

I.—REPORT OF EXPLORATIONS IN COLORADO AND UTAH DURING THE SUMMER OF 1889, WITH AN ACCOUNT OF THE FISHES FOUND IN EACH OF THE RIVER BASINS EXAMINED.

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[Plates I to V.]

INTRODUCTION.

Under the instruction of the U. S. Commissioner of Fish and Fisheries, Hon. Marshall McDonald, the writer undertook to make a series of examinations of the different streams of Colorado and Utah. This examination had two general purposes: First, to ascertain the general character of the streams of the Rocky Mountains and the Great Basin, their present stock of food-fishes, and their suitability for the introduction of species not now found there; second, to catalogue the fishes native to each stream, whether food-fishes or not, in order to increase our knowledge of the geographical distribution of each species and to throw further light on the laws which govern geographical distribution.

In the present paper is given an account of each stream, a list of the fishes found in it, and such notes, geographical or economic, as add to our knowledge of it.

In the work of the summer the writer had the very efficient help of his students, Prof. Barton W. Evermann of the Indiana State Normal School at Terre Haute, Mr. Bert Fesler of Topeka, Kans., and Mr. Bradley M. Davis of Chicago, Ill. The prosecution of the work was also materially aided by the help given by Mr. Richard Rathbun, assistant in charge of the work of scientific inquiry in the U. S. Fish Commission. We were also much indebted to several citizens of the regions visited for the interest they showed in our work and the help rendered by them. Of these we may mention especially Mr. George R. Fisher of Leadville, Hon. Gordon Land, fish commissioner of Colorado, Mr. Peter Madsen of Provo, Utah, and Mr. J. F. Brown of Blake City, Utah. Efficient help was also rendered by Col. John Gay, assistant to the U. S. Fish Commission, then in charge of the erection of the fish hatchery at Evergreen Lake, near Leadville.

The streams examined may be grouped as follows:

A.—Platte River:

South Platte River, at Hartsel's Hot Springs, in the South Park.

South Platte River, at Denver.

Bear Creek, at Morrison.

Boulder Creek, above Boulder.

B.—Arkansas River :

- Arkansas River, near Leadville, Colo.
- Lake Fork, near Leadville.
- Evergreen Lakes, near Leadville.
- Twin Lakes, at Interlaken, Colo.
- Lake Creek, near Granite, Colo.
- Arkansas River, at Cañon City, Colo.
- Grape Creek, at Cañon City, Colo.
- Arkansas River, at Good Night Ranch, near Pueblo, Colo.
- Font-qui-Bouille Creek, at Manitou Springs.
- Ruxton Creek, at Manitou Springs.
- Fountain Creek, at Pueblo.
- Arkansas River, at Coolidge, Kans.
- Arkansas River, at Wichita, Kans. (Collections of Mr. Sherman Davis.)

C.—Rio Grande :

- Rio Grande, at Del Norte, Colo.
- Rio Grande, at Alamosa, Colo.
- Rio Conejos, at McIntire's Ranch, below Alamosa.
- Rio Chama, at Chama, N. Mex.
- San Luis Lakes, near Alamosa.

D.—Colorado River :

- Grand River, Glenwood Springs, Colo.
- Sweetwater Lake, Eagle County, Colo.
- Trapper's Lake, Garfield County, Colo.
- Eagle River, at Gypsum, Colo.
- Roaring Fork, above Glenwood Springs.
- Cañon Creek, below Glenwood Springs.
- Gunnison River, at Gunnison, Colo.
- Tomichi Creek, at Gunnison, Colo.
- Cimarron Creek, at Cimarron, Colo.
- Gunnison River, at Delta, Colo.
- Uncompahgre River, at Ouray, Colo.
- Uncompahgre River, at Delta, Colo.
- Green River, at Blake City, Utah.
- Price River, at Castle Gate, Utah.
- Rio de las Animas Perdidas, at Durango, Colo.
- Mineral Creek, at Silverton, Colo.
- Leitner's Creek, at Durango, Colo.
- Rio Florida, near Durango, Colo.

