds, and the water is allowed to percolate the soil gradually, supplying the springs and streams which feed the lake. The altitude of Yellowstone Lake is 7,740 feet above sea level, with a surface area of 139 square miles and an indented shore line of nearly 100 miles. As yet we possess but little accurate knowledge of its depth, although there is no question that it presents the grandest natural storehouse for water within what is known as the arid region of the West. If the broad valley of the Yellowstone for 200 miles is ever to be settled with a prosperous people, this body of water will be of inestimable value for the purposes of irrigation. From careful measurements made of the flow of the Yellowstone River just below the outlet of the lake, the discharge of water was found to be 1,525 cubic feet per second, or about 34,000,000 imperial gallons per hour. The gauging of the stream took place in September, when the lake stood at a lower level than at any other period of the year.

In 1889 the Irrigation Survey measured the Yellowstone River at Horr and Springdale, just north of the Park, and obtained results remarkably close to those obtained by Mr. Hague. Capt. Dutton says:

> The Yellowstone in August carried at Horr 1,553 second-feet on the 26th of August, and at Springdale 2,111 second-feet, which is about as low as it may be expected to fall in any season.*

We examined the Yellowstone River pretty carefully between the lake and the falls, for the purpose of determining if any of the whitefish planted there in 1889 by Mr. Lucas could be found. Not one was seen, and it is not believed any have survived. Careful inquiry among members of Mr. Wyatt's road camp failed to elicit any evidence of the presence of whitefish. This party had been encamped upon the bank of the river for some time and had had excellent opportunities for observing the whitefish, if any were there. Trout, both large and small, were very abundant in the river here. They are eaten quite freely and are not regarded as being seriously affected by the parasitic worm. Many of the trout taken here are said not to be affected at all.

Blacktail Deer Creek was examined at the crossing of the Cooke City road, and Lava Creek or East Fork of Gardiner River was examined between the two falls, where one small trout was taken with the hook. Whether this was one of the plant made here by Mr. Lucas in 1889 can not be certainly known, as it is reasonably certain that trout were found naturally in this creek, as explained by Dr. Jordan in his report.

Red Rock River.—This river was examined by Mr. Clapham 3 miles north of Red Rock Station on the Union Pacific Railroad. It rises in Red Rock Lake, about 40 miles distant, in the mountains on the Idaho line. Near Red Rock it is a good-sized stream, about 30 feet wide and 20 inches deep. It is full of deep holes and eddies. The bottom is usually quite rocky, but there are stretches of sand and mud. The water is clear, but not very cold, the temperature being 58°. This is a very good fish stream, blobs, dace, suckers, grayling, and whitefish being abundant, and one specimen of the ling (*Lota lota maculosa*) was taken. No trout were found here, though higher up the stream and in Red Rock Lake trout are said to be abundant. The ling is also said to be common in Red Rock Lake.

Beaverhead River.—This is simply a continuation of Red Rock River, the name changing at Grayling Station. We examined this river at a point 2 miles above Dillon, Montana, and from there downstream to below the town. It is there a rather large stream, 50 feet wide and at least 2 feet in average depth. It flows through Dillon Valley, which is several miles broad. It has mud or adobe banks, usually covered with a rank growth of willows and other bushes. The bottom is usually one of gravel, but there are muddy places here and there where the current is less swift and where the stream is filled with *Ranunculus* and many species of *Algæ*. Along its banks are many ponds filled with water vegetation. The temperature of the water at noon, July 27, was 63°. This is apparently too warm for trout, as none were seen, and we were told that none are found this far down the stream. It is, however, an excellent stream for whitefish and grayling, with which species it is well supplied. Suckers, dace, and blobs were also abundant, the blobs being exceptionally large. Black bass would certainly do well in such a stream as this.

* Powell's Tenth Annual Report, Part II, p. 89.

Beaverhead River flows in a general northeasterly direction, and joins the Bighole River east of Melrose to form the Jefferson River. The Bighole River is much the same kind of a stream as the Beaverhead. It is said to be well filled with whitefish and suckers.

Our route from the Mammoth Hot Springs to Shoshone Lake was essentially the same as that followed by Dr. Jordan's party in October, 1889. The waters of this region were fully described by him, and but little need be added in this report concerning them. A few observations were made, however, that should be recorded. The temperature of Glen Creek at 11 a. m., August 25, was 54°. The temperature of Indian Creek at 11:30 a. m., August 25, was 52°, while on August 7, when the air was 70°, the water was 55°.

The brook trout that were placed in these streams in 1889 are evidently thriving well, as we found not only individuals of that plant, but young that could not be over a year old. In Cañon Creek we found an abundance of blobs, but did not succeed in taking any trout, although specimens were collected there by Dr. Jordan.

A plant of 9,800 Von Behr trout was made in Nez Percé Creek in 1890. Though we were, at the time of our visit, unable to find any fish, we were informed by Lieut. Pitcher that fish have been seen there this season; and Mr. Elwood Hofer writes me that, on October 9 of this year, he saw trout in Nez Percé Creek near the "Soldiers' Camp." These are most probably of the plant of 1890, as this creek was believed to be wholly barren of fish until the time of this plant. Mr. Hofer, however, believes that the native black-spotted trout is found in Nez Percé Creek, but can not see how they got there.

The *Firehole* was examined at various places. This stream contained no fish above Keppler Cascade until 1889, when a plant of Loch Leven trout was made here by the U. S. Fish Commission. Specimens of this trout were seen above the cascade, and one was obtained in the river above Old Faithful Geyser. At the mouth of Firehole River grayling, whitefish, dace, blobs, and suckers were found in abundance.

Gibbon River was examined at various points from above Virginia Cascade to its mouth, where it joins the Firehole to form the Madison. This stream was stocked with rainbow trout in 1889, and we found specimens both above and below Virginia Cascade. At the mouth of Gibbon River we found all the species that were found in the Firehole near by. These two streams unite about 6 miles below Gibbon Falls, and about the same distance below the Lower Geyser Basin.

Madison River.—On August 23, 24, and 25, I made a trip from Norris Basin down the Madison River to Horsethief Springs, beyond the western boundary of the Park. The road to this place passes down the Gibbon River, which it crosses near its mouth, and then follows the Madison River very closely for several miles, crossing it no less than five times before reaching Horsethief Springs. The upper course of the Madison River is through a narrow and very picturesque cañon which widens out below into a broad, grassy valley. The banks and bed of the stream are rocky or of coarse gravel. The water is clear and sparkling, but not cold—this latter fact being due, of course, to the great amount of hot water which is poured into it from the Upper and Lower Geyser Basins. The current is in most places quite swift, and the stream is well filled with *Chara*, *Algæ*, and various other kinds of water vegetation. This is evidently an excellent fish stream, at least as far up as the forks—grayling and whitefish being really abundant; dace, blobs, and suckers were all common.

Horsethief Springs are described in detail in another part of this report, and the description need not be repeated here. Suffice to say that there is probably no place in Montana where grayling, whitefish, and mountain trout are more abundant.

Mr. E. R. Lucas, in a note to Dr. Jordan, says:

> On October 2 [1889], I collected from Horsethief Springs 2,000 whitefish, which I planted the next day in Twin Lakes. * * * On October 15 I collected 1,000 more whitefish and planted them in Yellowstone River above the falls. There are unlimited numbers of these whitefish in Horsethief Springs, running in size from 2 to 5 inches. There are also quite a large number of grayling in the stream.

Mr. R. R. Cummins, the owner of the springs, in a letter to me dated December 20, 1891, says:

> The grayling and trout are just swarming in the stream. I caught eighty-two grayling weighing from one-half pound to 2 pounds 2 ounces in about five hours' fishing, using grubs for bait.

My own observations, made August 24, convinced me of the abundance of these species here. Every nook and corner and especially every deep pool was found to be full of fish, most of them young, but some of good size. The whitefish and grayling seem to exceed the trout in numbers. These three species not only find an abundance of suitable food here, but also use this as a spawning ground. The blob is also very common here.

Bozeman Creek.—This is one of a great number of interesting streams flowing through the rich agricultural Gallatin Valley. It flows northward from Sour Dough Cañon, through the town of Bozeman, and, with Middle Creek, forms the East Gallatin River about 10 miles northwest of Bozeman. This latter stream flows into the main Gallatin River at Barton's Bridge, about a dozen miles farther northwest, or about 10 miles east of where the Gallatin, Madison, and Jefferson Rivers unite to form the great Missouri. Bozeman Creek at the bridge in the edge of the town is perhaps 30 feet wide and will average 18 inches deep. The banks are covered with bushes and the bed of the stream is of coarse gravel. The water is pure and clear. The temperature at 9:30 a. m., August 27, was 61°.

Bridger Creek is a somewhat smaller stream, but is otherwise very much like Bozeman Creek, into which it flows. At Davies Springs this creek was 10 feet wide, 10 inches deep, and had a current of 2 feet per second. The temperature of the water at noon was 60° opposite the springs, while a little higher up it was but 56°. This difference is no doubt due to the fact that a warm spring pours its water into the creek just opposite Davies Springs. Just above these springs is a very interesting cañon, through which the creek flows.

Both of these creeks are very good fish streams, and are said to be well filled with trout and grayling.

Dr. F. V. Hayden says:

> The drainage of the Gallatin is composed of a large number of little streams that rise in the Great Divide for a distance of 80 to 100 miles, and each of these little streams gashes out a deep gorge or cañon in the mountain sides. * * * The valley of the Gallatin, like the valleys of all the streams in Montana, is undoubtedly one of erosion originally, and was also the bed of a lake. This lake basin extended down to the junction of the Three Forks northward, and the modern deposits are found all along the base of the mountains on either side of the valley up to the very sources of the river, sometimes rising quite high on their sides. So great has been the removal of sediment, during and since the recession of the waters of the lake, that it is not always easy to determine the entire thick-

ness of the original deposit. Remnants are left, however, at different points, sometimes in the higher ranges of foothills, or in patches among the metamorphic rocks at considerable elevation on the divides between the Gallatin, Madison, and Jefferson forks. Areas of greater or less extent occur 600 to 800 feet above the channels of the rivers, showing that the waters must have been so high that only the more elevated summits were above the surface.

McClellan Creek rises among the hills on the "Crow Divide," flows northward about 15 miles, and empties into Prickly Pear Creek about 5 miles southeast of Helena. We examined this stream for some distance along its course, 12 miles east of Helena, near an old Spanish quartz mill or *arastra*. This creek is said to be usually a clear stream, but at the time of our visit the water was somewhat muddied by recent rains and by some placer mining going on in this vicinity. The banks and bed of the stream are very rocky and the current very swift. The stream is 8 to 15 feet wide and averaged perhaps 2 feet deep. The temperature of the water at 10 a. m., July 20, was 47.5°; air, 70°. Owing to the extreme swiftness of the current the use of the seine was made very difficult. Numerous hauls resulted in the taking of five trout, each 8 to 10 inches long. Some of these were full of eggs, showing this to be near the spawning season. No other life was noticed in the stream. A few frogs and snakes were seen along the banks.