E.—Salt Lake Basin :

- Utah Lake, at Provo, Utah.
- Provo River, at Provo, Utah.
- Jordan River, above Salt Lake City.
- Great Salt Lake.

F.—Sevier Lake Basin :

- Sevier River, near Juab, Utah.
- Chicken Lake, near Juab, Utah.

The following is, in brief, the itinerary of the summer's work :

July 16.—Left Bloomington in company with Prof. B. W. Evermann.

July 17.—Joined at Kansas City by Mr. B. M. Davis.

July 18.—At Coolidge, Kans.

July 19.—Arrived at Pueblo, Colo.

July 20.—Drove to Good Night Ranch; seined the Arkansas River and Fountain Creek.

- July 22.—At Cañon City; seined Arkansas River and Grape Creek.
 July 23.—At Granite; seined Lake Creek.
 July 24.—At Leadville; seined Arkansas River.
 July 25, 26.—Went to Twin Lakes with Col. John Gay and Mr. George R. Fisher; met Mr. Gordon Land; obtained specimens of trout of two varieties.
 July 27.—At Glenwood Springs; seined Roaring Fork and Grand River.
 July 28, 29.—At Gunnison; joined by Mr. Bert Fesler; Evermann and Davis remain a day at Gypsum.
 July 30.—At Gunnison; seined Gunnison River and Tomichi Creek.
 July 31.—At Cimarron; seined Cimarron Creek.
 August 1, 2.—At Delta; seined Gunnison and Uncompahgre Rivers.
 August 4, 5.—At Provo; seined Provo River and, assisted by Peter Madsen and his sons, drew a long net in Utah Lake.
 August 6, 7.—Salt Lake City; seined Jordan River.
 August 9, 10.—At Juab; seined Sevier River and Chicken Lake.
 August 11, 12.—At Green River (Blake City), Utah; seined the river, assisted by Mr. J. F. Brown.
 August 13, 14.—At Ouray; examined Uncompahgre River.
 August 15, 16.—At Durango; seined Rio de las Animas Perdidas and Rio Florida.
 August 17-19.—At Alamosa, Colo.; Evermann and Fesler visit Del Norte, Colo.; seined Rio Grande, Rio Conejos, and San Luis Lakes.
 August 20, 21.—At Manitou Springs.
 August 22.—At Hartsel's Hot Springs; seined the South Platte.
 August 23.—At Denver; seined the South Platte.
 August 24.—At Boulder; seined Boulder Creek; Fesler and Davis visit Morrison, seining Bear Creek.
 August 25.—Left Colorado, reaching Bloomington, Ind., August 27.

COLORADO.

The State of Colorado is for the most part an elevated and arid region, traversed by ranges of lofty mountains extending north and south, one of them being the main divide of the continent, which is nowhere crossed by streams.

In the eastern part of the State the mountains cease almost abruptly, and give place to the sage-plains, an elevated and nearly level region which slopes gradually eastward through Kansas and Nebraska to the Missouri River. This region has in Colorado little rain-fall. Its vegetation is scanty, except along the streams, where the soil may be made very fertile by irrigation. In the central part of the State elevated and arid valleys rendered fertile by irrigation lie between the mountain chains. On the north slopes of mountains, especially northward, are considerable pine forests, while above the timber line are level grassy areas, mountain meadows, well watered and with a profusion of wild flowers. The mountain chains also sometimes inclose large flat green areas, many of them former lake beds, which have become filled with sediment and the débris of vegetation. These are known as parks, and in these the clear mountain streams pursue courses with interminable meanderings and with but slight current.