Prickly Pear Creek, into which McClellan Creek flows, is a much larger stream, but nearly all of its water is used for irrigation purposes. It flows through the beautiful Prickly Pear Valley and empties into the Missouri north of Helena Junction. This was at one time an excellent trout stream, and a few trout are still found in its upper portion.

PLACES EXAMINED WITH REFERENCE TO THE LOCATION OF A STATION.

In general, it may be said that every stream and place visited by us was examined with reference to its furnishing the necessary natural conditions of such a fish-cultural station as is desired for that region. In another part of this report will be found a discussion of the general physical features of western Montana and northwestern Wyoming, including a somewhat full description of each particular lake, stream, or spring examined; this will show that there are several places, any one of which can furnish perhaps all the required natural conditions. It is proper to state here that it was not possible, within the time at our disposal, to visit all parts of Montana and Wyoming and examine all the localities that might supply suitable sites for a fish-cultural station. Nor was it necessary that every place should be visited, for among those that we were able to examine is found an ample number from which to make the selection.

The following is a list of the places where we made special examination with reference to the hatchery question: McClellan Creek and Child's ranch, near Helena; Little Blackfoot River, at Elliston; Cottonwood Creek, at Deer Lodge; Rattlesnake and Lolo creeks, near Missoula; Swan River, at Swan Lake; Glen Creek and Gardiner River, near Mammoth Hot Springs; Reese Creek, near Horr; Horsethief Springs, Montana; Botteler Springs, south of Livingston; and Davies and Wolverton springs, near Bozeman.

McClellan Creek rises in the hills on the Crow Divide, flows northward about 15 miles, and empties into the Prickly Pear Creek about 1½ miles south of East Helena. We examined the stream up and down for more than a mile, 12 miles east of Helena,

this being in the vicinity of the old Spanish arastra or quartz mill. Here it is a stream 8 to 15 feet wide and averaging 20 to 24 inches deep. It has a very swift current, the flow being not less than 3,300 gallons per minute. It is usually a clear stream, but at the time of our visit it was rather muddy, due to a heavy rain on the preceding day. Several mining ditches are taken out at various places both above and below where we saw the stream, and there is, of course, some danger of contamination from this source. The bed of the stream is very rocky, as are also the banks and much of the country through which the stream flows. The banks are in many places covered by a dense growth of alders and other small trees and bushes. The temperature of the water at 10 a. m., July 20, was 47.5°; air, 70°.

Owing to the rough character of the bed and the swiftness of the current, it was very difficult to use the seine to any advantage. Quite a number of attempts to haul the seine were made, however, resulting in the taking of but five small trout, from 8 to 10 inches long. Two of these were females, in one of which the eggs were quite ripe, showing that this was near the spawning season of the species in this locality. No other kind of life was noticed in this creek.

Child's bedrock drain is on the land of Hon. C. W. Child, about 2 miles from East Helena, or 6 miles east of Helena. Mr. Child has put in this drain for irrigation purposes. The water is collected by means of transverse ditches in the glacial drift resting upon the bed rock near Prickly Pear Creek. The water thus collected is carried in a box flume for some little distance and is then turned into an irrigating ditch where it goes to augment the supply in a ditch from McClellan Creek. The stream flowing from this drain was 20 inches wide, 10 inches deep, and had a current of 17 inches per second, which means a flow of 883 gallons per minute. The water is of course very clear and pure and exceedingly cold. The temperature at 11 a. m., August 5, was 42°; air, 75°. This is the coldest water that we found anywhere in Montana or Wyoming, and its temperature is no doubt constant or nearly so the year round. According to Mr. Child, the quantity of the flow is approximately constant. The nature of the source of supply, of course, makes these facts evident. The water is perfectly clear and free from solid matter, and would seem to be well suited for trout-cultural purposes, unless, indeed, it be somewhat too cold. A rather level tract of several acres lies below the drain about three-fourths of a mile, where suitable grounds for the building and ponds can be had. The ground is somewhat rocky, being covered with coarse morainic material, and the cost of clearing it off and constructing the ponds would be considerable. Sufficient fall from the drain to this place can be had to give a good gravity supply.

Both the Northern Pacific and the Montana Central railroads run within less than a mile of the place where the station would be located. By additional work the amount of water could be doubled, which would make an abundant supply for the purposes required. Mr. Child would make all the guarantees as to water control that the Commission would desire. No definite proposition has been made by Mr. Child as to what the necessary land would cost the Commission. The cost of getting the water in sufficient quantity under control and the expense that would be necessary in the construction of the ponds are serious objections.

Little Blackfoot River was examined July 21, near Elliston. It was at that time about 25 feet wide, 2½ feet deep, and had a current of 3 feet per second, this giving a flow of 84,375 gallons per minute. Above Elliston the water is clear and pure, but

below that place the stream is muddied by mining operations carried on along its banks. The current is very swift, the bed of the stream is strewn with rocks of various sizes, and the banks are well lined with willows, cottonwoods, and various other small bushes. The temperature of the water at 4 p. m. was 55°; air, 71°. In this river we found an abundance of blobs and young whitefish, and a few small trout. In a small creek flowing into the river, suckers and minnows (*Catostomus catostomus* and *Rhinichthys dulcis*) were abundant. The high temperature of the water and the danger of contamination from heavy rains are serious objections.

Cottonwood Creek.—We examined this stream from its mouth at Deer Lodge upstream for about 3½ miles. At a point about 2 miles above the town of Deer Lodge and on the land of Mr. Albee, we found the most suitable location. The stream here measured as follows: Average width, 20 feet. Average depth, 1½ feet. Current, 3 feet per second. Volume, 40,394 gallons per minute. Temperature, 54° at 3 p. m., July 22; air, 77°.

This is a clear stream flowing through gorges farther up, while here it flows through rather rough meadow land. The bed of the stream is very rocky; the banks are lined with cottonwoods, alders, and other bushes. The stream seems to be well filled with insect larvæ and other fish food, and is regarded as being an excellent trout stream. During less than two hours' fishing with seine and fly, we took a great many blobs and about thirty trout, the largest weighing about 7 ounces. The fall is sufficient for getting the water properly and easily into the hatchery, and very desirable ground can be had either near the residence of Mr. Albee or on the ranch of Mr. N. J. Bielenberg, a few rods farther up the stream. The cost of getting the water under control and of constructing the ponds would be very moderate. At the time of our visit a little mining was going on above Mr. Albee's; this contaminated the water somewhat, but Mr. N. J. Bielenberg assures us that this can be easily controlled. The town of Deer Lodge gets its water from this stream, and of course would interest itself in seeing that the stream is never seriously contaminated.

Mr. Bielenberg offers to donate as much land as would be needed and to make all necessary guarantees as to the water supply. The location with reference to the region to be stocked is a central one and the railroad facilities are good. The city of Deer Lodge is one of the prettiest, most thriving cities in the State, and would afford excellent school, church, and social advantages to all connected with the station, matters of no little importance.

Rattlesnake Creek.—This is a good-sized stream flowing into the Missoula River, at Missoula. We examined it throughout the last 8 miles of its course; average width, 30 feet; average depth, 1⅔ feet; current, 2½ feet per second; volume, 56,250 gallons per minute; temperature, 54° at 3 p. m., July 28. This stream rises in two small lakes in the mountains north of Missoula, is about 20 miles long, and flows through Government land, except for the last 2 miles of its course. The rock of the region seems to be chiefly a metamorphic sandstone; the bed of the stream is full of bowlders of various sizes, and there is but little water vegetation. The water is pure, clear, and cold. The city of Missoula gets its water from this stream, the ditch being taken out less than 2 miles above the city.

There are many places within a distance of 2 to 6 miles of the city where very suitable land can be found. The fall is sufficient and the land lies so as to make it a comparatively easy matter to get the necessary amount of water under control.

Missoula is situated upon the Northern Pacific Railroad, in the western part of the State, a location hardly sufficiently central as regards the region to be supplied. I have no information as to what would be the cost of sufficient land in this locality. Hon. W. M. Bickford, of Missoula, would furnish any information of this kind that might be desired.

Lolo Creek is a very pretty mountain stream having its rise on the Divide, near the Idaho line. It flows eastward for about 40 miles and empties into the Bitter Root River about 12 miles southwest of Missoula. We examined this stream through the last mile of its course but one. It is here about 35 feet wide, with an average depth of 2½ feet, and with a rather swift current. It flows over a gravelly bottom and between gravelly banks, which are covered by a heavy growth of alders, willows, and cottonwoods. The stream here is often divided up and runs in several channels with low-lying islands in between, which are covered with a heavy growth of bushes and small timber. There are also many small bayous or marshy places along this lower portion of the stream which are filled with a species of *Ranunculus* (*R. aquatilis trichophyllus*). Trout, blobs, suckers, and minnows were common. The temperature of this stream at noon July 30, was 56°.

Depew Creek is a small stream, about 8 miles long, which flows into Swan River from the right, just below the foot of Swan Lake. Its entire course is on Government land and through dense pine forests. It runs between 1,000 and 2,000 gallons per minute. The water is clear and pure and has a temperature of less than 50°. At 11 a. m., August 3, its temperature at its outlet was 48°. The amount of water is said not to vary much. It never becomes contaminated on account of rains, and there is no probability of its ever being injured in any way through mining operations. The fall is great enough to enable the water to be gotten under control very easily. All the natural advantages requisite for the establishment of a hatchery can be found at the mouth of this creek. Its nearness to Swan River and the large and interesting lakes which that river connects would prove a great advantage in many ways. The remoteness of the location from a railroad is a serious objection.

Horsethief Springs.—These springs are on the ranch of Mr. R. R. Cummins, in Gallatin County, Montana, about 4 miles from the west line of the Yellowstone National Park, and near its northwest corner. There are two of them coming out on the south slope of a small grassy mountain near its base, and soon uniting to form one stream, which flows into the North Fork of the Madison River. The accompanying diagram (Pl. III) will help to an understanding of these springs:

Distance between springs (*a* to *b*)	feet..	135
Width of west spring at *1*	inches..	40
Depth of west spring at *1*	inches..	4
Current between *1* and *2* (35 feet)	feet per second..	3½
Volume of west spring	gallons per minute..	1,745
Width of main stream at *3*	feet..	35
Depth of main stream at *3*	inches..	5
Current from *3* to *4* (51 feet)	feet per second..	4
Volume of main stream at *4*	gallons per minute..	26,181
Width of stream at *5*	feet..	70
Depth of stream at *5*	inches..	10

Current between *6* and *7* (50 feet), a trifle over 1 foot per second.

Volume at *7*, about 26,181 gallons per minute.