In the western part of Colorado the great folds of the granite mountains give place largely to horizontal strata. Here erosion of water on a grand scale has filled this region with gorges, the intervening rocks being left as mesas and buttes. In one case, the Grand Mesa stands at a height of nearly a mile above the Gunnison River at Delta, the top of the mesa being reached by some seven or eight successive stairs, each representing a separate plane of erosion.

In the northwestern part of Colorado are many clear lakes of glacial origin, but in the rest of the State the lakes are comparatively few.

Most of the streams of Colorado rise in springs in or above the mountain meadows, many of them having their origin in banks of snow, which the clear weather of summer is not sufficient wholly to melt.

These streams are clear and very cold. In their descent from the snow-banks they are brawling and turbulent, often so much so as to be unfitted for fish life. In their course through the mountain meadows (very similar to the "Alp" pastures of Switzerland) the streams are usually of gentle current, with many windings and with occasional deep holes beloved of trout. Lower down most of them pass to the valleys through deep cañons, some of them very deep and with many rapids. Vertical falls are, however, very rare in Colorado, and most of these cañons form no obstacle to trout. Below the cañons, the stream, still clear and cold, enters the valley, where the flat bottom is usually covered deep with sediment which the streams bring down.

Here the water grows warmer, the fine silt renders it more or less turbid, and at last it becomes unfit for trout and at the same time suitable for the suckers and chubs. In the winter and spring the water is cold and clear for some distance down the valleys. In these seasons the trout extend their range to a corresponding degree. In the summer and fall they are more or less confined to the mountains or the cañons. Often the stream after entering the valley cuts its way through a moraine deposit. In that case its course is filled with boulders, and its waters are sometimes as brawling in a boulder-strewn valley as in the mountains.

In some cases placer-mining and stamp-mills have filled the waters of otherwise clear streams with yellow or red clay, rendering them almost uninhabitable for trout. Parts of the upper Arkansas and Grand Rivers have been almost ruined as trout streams by mining operations. In a few streams the presence of iron springs seems to exclude all fishes.

After reaching the base of the mountains the streams flow with little current over the ill-defined beds across the plains. They tear up the fine soil and shift it from place to place. Occasional rains swell the dry beds of "Sand-Arroyos;" the stream becomes more and more charged with clayey sediment, and in time not one of these rivers would be recognized as the crystal-clear stream which came down the mountains. The Platte spreads out broad and shallow over the plain, and its course is full of quicksands. Its banks are rarely well defined. The Arkansas resembles the Platte, being even more muddy, however, and the Rio Grande is similar to it. The Colorado carries the peculiar erosion of the mesas to a still greater extent as it goes southward. The stream is large and swift, with treacherous currents and shifting bottom. As no rain-fall or frosts wear away its banks, it sinks deeper and deeper below the surface, until it forms the deepest gorge in the world, with banks which are vertical or like stair-cases.

In the progress of settlement of the valleys of Colorado the streams have become more and more largely used for irrigation. Below the mouth of the cañons dam after dam and ditch after ditch turn off the water. In summer the beds of even large rivers (as the Rio Grande) are left wholly dry, all the water being turned into these ditches. Much of this water is consumed by the arid land and its vegetation; the rest seeps back, turbid and yellow, into the bed of the stream, to be again intercepted as soon as enough has accumulated to be worth taking. In some valleys, as in the San Luis, in the dry season there is scarcely a drop of water in the river-bed that has

not from one to ten times flowed over some field, while the beds of many considerable streams (Rio la Jara, Rio Alamosa, etc.) are filled with dry clay and dust.

Great numbers of trout, in many cases thousands of them, pass into these irrigating ditches and are left to perish in the fields. The destruction of trout by this agency is far greater than that due to all others combined, and it is going on in almost every irrigating ditch in Colorado.

It is not easy to suggest a remedy for it. The valleys in question would be worthless for agriculture were it not for irrigation, and the economic value of the trout is but a trifle as compared with the value of the water privileges. It is apparently impossible to shut out the trout from the ditches by any system of screens. These screens soon become clogged by silt, dead leaves, and sage brush, and thus will not admit the passage of the water.

Perhaps most of the trout are lost by entering the ditches in the fall, when running down stream with the cooling of the water. It has been suggested that a law could compel the closing of the ditches after the harvest, allowing the streams to flow freely until March or April. In the fall the water is worth most to the fishes and least to the farmers. I am unable to say whether this plan will prove practicable or effective. This is certain, that if the present conditions go on the trout in the lower courses of all the streams will be exterminated, and there will be trout only in the mountain lakes and in the mountain meadows, to which agriculture can not extend.

INDIGENIOUS FISHES.

The fishes of Colorado are very few in number, notwithstanding the fact that four distinct faunal basins are within the limits of the State.

The trout, *Salmo mykiss* Walbaum, and its varieties are found in all the mountain lakes and streams, down to a point where the summer temperature reaches 60° to 65°, when they gradually disappear. In clear streams and streams with bottoms of gravel they extend much farther than in turbid streams or those with clay bottoms.

The mountain minnows, *Rhinichthys dulcis*, on the eastern slope and in the Rio Grande, and *Agosia yarrowi*, in the Colorado basin, accompany the trout in the mountain meadows, not, however, ascending so near to the sources of the stream. On the other hand, they extend their range farther down than the trout, and exist in millions in the upper part of some of the valleys. They seem to be harmless little fishes, and they are eaten by the trout.

The blob or Miller's Thumb (*Cottus bairdi punctulatus*) is equally fond of cold and clear waters. In the Colorado basin it is very abundant, but in the other regions it is scarce, if present, and we did not find it. It is very destructive to the eggs of trout.

The suckers of various species extend up the rivers more or less to the point where the trout disappear. Generally speaking, the suckers of the different basins are unlike. We found *Catostomus griseus* and *Catostomus teres* in the Platte, the former ascending the streams much higher than the latter. In the Arkansas, *Catostomus teres*; in the Rio Grande, *Pantosteus plebeius*; in the Colorado, *Pantosteus delphinus*, *Catostomus latipinnis*, and *Xyrauchen cypho*. The species of *Catostomus* and *Xyrauchen* reach a considerable size, and are food-fishes of poor quality. All are destructive to the eggs of the trout.

More destructive, however, are the chubs (*Leuciscus*). Of these, none ascend to the mountains in the Arkansas or the Platte. But, in the Río Grande, one species, *Leuciscus pulcher*, exists in abundance, while in the Colorado, the Round-Tail (*Gila robusta*) is equally common. Another chub-like fish in the Colorado, *Ptychocheilus lucius*, reaches a great size, the largest of all the *Cyprinidae*, and in default of better fish, assumes economic importance.

Other minnows ascend the Arkansas and Platte, though only to the foot of the mountains. Most of these are of species common in the Mississippi Valley. The bulk of the rich fauna of the Mississippi is however excluded from Colorado, because the species can not ascend the turbid waters of the lower Arkansas or Platte.

The darters, sunfishes, and catfishes can hardly be said to belong to Colorado, as nearly all the species are shut out by the unfit character of the lower streams. These were seen by us only about Denver and Pueblo. In a similar way most of the Texan fishes are excluded from the Río Grande.

INTRODUCED FISHES.

The Eastern brook trout (*Salvelinus fontinalis*) has been introduced into numerous streams (Bear Creek, Twin Lakes, Echo Lake in Egeria Park, Ruxton Creek, Tomichi Creek, etc.). It does well everywhere, and is said to grow more rapidly than the native trout, but this statement is denied by some partisans of the latter fish.

The rainbow trout of California (*Salmo irideus*) has been sparingly introduced, and is reported to do well. One specimen was obtained by us in Twin Lakes.

The land-locked salmon of Maine (*Salmo salar sebago*) has been introduced into Twin Lakes, where specimens are occasionally taken.