Temperatures were taken in the morning of August 24, between 8 and 10 o'clock, when the air was about 70°:

	Degree.		Degree.
Temperature of water at *a*, at 8 a. m.	48	Temperature three-fourths mile below *e*, at 9:40 a.m.	49
Temperature at *b*, at 8 a. m.	45.5	Temperature of small stream *f*	46.5
Temperature at *c*, at 8:15 a. m.	46	Temperature of small stream *g*	44
Temperature at *d*, at 8:35 a. m.	48	Temperature of small stream *h*	46
Temperature at *e*, at 9 a. m.	48		

The stream, formed by the uniting of the waters from the two springs, flows south about 300 feet, then turns west and flows in that general direction for at least one-fourth mile, where it receives the small branch *h* from the left, and continues about 1 mile further before joining the Madison. The current within the first 180 feet from the springs is very swift, the fall being at least 20 feet. Below that the fall is very slight, the current in no part of this portion being much greater than 1 foot per second. Just north of the springs and west of them the ground rises rapidly; to the east there is also a slight rise, but to the south and southwest is very attractive meadow land with just sufficient slope to render the construction of ponds upon it a very easy matter. Indeed, the stream itself could be easily converted into ponds simply by damming, thus cutting it up into suitable sections, any one of which could be drained into the one below. The water is pure, clear, and cold, and certainly well suited in every way for trout. The bed of the stream is gravelly. There is an abundance of *Algæ*, *Chara*, and other water vegetation in the stream. Small mollusks and insect larvæ abound, and trout, grayling, and whitefish are exceedingly abundant. In fact, the grayling and trout use this stream and the small branches coming into it as a spawning ground, vast numbers of these two species and many whitefish being found here during the breeding season. This is, of course, conclusive evidence as to the excellent character of these waters as breeding grounds for members of the *Salmonidæ*.

The water in these springs never freezes, and Mr. Cummins informs me that it does not freeze in the creek at any point within a mile of the springs.

Mr. Cummins, who owns the springs and the lands through which the creek flows, will donate to the Commission all the ground that may be needed.

At present, the nearest railroad station to these springs is at Cinnabar, Montana, about 70 miles northeast. They are 125 miles south of Bozeman. The Northern Pacific Railroad has recently surveyed a line from Gallatin, Montana, to the north line of the Yellowstone Park, running within 1½ miles of the springs. The Union Pacific Railroad has two lines surveyed through this region, each of them running very close to these springs; one of the lines proposed by the Union Pacific is from Gallatin, the other from Beaver Cañon. Each runs to the Park line near Mammoth Hot Springs.

The natural advantages offered by Horsethief Springs are, in my judgment, superior to those found at any other place visited by us. The water is excellent in character and enormous in quantity. The topography could scarcely be improved. The location is central with reference to the region to be stocked—in short, *all* the *natural* conditions are most favorable. Should the Northern Pacific or the Union Pacific build a branch road to the Park over the line surveyed, I do not think a better location for the station could be found than at Horsethief Springs.

Glen Creek was examined just above the Golden Gate in the Yellowstone National Park. It is there a small stream about 5 feet wide, 6 inches deep, and with a current of about 18 inches per second. This gives it a flow of about 1,683 gallons per minute.

The following table gives the approximate width, depth, current, and volume, together with the temperature of the water of each main spring:

Group.	Width in inches.	Depth in inches.	Current in inches per second.	Gallons per minute.	Temperature.
					°
1	8	2	48	200	50.75
2	8	2	36	149	.....
3	12	3	36	336	50.50
4	Could not well measure.				
5	24	6	12	449	48.50
6	36	3	16	449	49.00
7	72	6	16	1,795	48.00
8	36	8	12	897	50.00
	Total flow over			4,275	

We were informed that the water in these springs never freezes, and that the volume and temperature remain approximately constant throughout the year.

This location seems to be an admirable one in every way, so far as natural conditions are concerned. Its nearness to the Yellowstone National Park, which is destined to become the great national game preserve, is a matter of no little importance. I have no doubt that satisfactory arrangements regarding the necessary land for the site can be made with Mr. Botteler, the owner.

Davies Springs.—These springs, two in number, are on the land of Mr. W. J. Davies, 4 miles from Bozeman. They come out at the roadside at the base of a limestone bluff. Two small streams are formed which flow across the wagon road and within a few yards enter Bridger Creek. The east spring, at 10 a. m. August 27, had a temperature of 46°. The stream flowing from it was about 10 feet wide and 4 inches deep, and flowed at least 1,496 gallons per minute. The west spring is a little warmer, its temperature being 47°. It flows a stream 3½ feet wide, 4 inches deep, and with a current which gives not less than 525 gallons per minute. The water from these two springs can be easily united into one stream which would give over 2,000 gallons per minute. Just across Bridger Creek is a good-sized spring of comparatively warm water, its temperature being 79°. Bridger Creek near the springs is about 10 feet wide, 10 inches deep, and has a current of 2 feet per second. Its temperature was 60°. The springs are surrounded by alders, rose bushes, willows, cottonwoods, and bushes of other kinds. There is an abundance of cress, moss, and other water vegetation in the springs and the streams running from them. Sufficient suitable ground could probably be had just below the springs, and it would no doubt be furnished to the Commission on satisfactory terms.

The accompanying plat (Pl. V) shows clearly the nature of the proposed site. The location is a central one with reference to the region to be stocked. Bozeman is on the Northern Pacific Railroad where the main line branches, one running to Helena, the other to Butte, both branches again uniting at Garrison. The Gallatin Valley, in which Bozeman is situated, is one of the most fertile and most attractive that we have ever seen. Bozeman is but 29 miles west of Livingston, where the branch road leaves the main line of the Northern Pacific for the National Park.

Wolverton Spring, 4 miles south of Bozeman, was also examined. This consists of one main spring and a great number of small ones coming out at various places in

a marshy tract of ground just below the main spring. The stream from the main spring was 2 feet wide and 10 inches deep, and flowed about 748 gallons per minute. Its temperature at 3:30 p. m., August 27, was 52°, or 48° in the spring itself, which was shaded. Measured at a point one-fourth mile below the springs, the stream was found to be 5 feet wide, 8 inches deep, and to have a current of 1 foot per second. This would indicate a flow of about 1,500 gallons per minute. The temperature here was 52° at 4 p. m. These springs all come out in a low marshy piece of ground and form a kind of pond filled with watercress and other water plants. The pond is surrounded by willows, cottonwoods, chokecherries, and other bushes. The stream flows across the road to the north from the marsh, and continues northward through a meadow for a mile or more. Its banks are covered with a dense growth of bushes. The ground over which it flows is perhaps too level to afford sufficient fall for a gravity supply.

ANNOTATED LIST OF FISHES OBTAINED IN MONTANA AND WYOMING.

As shown in the preceding pages of this report, the region over which our explorations extended is, in general, a mountainous one, most of whose streams are clear and cold, and flow with a rapid, often turbulent, current. The number of species of fishes in such waters is never great. Though our collection contains but 16 indigenous species, it no doubt represents fairly well the fish fauna of that region. The species represented, grouped by families, are the following:

Catostomidæ.
1. *Catostomus discobolus* Cope.
2. *Catostomus catostomus* (Forster).
3. *Catostomus macrochilus* Girard.
4. *Catostomus ardens* Jordan & Gilbert.

Cyprinidæ.
5. *Rhinichthys dulcis* (Girard).
6. *Mylocheilus caurinus* (Rich.).
7. *Ptychocheilus oregonensis* (Rich.).
8. *Leuciscus hydrophlox* (Cope).
9. *Leuciscus gilli*, sp. nov.
10. *Leuciscus atrarius* (Girard).

Salmonidæ.
11. *Coregonus williamsoni* Girard.

Salmonidæ—Continued.
12. *Thymallus signifer* (Rich.).
13. *Salmo mykiss* Walbaum.
14. *Salvelinus malma* (Walbaum).

Cottidæ.
15. *Cottus bairdi punctulatus* (Gill).

Gadidæ.
16. *Lota lota maculosa* (Le Sueur).

Salmonidæ (introduced into the Yellowstone National Park).
17. *Salmo irideus* Ayres.
18. *Salmo fario* Will.
19. *Salmo trutta levenensis* Walker.
20. *Salvelinus fontinalis* (Mitchill).

The most abundant, important, and generally distributed of these is, of course, the black-spotted or mountain trout, with its almost constant and destructive attendant, the blob. Just how destructive the blob is to the eggs of the trout I am unable to say, but it is probably a very serious pest during the spawning season.

1. Catostomus discobolus Cope. (Pl. XVIII.)

Catostomus discobolus Cope, Hayden's survey, 435, 1870.

Thirteen examples of this species were taken in Red Rock River near Red Rock, Montana, and an equal number from Beaverhead River at Dillon. These specimens are from very small size to 7 inches in length. Head, 5; depth, 5; eye, 5; snout, 2 to 2¼; interorbital width 2; mouth and lips large, cartilaginous sheath of each lip well developed; fontanelle a very narrow slit; origin of dorsal fin much nearer snout than

caudal; scales very small and crowded anteriorly, about 93 in lateral line. D. 10, its height 1¼ in head, a little greater than length of its base; anal long, nearly equal to head; pectoral shorter, 1⅙ in head.

2. Catostomus catostomus (Forster).

Cyprinus catostomus Forster, Phil. Trans., 1773, 155.

The collection contains the following specimens, which I refer to this species:

a. Little Blackfoot River, Elliston, Montana 16
b. Browns Gulch Creek, Silver Bow, Montana 47
c. Lolo Creek, near Missoula, Montana 22
d. Jocko River, Ravalli, Montana 5

All are young specimens, none being over 8 inches in length. Head, 4¼ to 4½; depth, 5 to 5½; eye, 5 to 6; snout, 2⅙ to 2⅓.

There is a little variation in the papillæ, but there are never over four rows on the upper lip; in fact two to three rows is the almost constant number. Compared with specimens of *C. griseus* from the South Platte, at Denver, Colorado, the Montana specimens have the lips much smaller, the rows of papillæ fewer, and the jaws with much less distinct cartilaginous cutting edge.

I have also compared them with specimens of *Catostomus catostomus* from various places, and others labeled *C. longirostris*, and am not able to see any important differences. The type of *C. retropinnis* Jordan has very much larger lips than in any other specimens I have examined, and the scales are smaller. It is perhaps best to retain it as a distinct species for the present at least.

3. Catostomus macrochilus Girard. (Pl. XVIII.)

Catostomus macrochilus Girard, Proc. Acad. Nat. Sci. Phila. 1856, 175.

This large sucker is very common in Post Creek, on Flathead Indian Reservation, and in Swan Lake. It is no doubt common in Flathead Lake and the streams of that region, but we obtained specimens only from Post Creek and Swan Lake, three from the former and seven small ones from the latter. Examples 16 inches long have the head 4, depth 5, and eye 6. Scales, 11 or 12–72 to 75–10 or 11, about 40 before dorsal. Dorsal long, of 14 or 15 rays; pectorals and anal long, the latter nearly equal to head; papillæ not very large.

4. Catostomus ardens Jordan & Gilbert. (Pl. XVIII.)

Catostomus ardens Jordan & Gilbert, Proc. U. S. Nat. Mus., 1880, 464. (Utah Lake.)

We found this sucker very abundant in the Snake River at President Camp, where numerous specimens were taken, from very small ones up to a foot in length. Very much larger individuals, presumably of this species, were seen in water too deep to seine. Specimens 7 to 12 inches long have the head 4 to 4¼, depth 4½ to 5, eye 5½ to 6, and the snout 2¼ to 2½. Scales, 10–63–9, much crowded in front; origin of dorsal fin very slightly nearer snout than base of caudal. Papillæ on upper lip in about five rows, not evidently so many in younger specimens.

5. Rhinichthys dulcis (Girard). (Pl. XIX.)

Argyreus dulcis Girard, Proc. Acad. Nat. Sci. Phila. 1856, 185; P. R. R. Survey, X, 243, pl. LIV, figs. 5–8, 1858.

Rhinichthys dulcis, Jordan, Bull. U. S. Fish Com., IX, for 1889, 1891, 48.

This little minnow is pretty generally distributed throughout the region visited by us, numerous specimens being obtained at each of the following places:

	No. of specimens.
a. Beaverhead River, Dillon, Montana	115
b. Red Rock River, near Red Rock, Montana	5
c. Junction of Firehole and Gibbon Rivers	23
d. Snake River at President Camp, Wyoming	6
e. Browns Gulch Creek, at Silver Bow, Montana	3
f. Big Blackfoot River, near Bonner, Montana	4
g. Little Blackfoot River, Elliston, Montana	6

Those from Beaverhead River are the largest specimens seen, many being $3\frac{1}{2}$ to 4 inches in length. It was also more abundant here apparently than elsewhere. The specimens from the junction of the Firehole and Gibbon are all very small. In many examples measured, the origin of the dorsal is a little nearer the nostril than base of caudal fin, but midway between base of caudal fin and tip of snout.

6. **Mylocheilus caurinus** (Rich.) Girard. (Pl. XIX.)

Cyprinus (Leuciscus) caurinus, Richardson, Fauna Bor. Am., III, 304, 1836.
Mylocheilus caurinus, Girard, Proc. Acad. Nat. Sci. Phila. 1856, 169.

Common in Flathead Lake and in Bitter Root River. Curiously enough, at Flathead Lake it is called "whitefish" and is served at the hotels as such, while the true whitefish, which is not uncommon in the lake, does not appear to have attracted the attention of the local fishermen. About a dozen specimens were examined, ranging from 8 to 11 inches in length.

Head, 4 to $4\frac{1}{3}$; depth, $4\frac{1}{4}$ to $4\frac{2}{3}$; eye, $4\frac{3}{4}$ to 5; snout, $3\frac{1}{4}$ to $3\frac{2}{3}$; pectorals, $1\frac{1}{2}$ to $1\frac{2}{3}$ in head; ventrals, $1\frac{1}{5}$; dorsal, 8, a little longer than pectorals, about $1\frac{1}{3}$ in head; anal, 8, equal to ventrals.

Scales, 12–77–7; teeth, 1, 5–5, 1 in numerous examples studied; in fact, I do not find a single case in which there are two teeth in the lesser row.

Color in life, dark greenish above, extending down nearly to the lateral line, where there is a dark irregular band two scales wide. Below this is a reddish band two or three scales wide, extending the full length of the fish, while the dark band stops at the posterior edge of dorsal fin; below, white; top of head, greenish; cheeks and opercles paler, with fine punctulations of dark; corners of mouth with a reddish wash extending backward on cheeks; a little orange on opercles and at base of pectorals.

7. **Ptychocheilus oregonensis** (Rich.). (Pl. XIX.)

This voracious fish is very common in Flathead Lake, where it is currently known as "squawfish." We also found it common in Lolo Creek and in Bitter Root River, near Missoula.

Numerous individuals from 7 to 12 inches long were examined. Head, $3\frac{3}{4}$; depth, $4\frac{1}{2}$; eye, 6; snout, 3; scales, 19–80–7; teeth, 2; 5–4, 1. Tip of snout to angle of mouth, $2\frac{2}{3}$ in head. Dorsal, 10; anal, 8; the pectorals equal the anal but exceed the ventrals; the height of the dorsal fin is contained $1\frac{3}{4}$ times in the head, and is $\frac{1}{4}$ greater than its length.

Color in life, above nearly uniform muddy greenish, a few scattered scales showing silvery; growing gradually silvery on the sides, with a slight tinge of orange, and slightly dusted with dark, this extending about four scales below the lateral line; under parts white, pale greenish on caudal peduncle; cheeks silvery, with a few dark

spots, opercles silvery with orange washing and a few dark spots; ventral fins yellow, pectorals a little less so, anal same as ventrals; dorsal and caudal darkish or muddy yellow; maxillaries and tip of lower jaw with fine dark punctulations.

Younger individuals are essentially the same in color, only that the fins and posterior parts of the body are not so yellow and in the youngest there is a dark blotch at base of caudal fin.

8. **Leuciscus hydrophlox** (Cope). (Pl. xx.)

This species was very abundant in Snake River at President Camp, Wyoming, where eighty-three specimens were obtained; also in the small creek at the head of Jackson Lake. The specimens are 3 inches or less in length. Dorsal rays 9 in numerous specimens counted; anal usually 12, 11 in some examples; base of fin $6\frac{1}{2}$ in length of body; maxillary barely reaching orbit, lower jaw somewhat projecting; dark band on side continued forward over the opercle; lateral line less decurved than in Heart Lake specimens.

9. **Leuciscus gilli**, sp. nov. (Types No. 43953, U. S. Nat. Mus.) (Pl. xx.)

This species is based upon fourteen specimens, 3 to $4\frac{1}{4}$ inches long, taken in Browns Gulch Creek, at Silver Bow, Montana, July 27, 1891. Head, 4 to $4\frac{1}{4}$ in length to base of caudal; depth, $3\frac{1}{2}$ to $3\frac{3}{4}$; eye, $3\frac{1}{2}$ to 4 in head, $1\frac{1}{2}$ in interorbital width; snout, $3\frac{1}{2}$ to $3\frac{3}{4}$; D. 10 (occasionally 9 or 11); A. 14 (13, 15, or 16 in a few specimens); scales, 11–66–7; teeth, 2, 5–4, 2. Body compressed, deep, back little arched, ventral line considerably curved, bending gently upward at beginning of anal fin; head heavy, snout short and blunt, lower jaw not projecting, mouth oblique, maxillary not quite reaching front of orbit; caudal peduncle long and slender; scales moderate, deeper than long on anterior part of body, but longer than deep on caudal peduncle, about 32 before the dorsal. Dorsal fin small, much nearer caudal fin than snout, about midway between beginning of scaled surface at back of head and beginning of rudimentary caudal rays, its origin behind vertical line from ventrals a distance equal to the length of its base; base of dorsal fin $1\frac{3}{5}$ in its height, which in turn is $1\frac{1}{4}$ in head; its free margin falcate. Anal fin large, its base about $5\frac{3}{4}$ in length of body to base of caudal fin, or about equal to length of pectoral; longest rays a little shorter than length of fin; free margin very nearly straight; origin of fin under last fifth of dorsal; ventrals short, $1\frac{1}{2}$ in head, reaching vent in some specimens; pectorals long, $1\frac{1}{5}$ in head, nearly reaching ventrals in some examples; caudal fin very long and deeply forked, lower lobe the longer, $4\frac{1}{4}$ in total length.

Color in alcohol, upper parts dark down to level of eye; beginning at upper level of eye is a band about one scale in width that is chrome yellow on head, then widening slightly and becoming rosy until the middle of the side is reached, where it becomes gradually less distinct until hardly discernible on the caudal peduncle; below this is a dark band about twice as wide, the middle portion of which lies just above the lateral line, but at each end it extends a little below; side of body below lateral line rich rosy with tinge of yellow, whitening on the caudal peduncle; orange at base of ventrals and pectorals, the latter with some reddish; belly white; cheek with a large crescent of chrome yellow, very bright in some specimens, extending from angle of mouth across the cheek and up back of the eye, nearly connecting with the line first described; opercles silvery, with some little orange washing, covered over with many fine black punctulations, most numerous above, where they form a large dark blotch; whole body

sprinkled over with similar black specks, most numerous above the lateral line; lower jaw and branchiostegal membranes with numerous very fine dark specks; lower border of orbit dark; dorsal, anal, caudal, and ventral fins with a few fine black points; pectorals slightly yellowish green, with few black specks, the outer ray edged with black; a yellow blotch at base of pectoral extending forward to gill-opening.

This species is closely related to *Leuciscus montanus* (Cope), but differs from it in the shorter maxillary, smaller eye, greater width of the interorbital space, the shorter head, and the much greater depth. Compared with specimens of *L. montanus* from Utah Lake and Bear River, at Evanston, Wyoming, and with specimens of *Squalius tænia* (Cope) from Utah Lake, the snout is much more blunt and the anal fin larger. It is also related to *Leuciscus hydrophlox* (Cope), but the body is much deeper, the snout is very much blunter, the lower jaw does not project, and the lateral line is considerably more decurved; the dorsal fin in *L. hydrophlox* is midway between snout and base of caudal fin, while in this species it is placed midway between posterior line of head and base of caudal; there is also a difference of one in the number of dorsal rays; the anal fin is very much larger and the number of rays greater than in *L. hydrophlox*, from which it also differs notably in the brilliancy of its coloration.

In the following table I give measurements of the fourteen specimens:

Length in inches.	Head in length.	Depth in length.	Eye in head.	Snout in head.	Base of anal in length.	Dorsal rays.	Anal rays.
4½	4+	3⅛	4	4	5⅔	9	14
4¼	4+	3⅛	4—	4	6	10	15
4¼	4½	3⅜	3⅝	3⅝	6	10	14
4	4	3⅜	3⅛	4	5⅔	10	14
4	4	3⅜	3⅛	4	5⅔	10	14
4	4	3⅜	3⅝	3⅔	5⅔	10	14
4	4+	3⅜	4	4	5⅔	9	14
4	4½	3⅜	4	4	5⅔	10	14
4	4½	3⅜	3⅝	3⅝	5⅔	10	14
4	4	3⅜	3⅝	3⅝	5	9	13
3⅞	4½	3⅜	3⅝	3⅝	5⅔	10	14
3⅞	4½	3⅜	3⅝	3⅝	5⅔	10	14
3⅞	4½	3⅝	3⅛	3⅝	5	9	13
3	4	3⅜	3⅛	3⅔	5½	11	16

One small specimen, 1⅝ inches in length, from the outlet of Swan Lake, near Flathead Lake, seems to belong to this species. Head, 4; depth, 4; eye, 2¾, greater than snout; the mouth more oblique than in the Browns Gulch specimens; the maxillary barely reaching the eye; body much compressed.