A number of carp-ponds also exist in the State.

As an addition to the above list, I would strongly recommend the introduction of the larger catfishes, especially *Leptops olivaris*, *Ictalurus punctatus*, and *Ameiurus nebulosus*, into the tributaries of the lower Colorado, as the Green River and the San Juan. Food is abundant, and every condition seems to be favorable for them, while the whole great basin of the Colorado contains, excepting the trout, no fish of even second-rate character as food for man.

A.—THE PLATTE BASIN.

The South Platte rises in the elevated plateau known as the South Park. Through the park it flows in an undulating course over grassy fields, finally breaking through the mountains to the sage plains above Denver. It receives many tributaries from the mountains, and the waters of numerous sandy runs, dry in summer, pour in from the plains. Its water, both above and below Denver, is largely used for irrigation. Thus it becomes a shallow, muddy stream, with sandy bottom and very low banks. In the northeastern part of Colorado it meets its fellow, the North Platte, a stream of similar character, rising in the North Park. The Platte, now a broad, very shallow stream, full of sandbars and quicksands, flows eastward across Nebraska to the Missouri. The fishes of the Platte, as far up as Denver, are mostly the ordinary species of the upper Missouri region. The trout do not descend below the level of the parks, and are scarce even in the South Park itself, being chiefly confined to the mountain gorges above it.

Collections were made at the following points :

1. *Hartsel's Hot Springs*, in the South Park, about 15 miles below the foot of the Park Range.—The South Platte here flows through grassy meadows, a fairly clear stream, a little soiled by the seepage from the irrigating ditches. Water rather cold, about 65°. In summer the stream is about 10 feet broad, 2 to 3 feet deep, with many deep holes in its windings. It is literally full of suckers (*Catostomus griseus*). *Rhinichthys dulcis* is also abundant, but no other species were seen. Trout are found in the mountains above and frequently descend to the level of the park where they are carried out over the fields by the irrigating ditches. It is said that a washtub full of young trout were picked up from the ditch at Hartsel's last fall. Species from this locality are marked H.

2. *Denver*.—Collections were made in the Platte at the bridge just below the mouth of Bear Creek, 6 miles above Denver. The river is there 1 to 6 rods wide and 2 to 4 feet deep. Temperature about 72°. The water is grayish or brownish, nearly clear, with a bottom of gravel and sand. Fishes are very abundant, nine species being taken. These are marked D in the following list.

At its mouth, Bear Creek is clear, but very warm, the water being all seepage from irrigating ditches. It contains the same species as the river.

3. *Bear Creek*, above Morrison.—Seined at a point 10 miles up the cañon from Morrison, near Hines's. The stream is here about 20 feet wide and 3 feet deep. The water is clear and swift, with a bottom of gravel and boulders. Temperature about 67°. Trout are here abundant, both the native and the Eastern brook trout, which has been introduced. The suckers and minnows are the same as at Hartsel's. The species taken at Morrison are marked M.

4. *Middle Boulder Creek*, above Boulder.—Examined at various places in Boulder cañon to a point 12 miles above Boulder. A swift, clear, very cold (54°) mountain stream, full of rapids and deep pools. The bottom is everywhere made up of boulders, so that a net could not be used. It is said that trout are abundant in the upper part of the cañon, and that the fishing is especially good in the mountain pastures above the top of the cañon. The only fishes taken were young suckers, marked B in the following list :

FISHES OF THE PLATTE BASIN.

1. *Catostomus teres sucklii* (Girard). D.

Abundant at Denver.

2. *Catostomus griseus* (Girard). D., H., B., M.

Abundant everywhere, but especially so in the upper courses of the streams. D. 10. Scales 102. About six rows of tubercles on upper lip. Dorsal not nearer base of caudal than snout, except in the larger specimens. Lower lip with a slight cartilaginous sheath. Body long and low, dusky above, paler below. As already noticed in a paper on the fishes of the Yellowstone Park, this species seems to be the same as *Acomus lactarius* Girard and *Catostomus retropinnis* Jordan. It appears to differ from *C. catostomus* (Forster) in the greater number of rows of tubercles on the upper lip and in the greater inequalities of the scales on the body. But our specimens of *C. catostomus* are not numerous enough to test fully the value of these characters, and further study may show that this form intergrades with the other.

3. *Hybognathus nuchalis* Agassiz († var. *placita* Girard). D.

Rather rare about Denver. The specimens are all somewhat stout in form, the nose a little blunter than usual and rather less projecting beyond the mouth. Color very dark, the scales dark-edged, and a dark lateral shade. Suborbitals very narrow. Eye 4 in head.

These specimens may belong to the form called *placita*, but the distinctions of varieties and species in this group are very unsatisfactory.

4. *Notropis scylla* (Cope). D.

A few specimens from Denver, similar to others from Pueblo.

5. *Notropis gilberti* Jordan and Meek. D.

Very abundant at Denver. These specimens agree closely with the original types from the Des Moines River at Ottumwa, indicating that the species has a wide distribution over the western plains. The species has the lips somewhat thickened, and there is a little fleshy projection at the corner of the mouth, not, however, amounting to a barbel. A little dusky shade on each side of the dorsal fin seems to be characteristic. *Photogenis piptolepis* Cope may be this species, but the description is not sufficiently full to permit identification.

6. *Notropis megalops* (Rafinesque). D.

Not common; apparently typical, scales before dorsal 23.

7. *Notropis lutrensis* (Baird & Girard). D.

Not common; similar to Iowa specimens. Scales 33.

8. *Semotilus atromaculatus* (Mitchill). D.

Common. Scales 60. Similar to Indiana examples.

9. *Rhinichthys dulcis* (Girard). H., D., M. (*Rhinichthys maxillosus* and *transmontanus* Cope. *Rhinichthys ocella* Garman.)

The *Rhinichthys* of the Rocky Mountain region strongly resembles the eastern *R. cataractæ*. It, however, differs constantly in the insertion of its dorsal, the front of the dorsal being midway between the base of the caudal and the nostril, while in *R. cataractæ* the base of the dorsal is almost midway between the base of the caudal and the tip of the snout. *R. dulcis* is usually rather more slender than *R. cataractæ* and has a sharper snout. It does not usually reach as large a size as the latter species. No difference in the fins; scales or coloration seem to be permanent.

The *Rhinichthys* of the upper Missouri, Arkansas, and Platte seems to be the same. That of the upper Rio Grande, called *R. transmontanus* by Professor Cope, is not evidently different. The species found in the Utah Basin (*R. luteus* Garman) has, as a rule, two or three more scales in a vertical row from dorsal to ventrals, twelve to fourteen below lateral line in *luteus*, ten or eleven in *dulcis*. But this character is variable and of rather doubtful value, and no other difference is apparent.

10. *Zygonectes floripinnis* (Cope). D.

One specimen taken, agreeing with Cope's description. Outer teeth long, well separated. Scales 31-10. D. 10. Scales of back much punctulate with black.

11. *Etheostoma nigrum* Rafinesque. D.

Abundant, apparently like Iowa specimens. D. IX-12. Scales 47.

12. *Salmo mykiss stomias* Cope. M.

Abundant in the Park Range and in mountain streams generally.

B.—ARKANSAS BASIN.