I may add that I have made a careful comparison of the specimens of *Clinostomus montanus* Cope from Utah Lake and Bear River, at Evanston, Wyoming, and those called *Squalius tænia* (Cope), from Utah Lake, which are in the National Museum, and I can not see any differences between them.

I take pleasure in naming this handsome minnow for Dr. Theodore Gill, whose studies have added so much to our knowledge of fishes.

10. Leuciscus atrarius (Girard). (Pl. XX.)

Siboma atraria Girard, Proc. Acad. Nat. Sci. Phila. 1856, 208; P. R. R. Survey, x, 297, 1858 (spring in Utah); Cope, Zoöl. Wheeler Survey, v, 667, 1875.

Squalius atrarius, Jordan and Gilbert, Proc. U. S. Nat. Mus. 1880, 461 (Utah Lake); Synopsis, 241, 1882.

Leuciscus atrarius, Jordan, Bull. U. S. Fish Com., IX, 48, 1891 (Heart Lake and Witch Creek, Yellowstone Park).

Tigoma obesa Girard, Proc. Acad. Nat. Sci. Phila. 1856, 206; P. R. R. Survey, x, 290, 1858 (Salt Lake Valley, Utah).

Squalius obesus, Jordan and Gilbert, Synopsis, 237, 1882.

Tigoma squamata Gill, Proc. Bost. Soc. Nat. Hist. 1861; Ichthyol. Capt. Simpson's Expl., 405, 1876.

Squalius squamatus, Jordan & Gilbert, Synopsis, 241, 1882.

Squalius cruoreus Jordan and Gilbert, Proc. U. S. Nat. Mus. 1880, 460 (Utah Lake; young specimens).

Squalius rhomaleus Jordan and Gilbert, Proc. U. S. Nat. Mus. 1880, 461 (large specimens from Utah Lake); Synopsis, 240, 1882.

Siboma atraria longiceps Cope, Zoöl. Wheeler Survey, v., 667, 1875.

This species is represented in the collection by nine large specimens taken with the hook in Jackson Lake, and by numerous smaller specimens from the small creek at the head of Jackson Lake, and from Snake River at President Camp. It is very abundant in Jackson Lake and takes the hook readily.

Measurements of nine specimens.

No.	Length in inches.	Head in length.	Depth in length.	Eye in head.	Snout in head.
27	11	3¾	4	6	4½
28	12	3¾	4	6—	3½
29	11	4	3¾	6	4
30	10¼	4	4+	6—	4
31	9	4	4+	5½	4
32	11	4	4	6	3¾
33	13	4	4+	6	3½
34	12	4	4+	6—	3¾
35	11	4	3½	6	3¾

Scales, 11 to 13–56 to 63–6 or 7; 12–63–7 being the most usual number.

Teeth, oftener 2, 5–4, 1 than 2, 5–4, 2.

I have compared these specimens with those collected by Dr. Jordan in Heart Lake and find them identical. Girard's type of *Siboma atraria*, a specimen 6½ inches long, from "near 38° latitude, in Utah," agrees well with these, as do also others collected at Willow Springs, Utah, by Dr. G. K. Gilbert, and those called *S. rhomaleus* by Jordan and Gilbert. Specimens in the National Museum, labeled *Squalius squamatus* Gill, from Utah, are evidently *atrarius*. An examination of the type of *Squalius cruoreus* J. and G. shows it to be a little more slender than other examples of *atrarius*, but it differs in no other particular. Specimens in the Museum collected in Beaver River, Utah, by Henshaw and Yarrow, and called *Squalius egregius* Cope, can not be distinguished from *atrarius*, and that species should probably go in the above synonymy.

The type of Girard's *Cheonda cærulea*, from Lost River, Oregon, is a very different-looking fish. The head is longer, the snout much longer and more pointed, the mouth is larger, the maxillary is longer and less oblique, the eye is somewhat larger, and the top of the head more flat.

11. Coregonus williamsoni Girard. (Pl. XXI.)

The collection contains specimens of whitefish from the following localities:

a. Swan River below Swan Lake, Montana	21
b. Jocko River, Ravalli, Montana	6
c. Big Blackfoot River, Bonner, Montana	3
d. Little Blackfoot River, Elliston, Montana	12
e. Cottonwood Creek, Deer Lodge, Montana	1
f. Snake River, President Camp, Wyoming	19
g. Red Rock River, Red Rock, Montana	7
h. Beaverhead River, Dillon, Montana	5
i. Junction of Firehole and Gibbon rivers	2

In addition to the material collected by us, I have examined numerous other specimens from the Upper Missouri Basin, comparing them with a large number from the upper tributaries of the Columbia, but I am unable to find any difference of value. The Columbia specimens are perhaps somewhat deeper. Examples from Red Rock and Beaverhead rivers have the head $4\frac{1}{2}$ (4 to $4\frac{3}{5}$); depth, $4\frac{1}{6}$ to $4\frac{1}{5}$; scales, 80 to 84. Those from Little Blackfoot and Swan rivers have the head $4\frac{1}{5}$ to $4\frac{1}{2}$; depth, 4 to $4\frac{1}{5}$; scales, 80 to 84.

Small specimens, 3 to 5 inches long, show the following color markings: Silvery over entire surface below the lateral line, with a few scattered dark punctulations and a little black on lower caudal rays, plainest toward the base; bluish above lateral line, with numerous larger and darker punctulations; under these are seen the vanishing bluish blotches so evident in younger examples. Dorsal and adipose fins, as well as snout and top of head, covered with very fine dark spots. Younger specimens, a little under 3 inches in length, have the steel-blue blotches very distinct, there being about 10 of them, most of which just touch the lateral line from above; above these are about 20 similar blotches of various sizes—mostly smaller, however, than those along the lateral line.

A still smaller specimen ($2\frac{1}{2}$ inches) in life was silvery below, 8 or 9 dark-bluish spots along side, mostly above lateral line; back darker, with numerous spots; top of head with very fine spots.

The fact that the young whitefish has the *parr* markings is a very interesting one, and is of value in showing its relations to the trout. (See Pl. XXI.)

12. Thymallus signifer (Richardson). (Pl. XXII.)

We found the grayling in Red Rock River, Beaverhead River, and in the Gibbon at its junction with the Firehole River; and also in the stream formed by Horsethief Springs—all tributary to the Upper Missouri.

Two examples, 10 and 11 inches long respectively, from the junction of the Firehole and the Gibbon, show some differences in measurements; the larger has the head $4\frac{3}{4}$; depth, 4; eye, $4\frac{1}{3}$; scales, 8–97–10, and dorsal 19; the other, head, $4\frac{3}{5}$; depth, $3\frac{4}{5}$; eye, $4\frac{1}{2}$; scales, 8–91–10, and dorsal 19. Length of dorsal fin a little greater than head, height about $1\frac{1}{2}$ in head, but much less than depth of body; origin of dorsal one-third length of body from snout. About 18 inky black spots and about 6 fainter ones on side of body. The number of these spots is of little value, however, as the smaller of these two specimens has 25 distinct spots on one side and but 18 on the other; nearly all the spots are anterior to the dorsal fin.

A small specimen (3 inches long) from Beaverhead River has the depth and head about equal, each 4 in length of body. Upper half of its body covered with fine dark specks, most numerous on edges of scales where they form a dark border; along the region of the lateral line is a series of about fifteen steel-blue blotches, the vertical diameter greatest, much resembling the *parr* markings of young trout and whitefish. Above these are many smaller spots or blotches of same color. (See Pl. XXII.)

Two specimens, $3\frac{1}{8}$ and $3\frac{1}{2}$ inches long respectively, from Red Rock River, have the steel-blue blotches very distinct, while the dark borders or lines between the rows of scales on the upper half of body have begun to break up into short, inky, zigzag lines each with one to eight or more angles.

13. Salmo mykiss Walbaum. (Pl. XXIV.)

The black-spotted or mountain trout is represented in the collection by specimens from the following localities:

a. Swan River below Swan Lake, Montana	8	*m.* Crawfish Creek just below Moose Falls	2
b. Flathead Lake	2	*n.* Snake River, President Camp, Wyoming	9
c. Mission Creek near Ravalli, Montana	1	*o.* Pacific Creek 25 miles below Two-Ocean Pass	6
d. Jocko River, Ravalli, Montana	20	*p.* Pacific Creek about 8 miles below Two-Ocean Pass	3
e. Rattlesnake Creek, Missoula, Montana	7	*q.* Pacific Creek at Two-Ocean Pass	16
f. Lolo Creek, Missoula, Montana	9	*r.* Atlantic Creek at Two-Ocean Pass	20
g. Big Blackfoot River, Bonner, Montana	1	*s.* Atlantic Creek 1 mile above its mouth	1
h. Little Blackfoot River, Elliston, Montana	12	*t.* Mouth of Upper Yellowstone River	2
i. Cottonwood Creek, Deer Lodge, Montana	19	*u.* Meadow Creek near its mouth	6
j. Dempsey Lakes, Deer Lodge, Montana	12	*v.* East Fork Gardiner River above falls	1
k. Browns Gulch Creek, Silver Bow, Montana	3	*w.* McClellan Creek near Helena, Montana	2
l. Lewis River just below Lower Falls	2		

This species is found abundantly in all suitable streams and lakes explored by us.

Besides the 135 specimens from the Columbia basin and the 32 from the Missouri side, a great many individuals were examined in the field which were not preserved. In addition to the above, numerous specimens in the collections in the U. S. National Museum were compared with those of my own collection. The whole amount of material examined goes to show the correctness of the conclusion reached by Dr. Jordan,* that all the native trout of the Park belong to a single species, and that *Salmo clarkei*, *Salmo lewisi*, etc., can not be recognized even as varieties.

The fact that there is a free waterway over Two-Ocean Pass, by means of which trout can pass readily from either side of the "Divide" to the other, as explained elsewhere in this report, is of great importance in showing that the trout of the two sides can not be regarded even as geographical forms. The differences that are observable among different specimens do not exist as differences between Missouri and Columbia drainage specimens, but rather as slight peculiarities due to the nature of each particular stream. This will appear evident from a comparison of the following color notes, based upon specimens of different sizes and from different places:

A specimen $4\frac{3}{4}$ inches long, from McClellan Creek, Helena, Montana: Side with about ten dark blotches lying on the lateral line, the vertical diameter being the greater; a series of about a dozen larger, rounder ones along middle of space between lateral line and middle line of back; among and about these are numerous small spots; spots

* Bull. U. S. Fish Commission, vol. IX, 50, 1891.

below lateral line not numerous, about ten large and perhaps twice as many small ones; cheek with two or three small dark spots and numerous fine punctulations; a few small spots on top of head; dorsal fin with about a dozen small spots or blotches; adipose fin dark-edged; caudal fin well spotted, the spots more or less evidently arranged in five vertical rows; other fins plain; tip of lower jaw dark.

A specimen, 7 inches long, from the same place, differs from the smaller one in having the large vertical blotches less distinct, and the other spots more numerous, especially on dorsal, adipose, and anal fins, and on top of head; the spots on the cheeks are also less distinct.

Twenty specimens, each about 4½ inches long, from Atlantic Creek in Two-Ocean Pass, show no marked differences from those from McClellan Creek. The spots are a little larger in some specimens; the large blotches seem a little less distinct than in the larger, but much the same as in the smaller specimen from McClellan Creek. Those from Atlantic Creek are a little more slender than the others.

A specimen 2¾ inches long, from Atlantic Creek, about one mile from its mouth, does not differ in color from those taken in the same creek at Two-Ocean Pass.

Sixteen specimens, 4 to 6½ inches long, from Pacific Creek, in Two-Ocean Pass, can not be distinguished from those of the same size taken in Atlantic Creek, a few yards away.

Three examples taken in Pacific Creek, about 7 miles below the pass, and measuring 5½ and 6½ inches in length, have the spots less numerous and larger, agreeing in this with the Atlantic Creek specimens.

A specimen 14 inches long from Pacific Creek, about 25 miles below the pass, presented the following life colors: Above, dark greenish, very dark on head, lighter posteriorly; paler on sides, nearly white on belly, but with some dark washings. No spots on top of head, very few on body in front of dorsal, more numerous behind; ten or eleven small round spots on cheek. Sides of head with red or pinkish wash, old gold at upper edge of opercle and a blotch of the same behind the eye. Shoulder above pectoral reddish; throat white, with red gash; rim of lower jaw washed with dark. Pectorals dark wine color; ventrals and anal red. Spots on body nearly round.

Another specimen, 11½ inches long, from same place, was, in life, dark-greenish above, silvery on the sides, but with an underwash of yellowish; belly white; few, if any, spots on head or on back in front of dorsal, and but few on anterior half of body, while they are rather thick under the dorsal and quite thick along the back between the dorsal and caudal fins; not over fifty spots altogether below the lateral line; dorsal and caudal fins well spotted; two dark blotches on cheek; opercles pinkish, yellowish at top; red gash on throat not heavy; pectorals dark, ventrals and anal yellow.

Another specimen, 12 inches long, was yellowish like the one just described, but had the spots more numerous and not so nearly round, each spot being made up of two or more short black lines joined in such a way as to make the spots appear somewhat star-shaped at first glance.

An examination of about thirty large individuals from this place seemed to show that they may be separated into two groups: one more slender, and yellowish in color; the other less slender and with little or no yellow. The star-shaped spots seemed to be more common among the yellow examples, but all were not so marked, nor was this style of marking absent from the other form.

Two specimens, 4 and 7 inches long, respectively, from Crawfish Creek, just below Moose Falls, can not be distinguished from specimens of the same size from Cottonwood Creek or from McClellan Creek.

Ten specimens from Little Blackfoot River, 3½ to 7½ inches in length, show considerable variation among themselves as to number, size, and shape of the spots, but these variations are independent of size, sex, or age of the fish.

An 11-inch specimen from Lolo Creek, in life, was washed with red along the lateral line, more on upper parts of belly; back dark, with numerous black spots which are larger and more irregular in outline toward the caudal peduncle; seven rather regular vertical rows of spots on the tail, about same number on dorsal fin; but few spots below the lateral line anteriorly, more numerous behind; two black spots on opercle; bright red dash on lower jaw; pectoral fins pale yellow, ventrals and anal darkish; very few spots on head. Little or no red on jaw of younger specimens.

A great many examples from Dempsey Lakes were examined. These present no peculiarities of coloration, but some of them are a trifle deeper than any others that I have examined. The specimens from Rattlesnake Creek are also inclined to be deeper than the usual form.

Two specimens, each 7 inches in length, from Swan River, at outlet of Swan Lake, present some peculiarities. One of them has the spots of the usual form and number, but the other has scarcely any spots on the anterior two-thirds of the body, while those on the caudal peduncle and caudal fin are much less numerous than usual.

A specimen, 14 inches long, from Lewis River, just below the lower falls, showed the following color markings in life: Ground color of the body dirty white, yellowish toward under side; spots very thick, largest posteriorly; dark greenish on back; no spots on top of head; sides of head yellowish silvery, with a few small, round, black spots; a red blotch below and behind eye, wash of same on preopercles; opercles washed with red on lower two-thirds, extending over the branchiostegals to the red cut on the throat; a reddish wash along sides, mostly below lateral line; pectorals, anal, and ventrals all dark-reddish with some little traces of yellow; caudal and dorsals well covered with spots.

A small specimen, 6 inches long, from Big Blackfoot River, in life showed four pale red splotches on side, the last one under the dorsal fin; few black spots on top of head, along back, and on dorsal and caudal fins; other fins, plain pale yellow; under parts silvery; opercles purplish; small red lines on lower part of throat, the beginning of the red gash characteristic of the species.

I have given thus fully color notes on so many individuals and from streams tributary both to the Columbia and the Missouri, to make plain the little importance of color distinctions and the futility of attempting to find even varietal differences among the trout of the Columbia and Upper Missouri river basins.

14. Salvelinus malma (Walbaum). (Pl. XXV.)

Salmo malma Walbaum, Artedi Pisc., 66, 1792.

This is the salmon trout or bull trout of western Montana. We obtained six specimens, 6½ to 10 inches long, from Rattlesnake Creek, at Missoula, and from information gained from local fishermen we have no doubt that it is common in most of the larger affluents of the Columbia in Montana, particularly in the Hell Gate, Missoula, Pend d'Oreille, Flathead, Bitter Root, and Big Blackfoot rivers and in Flathead and

Swan lakes. This extends its known range considerably eastward. The following table gives measurements of six specimens from Rattlesnake Creek:

No.	Length in inches.	Head in length.	Depth in length.	Eye in head.	Maxillary in head.	Interorbital space in head.	Snout in head.	Pectoral fin in head.	Ventral fin in head.	Anal fin in head.	Longest dorsal ray in head.
53	10	3⅔	4⅔	5½	2	3⅔	3⅔	1⅔	2	1⅝	1⅔
54	7½	3⅔	4⅔	5+	2	3⅔	4	1⅔	2⅓	1⅝	1⅔
55	7¼	3⅔	4⅔	5+	2	3⅔	4+	1⅔	2⅓	2	1⅔
56	6⅞	3⅔	4⅔	5	2	4	4⅓	1⅔	2⅓	2	1⅔
57	7¼	3⅔	4⅔	5	2	3⅔	4	1⅔	2⅓	2	1⅔
58	7¼	3⅔	4⅔	5	2	3⅔	4	1⅔	2⅓	1⅔	1⅔

Color, in alcohol, of No. 53, which is not unlike the others: Dark gray, darkest on head and body in front of dorsal fin, becoming lighter below; yellowish white on belly; sides with about three longitudinal rows of orange or reddish spots, each about ⅛ of an inch in diameter; these rows are irregular, but in general it may be said that the upper row lies along the middle of the space between the dorsal fin and the lateral line, the second one along the lateral line, and the third about midway between the lateral line and the level of the origin of the pectoral fin; there are a few other spots that do not lie evidently in any of these lines; those on upper part of body smaller than those below. Besides the orange spots, the body is well covered with numerous dark punctulations, especially abundant on sides of head, fins, and lower parts of body; median line of belly, plain yellowish white; branchiostegals and lower jaw with some punctulations; upper parts of pectorals and ventrals darker than lower. Comparing these with specimens of same size from McCloud River shows the Rattlesnake Creek specimens to be much more slender (those from McCloud River having the depth 3¾ to 4⅓ in length), the eye a little larger and the color darker.

Specimens of "salmon trout" weighing 12 and 14 pounds have been taken from the Bitter Root River, near Missoula.

15. Cottus bairdi punctulatus (Gill). (Pl. XXII.)

Potamocottus punctulatus Gill, Proc. Bost. Soc. Nat. Hist. 1861, 40 (Bridger Pass).
Cottus bairdi punctulatus, Jordan, Bull. U. S. Fish Com., IX, for 1889, 29, 1891.

Numerous specimens of the blob, or "bullhead," as it is known in Montana where known at all, were obtained from the following localities:

a. Beaverhead River, Dillon, Montana..... 76
b. Red Rock River near Red Rock, Montana- 20
c. Cañon Creek, Yellowstone National Park. 9
d. Junction of Firehole and Gibbon Rivers. 19
e. Pacific Creek in Two-Ocean Pass..... 4
f. Pacific Creek 25 miles below the Pass .. 5
g. Small Creek at head of Jackson Lake.. 21
h. Snake River, President Camp, Wyoming 2
i. Browns Gulch Creek, Silver Bow, Montana..... 2
j. Cottonwood Creek, Deer Lodge, Montana..... 32
k. Little Blackfoot River, Elliston, Montana 57
l. Rattlesnake Creek, Missoula, Montana.. 11
m. Lolo Creek near Missoula, Montana 13
n. Jocko River, Ravalli, Montana..... 7
o. Swan River at outlet of Swan Lake, Montana 15

It was also seen in Horsethief Springs and in Gardiner River below the falls.

The specimens from Red Rock and Dillon are very large, measuring from 3 to 4½ inches in length, while those from the head of Jackson Lake are all very small, as are most of those from Pacific Creek.

In numerous specimens examined the head is a little shorter than indicated by Dr. Gill's description, it being 3½ instead of 3 in body to base of caudal. There are also other slight differences; the dorsal is VI or VII–17 or 18, and the anal 12 or 13. The length of the head is just about equal to its width measured at the preopercular spines; the pectoral fins 1¼ in head, the rays extending markedly beyond the interradial membrane. In most specimens the black spots are evident, but some seem to be almost or entirely without them; a dark blotch at base of caudal, and three or four on the side are very plain in some individuals. One of the specimens, 2¼ inches long, from Rattlesnake Creek, is greatly distended with nearly ripe eggs, which gives us some idea as to their time of spawning in that region. Some of the specimens from this place, and others from the outlet of Swan Lake, have the visceral cavity completely filled by a parasitic worm more than an inch in length, in blobs that are not over 2 inches long. Some of these parasites were sent for identification to Prof. Linton, who says:

> The parasite in the abdominal cavity of the fish is *Schistocephalus dimorphus* Creplin. It is immature. Like *Dibothrium cordiceps* Leidy, of the trout, it attains the adult stage in the intestine of fish-eating birds. This, so far as I know, is the first find of this worm in America. In Europe it has been found most commonly in *Gasterosteus*.

16. Lota lota maculosa (Le Sueur). (Pl. XXIV.)

Gadus maculosus Le Sueur, Jour. Acad. Nat. Sci. Phila., I, 83, 1817.

A single specimen of the ling was taken in the Red Rock River, and it is said by Mr. Scott, of Red Rock, to be common in Red Rock Lake, in which the river has its origin. While this is a very widely distributed fish, it has not been previously reported from any point near the headwaters of the Missouri. Head, 4½; depth, 6½; eye, 6½; snout, 4. The maxillary reaches the posterior edge of the pupil; the barbel is a little longer than the eye; pectorals 1¾ in head, and about equal to the ventrals.

Specimens of the following species, introduced into the waters of the Yellowstone National Park by the U. S. Fish Commission in 1889 and 1890, were taken and are now in the collection:

17. Salmo irideus Ayres. Rainbow trout. (Pl. XXIII.)

Two specimens from Gibbon River above Gibbon Falls.

18. Salmo trutta levenensis Walker. Loch Leven trout. (Pl. XXIV.)

One specimen from mouth of Heron Creek, Shoshone Lake.

19. Salmo fario Will. Von Behr trout; Brown trout. (Pl. XXIII.)

One yearling specimen from Firehole River, above Old Faithful Geyser.

20. Salvelinus fontinalis Mitchill. Eastern brook trout. (Pl. XXV.)

One specimen 12 inches long from Indian Creek, near its mouth.

RESULTS OF STOCKING THE WATERS OF YELLOWSTONE NATIONAL PARK WITH FISH.

In 1889 and 1890 yearling fish were placed by the U. S. Fish Commission in the waters of the Yellowstone National Park, as follows:

Date.	Place.	Kind of fish.	Number.
Sept. 22, 1889	Gardiner River	Brook trout	4,975
Sept. 15, 1890	West Fork of Gardiner River	do	7,875
Sept. 22, 1889	Gibbon River	Rainbow trout	990
Do	Firehole River	Loch Leven trout	995
Sept. 2, 1890	Lewis Lake	do	3,350
Do	Shoshone Lake	do	3,350
Sept. 22, 1889	East Fork Gardiner River	Mountain trout	968
Aug. 9, 1890	Shoshone Lake	Lake trout	18,000
Aug. 23, 1890	do	do	7,262
Do	Lewis Lake	do	7,263
Sept. 2, 1890	do	do	4,750
Do	Shoshone Lake	do	4,750
Sept. 15, 1890	Nez Percé Creek	Von Behr trout	9,300
Oct. 3, 1889	Twin Lakes	Native whitefish	2,000
Oct. 15, 1889	Yellowstone River	do	980
Aug. 15, 1890	do	do	5,000
Sept. 11, 1890	do	do	5,000

Excepting the Yellowstone and Gibbon rivers, and possibly the East Fork of the Gardiner, there were no fish whatever in any of these streams or lakes, the falls that are found in each having apparently proved effective barriers in preventing fishes from ever reaching the waters above. The only species known from the Upper Gibbon River is the little blob or miller's thumb, while the native mountain trout was well known to be abundant in the Yellowstone River, above the falls as well as below. Each of these bodies of water is practically so isolated from the others that fish can not pass from one to another. The Commissioner, therefore, planted a different species in each basin, except in Lewis and Shoshone lakes, where two species were placed. This will greatly simplify any observations that it may be desired to make upon them at any time.

One of the principal purposes of our visit to the Park was, as directed by the Commissioner, "to make such examinations as are possible with a view to determining what success has attended the plantings of fish already made in that reservation." I visited the different places where the plants were made, and am able to report that, as a whole, the work of the Commission in that region has proved very successful. At least five of the seven species planted are doing well, and we have no reason to think that a sixth species (lake trout) is not also doing equally well. We obtained specimens of brook, Loch Leven, rainbow, and black-spotted native trout, and learned that the Von Behr trout, which was put in Nez Percé Creek, have been seen at different times this year by several persons.

At least the brook and Loch Leven trout, which were planted in 1889, spawned in 1890, as we found young of these species that could not be over a year old. All of the specimens we took were in excellent condition, thus showing that the waters are suitable and the food supply abundant.

It is doubtful if any of the whitefish that were transplanted from Horsethief Springs to Twin Lakes and Yellowstone River have survived. Each of these places was examined, and we made careful inquiry of persons who had opportunities for

knowing, whether they had seen any whitefish in Yellowstone River, but none had been seen and no one believes any are there. Every one inquired of is of the opinion that the whitefish fell a ready prey to the voracious native trout which abound in that stream. Their failure to thrive in Twin Lakes is probably due to the mineral character and high temperature of the water.

Upon the whole, the Commission is certainly to be congratulated upon the high degree of success which has attended its efforts toward supplying valuable food-fish to these hitherto barren waters.

Following is the detailed account of our investigations:

Gardiner River.—This stream was stocked September 22, 1889, with 4,975 young brook trout. Our examinations were made on Indian Creek, at and above the mouth of Obsidian Creek, and along Obsidian Creek in Willow Park. We saw at least five trout near the mouth of Indian Creek, one of which was caught. This one was a foot in length, and the others seen were estimated to be at least 9 inches long. These streams were so rocky and the current so swift that it was not possible to use the seine to any advantage. In Winter Creek we saw two small trout, each perhaps 6 inches long or less. From these facts it is evident that the brook trout is thriving in these streams (all branches of the Gardiner River) and that the fish planted in 1889 spawned in 1890, the small specimens seen being yearlings. I should add that the large specimen caught was full of spawn.

Gibbon River.—This stream was stocked with 990 rainbow trout September 22, 1889, the plant being made just above Virginia Cascade. We examined the stream for some distance both above and below the cascade. One trout (a male, 10¼ inches long) was taken about one-eighth of a mile above where the plant was made, and another male of the same size was taken about the same distance below the cascade. Four others of apparently the same size were seen above the cascade, and at least five others, equally large, below it. Owing to the nature of the stream, all of our fishing here had to be done with the fly. Other persons familiar with Gibbon River report seeing fish in it this year.

Firehole River.—A plant of 995 Loch Leven trout was made September 22, 1889, in this stream above Keppler Cascade. We seined the river below the cascade, near Old Faithful Geyser, and caught one example, 3½ inches long. We also fished with the fly for some distance along the stream above the cascade, and, though no specimens were secured, the two small trout (not over 4 inches long) which rose to the fly are sufficient evidence that this plant has also proved successful. The fish of the plant certainly spawned last year, as the one specimen secured, as well as the others seen, are yearlings.

Nez Percé Creek.—On September 15, 1890, 9,300 Von Behr trout were placed in this creek. We examined the stream just above the "Soldiers' Camp" near the Fountain Hotel, but were unable to find any fish. Lieut. Pitcher, who was stationed here, assures us, however, that fish have been seen in the stream this year. On October 9, of this year, Mr. Elwood Hofer saw trout in this creek.

Shoshone and Lewis Lakes.—In August and September, 1890, there were placed in these lakes 6,700 Loch Leven and 42,025 lake trout. In the mouth of Heron Creek, at the north end of Shoshone Lake, I saw a great many young trout, apparently 5 to 6 inches long. In one bunch there were at least 50. One specimen was caught which proved to be a Loch Leven trout, 5½ inches long. We were not certain that we saw

any fish in the lake, but on October 7 Mr. Hofer was passing along the east shore of Shoshone Lake and reports seeing several trout rise to the surface out about 75 yards from the shore. He also reports seeing trout at a beaver dam in Heron Creek about 1½ miles from the lake. Whether any of these were lake trout could not be certainly determined, but the probabilities are that those seen in the lake were lake trout, while those in the creek were Loch Leven trout. Finding them so numerous in the creek would seem to be very satisfactory and positive evidence of the success of this important planting.

East Fork of Gardiner River.—This stream was stocked September 22, 1889, with 968 native trout gotten by Mr. Lucas from Howard Creek. We made a somewhat hurried examination just above Undine Falls and caught one trout, 6½ inches long. There seems to be a question as to whether this stream did not already contain trout before this plant was made. The nature of the divide between this stream and Blacktail Deer Creek, in which there are no falls, makes it quite possible for trout to get over from Blacktail Deer Creek, which is well supplied with trout. This, of course, makes it impossible to say whether the trout taken by us is of the plant or not.

NOTES ON MAMMALS NOTICED IN MONTANA AND WYOMING.

Though no special attention was given to the mammals found in the region traversed by us, no specimens collected, and no special attempt made to list the species of the region, yet numerous notes were made upon some of the species observed. Such of these notes as seem to be of value are given here.

1. **Arctomys** sp.?

Ground hogs were seen in several places south of the Yellowstone National Park. On Pacific Creek, not far below Two-Ocean Pass, we saw a pair of old ones and four or five half-grown young, one of which our dog killed. Dr. Merriam informs me that the marmot found there is probably *Arctomys dakota*.

2. **Tamias** sp.?

Chipmunks were frequently seen about Flathead Lake, on Dempsey Creek, at Missoula, and perhaps other places. Two different species were probably seen.

3. **Sciurus richardsoni** Bachman?

A squirrel, likely this species, was abundant at Swan and Flathead lakes, Missoula, and the National Park.

4. **Castor canadensis** Kuhl.

Fresh signs of beaver were seen at Beaver Lake, Willow Park, and on Lewis River just below the Upper Falls; also near the mouth of Beaverdam Creek.

5. **Lagomys princeps** Rich. Rocky Mountain pika.

Several were seen near Obsidian Cliff in National Park; and four or five others were noticed in a rocky slide on the divide between Shoshone Lake and the Firehole River.

6. **Cervus canadensis** Erxleben.

A drove of sixteen elk was seen on Pacific Creek below Two-Ocean Pass. Several young elk were seen at Horsethief Springs. They had been captured in the mountains near by and were being raised by hand by Mr. Marshall. This man does quite a thriving business rearing elk and deer in this way and selling them to owners of private parks in the East.

7. Cariacus macrotis (Say). Blacktail deer.

Seen on Swan River (one doe, one fawn, and one old buck). The old buck when first seen was standing in the road just ahead of us. As we drove toward him he made a few bounds and stopped behind the top of a fallen pine tree not over 40 feet from the road, and there he remained while we drove by and on down the road. Two others were seen within a few rods of the hotel at the Mammoth Hot Springs. Others were seen at various places about the Park.

8. Antilocapra americana Ord. Antelope.

Several were seen on Pacific Creek, between Jackson Lake and Two-Ocean Pass.

9. Ovis canadensis Shaw. Mountain sheep.

A skull was found near our camp on Dempsey Creek near Mount Powell.

10. Bison bison (L.). Buffalo.

None were seen in the Park, but it was reported, August 23, that a herd had been seen about that time on the east side of Yellowstone Lake. Charles Allard, a half-breed, who runs the stage line from Ravalli to Flathead Lake, has a herd of about 70 on his ranch on the Flathead Reservation. We were told that he was very successful in crossing them with domestic cattle.

11. Canis latrans Say. Coyote.

Heard at Silver Bow and Deer Lodge.

12. Gulo luscus (L.). Wolverine.

August 21, I saw one on the east shore of Yellowstone Lake near Steamboat Point.

13. Mephitis sp.?

President Camp, on Snake River; also near Polecat Creek.

14. Taxidea americana (Bodd.). Badger.

One seen near Steamboat Point, August 21.

15. Ursus americanus Pallas. Black bear.

One seen one evening at the Lake Hotel. He had come up to feed at the swill barrel. Another seen on Lewis River below Upper Falls. Fresh bear tracks were also seen on Big Blackfoot River, above Bonner.

16. Erethizon epixanthus Brandt. Porcupine.

One dead one seen on east side of Yellowstone Lake. At various places in the Park, and especially in the heavy pine forests south of the Park, about Shoshone, Lewis, and Yellowstone lakes, a great many pine trees were seen from which great patches of bark had been eaten away. These barkless areas frequently, perhaps usually, encircled the tree and were at various heights above the ground, from only a few inches to 25 to 35 feet; generally, however, the height was 8 to 15 feet. Mr. Hofer and the other men of our party say that this is the work of porcupines and that the place indicates the depth of the snow.

ANNOTATED LIST OF REPTILES AND BATRACHIANS COLLECTED.

[By Frederick C. Test, Aid, Department of Reptiles, U. S. National Museum.]

The collecting of Reptiles and Batrachians was merely an incidental feature of the work of the party. No time was devoted to searching for specimens of these groups, and those found in the collection are such as the members of the party chanced to see while carrying on the main work of the expedition. Only a short time was spent at each locality and only the most common forms were found. The Batrachians greatly predominate, and the series of *Rana pretiosa* is an especially good one.

I wish here to express my thanks to Dr. Leonhard Stejneger for aid and suggestions in preparing these notes.

1. Eutænia sirtalis parietalis Cope.

Two typical adult specimens of this species were collected.

Museum No.	Collector's No.	Locality.	Date.
17566	8	Swan River, near Swan Lake, Montana	Aug. 3
17567	9	....do	Do.

2. Eutænia vagrans B. and G.

Of this species there are five specimens of varying ages and sizes.

Museum No.	Collector's No.	Locality.	Date.
17565	7	Swan River, near Swan Lake, Montana	Aug. 3
17568	10	....do	Do.
17569	74	McClellan Creek, near Helena, Montana	July 20
17570	75	....do	Do.
17571	76	....do	Do.

3. Ambystoma tigrinum Green.

Of this widely spread and usually abundant species, only four specimens were found, all larvæ.

Museum No.	Collector's No.	Locality.	Date.
17583	6	Jocko River, Ravalli, Montana	July 31

4. Bufo halophilus Baird.

Three typical specimens.

Museum No.	Collector's No.	Locality.	Date.
17634	15	Lewis Falls, Wyoming	Aug. 12
17635	16	....do	Do.
17636	66	President Camp, Wyoming	Aug. 13

5. Rana pipiens brachycephala Cope.

The two specimens collected have some of the proportions of *R. pipiens pipiens*, the head being considerably less than 3 in the length instead of 3½, as it is said to be

in *brachycephala*, but they have been referred to the latter on account of the absence of a well-defined dark bar on the front of the femur, a color feature more or less characteristic of Western specimens.

Museum No.	Collector's No.	Locality.	Date.
17572	80	Beaverhead River, Dillon, Montana	July 27
17573	.....	Swan River, near Swan Lake, Montana	Aug. 8

6. Rana pretiosa B. & G.

Of the fifty-six specimens all but five are from streams that empty into the Pacific. These five, Nos. 17574 to 17578, are from the junction of Firehole and Gibbon rivers, the headwaters of the Madison Fork of the Missouri. This fact is particularly interesting, inasmuch as I have been able to find but three other records of this species occurring in streams flowing to the east. One of these is noted by Prof. E. D. Cope, who found it in Prickly Pear Cañon, just north of Helena, Montana. (Am. Nat., 1879, p. 435.) Another is a single specimen, U. S. National Museum, No. 11503, collected at Fort Ellis, Montana, by W. B. Pratt; and the third record consists of two specimens, U. S. National Museum, Nos. 11937 and 11939, collected by C. Hart Merriam at "Upper Firehole Basin, Yellowstone Park." In the list of specimens of *Rana pretiosa* belonging to the U. S. National Museum (see Cope's Batrachia of North America, p. 434) there are apparently two more records of this species occurring east of the Rocky Mountains, but both are due to misidentification, No. 3437, from the Red River of the North, R. Kennicott, being *R. septentrionalis*, and No. 4824, St. Catharine, Canada, D. W. Beadle, *R. sylvatica*. It may possibly be owing in part to insufficient exploration that there are so few instances of this frog being found east of the Great Divide.

In looking over this series, a very noticeable point is the lightening in color as the frog increases in age and size. The young is very dusky, the moss-agate-like dark dorsal spots being barely apparent, but as it grows the ground color pales, and while some of the black markings thus become more prominent, others fade entirely away. The largest specimen collected, No. 17603, a female from Deer Lodge River, Montana, is also the lightest colored. The ground color is very pale, rendering more conspicuous the few black dorsal blotches. The inferior dark markings are absent, and the usual bars on the legs are broken up into several small spots. There is indication of a light median line on the back posteriorly. No. 17604, a smaller female from the same locality, is much darker, with all the usual markings, and the dorsal blotches more numerous.

Four or five small specimens from Cottonwood Creek, Deer Lodge, Montana, show the darkest phase of the young very well, particularly No. 17593, a female, which has the black marbling of the throat finely marked, and all the spots on the sides and lower surface unusually distinct, while the upper ground color is so dark that the blotches on the back are hard to distinguish. No. 17591, a very slightly larger male, is almost as well marked. These differences in color are plainly not due to local causes, since dark and light come from the same locality; nor to sex, for dissection shows that the sexes are irregularly distributed among the varying shades of color.

There are a few exceptions to the general rule, notably No. 17572, a small male, which should be dark, but is quite light, and No. 17606, a rather large female, which is considerably darker than it ought to be.

Museum No.	Collector's No.	Locality.	Date.
17574	71	Junction of Firehole and Gibbon rivers, Montana	Aug. 9
17575	72	....do	Do.
17576	73	....do	Do.
17577–8	.....	....do	Do.
17579	68	Lolo Creek, Missoula, Montana	July 30
17580	69	Big Blackfoot River, above Bonner, Montana	July 29
17581	70	....do	Do.
17582	67	Ravalli, Montana	July 31
17587–8	.....	Little Blackfoot River, near Elliston, Montana	July 21
17589–602	.....	Cottonwood Creek, Deer Lodge, Montana	July 22
17603–4	.....	Deer Lodge River, Montana	Do.
17605–16	.....	Browns Gulch, Silver Bow, Montana	July 27
17617–24	.....	Cañon Creek, National Park, Wyoming	Aug. 8
17625	14	Foot of Shoshone Lake, Wyoming	Aug. 12
17626–7	.....	Crawfish Creek, at Moose Falls, National Park, Wyoming	Aug. 13
17628	26	Jackson Lake, Wyoming	Aug. 14
17629	44	Two-Ocean Pass, Wyoming	Aug. 17
17630	45	....do	Do.
17631	46	....do	Do.
17632	48	....do	Do.
17633	49	....do	Do.

PRESERVATION OF FORESTS IN AND ABOUT YELLOWSTONE PARK.

According to Dr. Hayden, the Yellowstone Park region has a climate differing in many respects from that of other parts of the Rocky Mountain region. It has a very moist atmosphere, the rainfall is greater, its mean annual temperature is lower, and it is better clothed with vegetation. This region and the adjacent portions of Idaho and Wyoming constitute the most heavily timbered area in the West, excepting parts of Oregon and Washington west of the Cascade Range. The climate is, as regards temperature, subarctic. The winter begins with September and ends only in June, and frosts occur every month in the year.

On the morning of August 8, at our camp on Beaver Lake, the thermometer stood at 29° at 8 o'clock. At Two-Ocean Pass the temperature was 33° at 6:30 a. m., August 18, and nearly every night, during the time of our stay in and about the Park, the temperature was down to freezing.

According to Mr. Hague, "few regions in the Rocky Mountains are so highly favored as regards snow and rain fall. Snow falls early in October and rarely disappears before June, and throughout the winter is said to lie 6 feet in depth over the plateau and higher regions of the Park. On the evening of October 9 a storm began and continued without abatement for thirty-six hours, the snowfall measuring 36 inches. The Park is peculiarly well adapted for holding broad sheets of water. In consequence, we find here such bodies of water as the Yellowstone, Shoshone, Heart, and Lewis lakes, besides innumerable smaller ones. These lakes are the natural reservoirs for storing up the water supply. The Yellowstone Lake alone has an area of 150 [139] square miles," and the others no doubt double this area. From these numerous lakes the water is gradually fed out to the upper tributaries of the Missouri and the Columbia during the season of little rain.

Mr. Hague further says:

> Forests cover the hills to the water's edge. The timber retains the snow late in the season, while it slowly melts away and fills the springs and lakes. If the forests are removed the snow will rapidly disappear under the direct rays of the sun by evaporation, and it will be largely carried off by the dry west winds which prevail. There would be enormous freshets in the spring, followed by a long parched season, the lakes and springs diminishing rapidly.

In another place Mr. Hague, who has given much attention to this important question, says:

> I know of no tract in the Rocky Mountains where the necessity for the conservation of the forests appears so urgent, or the direct advantage to be gained so immediate, as right here on the Park Plateau at the headwaters of the Yellowstone and the Snake rivers. If the broad valley of the Yellowstone is ever to support any considerable population the forests and streams from these elevated regions must be protected. The Yellowstone Valley can stand no diminution in the water supply which it now receives.

The importance of this matter cannot be overestimated, and it is very gratifying to know that, under authority of an act of Congress of March 3, 1891, the President has already, by proclamation, set apart and reserved from settlement a wide strip of land lying south and east of the Yellowstone Park. This important addition to the Park comprises the greater part of the densely timbered region already mentioned.

RECOMMENDATIONS.

Among the many falls in and about the Yellowstone National Park, there are several in which the placing of fishways should receive consideration. Virginia Cascade and Gibbon Falls in Gibbon River, Keppler Cascade in Firehole River, and the upper and lower falls of Lewis River are of this number. All of these rivers, both above and below the falls which they contain, are ideal trout streams. Below each of the lower falls there is an abundance of excellent food-fishes—trout in the Lewis, and trout, grayling, and whitefish in the Gibbon—while above these falls there are no fish whatever, except those planted by the Commission in 1889 and 1890.

It would be comparatively an easy matter to construct a fishway at each of these falls which would enable the valuable native species to ascend to the upper courses of these streams and to the cold lakes in which most of them rise.

When sufficient time has elapsed to enable the various species of trout planted by the Commission in these waters to become thoroughly established, the desirability of placing fishways in these streams should receive careful consideration.

In the country about Cooke City, east of the National Park, are several lakes similar to those in the Park, but smaller. Clarke Fork of the Yellowstone, about the headwaters of which these lakes lie, has in it considerable falls which fish can not pass. As a result, these lakes and upper tributaries are barren of fish, and their stocking with species of *Salmonidæ* might be very properly undertaken by the Commission.