The Arkansas River rises in the mountains to the north of Leadville. It flows southward through a broad park-like valley, grassy in its upper part and becoming arid lower down. This valley is bounded on either side by lofty mountains, with snow-banks which are the source of many ice-cold streams. At Salida the river turns abruptly to the east, breaking through the mountains in a deep and rocky cañon, by which it reaches the level of the sage plains. Throughout the region above the cañon the Arkansas is clear and cold, in every way well suited for trout. Placer-mining at Leadville and Granite has much reduced the number of fishes in the river by filling the water with clay, but they still abound in all the tributary streams. Below the cañon the river becomes warmer and more muddy, and no trout are found there, the fauna from Cañon City down being much the same as that of the rivers of Kansas. The fishes of the Arkansas were examined at the following points:

1. *Arkansas River* and its Lake Fork near Leadville. (Seined at a bridge across Lake Fork between Evergreen Lakes and the village of Malta, about 3 miles west of Leadville.)—The river and the Lake Fork are about equal in size and entirely similar in character, flowing with a moderate current through green meadows, shaded by willows, and with occasional deep holes in the bends. The streams are each about 15 feet wide and the bottom is gravelly. The temperature is about 62°. These streams are ideal trout-brooks. Trout are very abundant and with them *Rhinichthys dulcis*. Species taken at Leadville are marked L in the following list.

2. *The Evergreen Lakes* are a series of trout-ponds, wholly or partly artificial, fed by cold streams from the flanks of Mount Massive. One of these streams, having its rise in the largest permanent snow-field in Colorado, has been chosen by the U. S. Fish Commission as the site of its hatchery. No better location could be desired.

3. *Twin Lakes*.—These two lakes, formed by a moraine-dam at the foot of Mount Elbert and Mount Grizzly, are the largest lakes on the east side of the divide in Colorado. The two lakes are separated also by a moraine, across which they are connected by a short stream, perhaps an eighth of a mile long. The lower lake is the larger of the two, and is about 3 miles long by 2 wide. The upper is about 1½ miles by 2. The lower lake is said to average 40 feet in depth, its lower part being extensively shallow, the middle and the south side very deep. The bottom is largely gravelly and covered with water plants. In some places are piles of boulders. The shallow north side of the lake is full of *Najas* and other water weeds, growing 3 to 5 feet high in water 10 feet deep. Among these plants the trout chiefly feed. In them they often escape after taking the fly by breaking the leader. "Shrimps" (*Gammarus*) are very abundant in the weeds. The upper lake is a little colder and not quite so well stocked with fish. Its area is about one-half that of the lower lake. Our collections were made in the lower lake, most of the trout being taken with the fly by Mr. George R. Fisher. Besides the two forms of trout, the lake contains suckers (*C. teres*) and *Rhinichthys dulcis*. Species from Twin Lakes are marked T in the list. The inlet of the upper lake is a very clear, cold stream of considerable size. A water-fall in this stream formerly checked the ascent of the trout, but it has now been destroyed by blasting.

4. *Lake Creek* near Granite.—Lake Creek, the outlet of Twin Lakes, is a very clear stream with green borders running across a desolate mesa, a glacial moraine, down to

the Arkansas River. It is about 2 rods wide and 2 to 4 feet deep. The temperature is about 73°. Its bottom is gravelly, rarely sandy, with some deep holes and with few water plants. Fishes are not plenty. Most were caught at the bridge, midway between the lakes and the Arkansas River, and about 1½ miles from either. The creek contains trout, suckers, and *Rhinichthys*, marked G in the list.

5. *Arkansas River* at Cañon City.—At Cañon City, at the foot of its great cañon, the river is somewhat turbid and has a temperature of 70°. The stream is rather swift, with gravelly bottom and no weeds. The bottom is muddy in places, doubtless from the placer mining above. The cañon marks the lower limit of the trout and the upper limit of the fishes of the plains. Fishes are scarce in the river here, the four species seen being marked A in the list.

6. *Pond at Cañon City*.—Opposite Cañon City is a small clear pond fed by sweepings from irrigating ditches, full of chara and other weeds. The water is warm, temperature 80°, and the pond and its small outlet is full of small fishes. The pond is 2 rods long and 3 feet deep. The species taken here are marked C in the list below.

7. *Grape Creek* above Cañon City.—Grape Creek is a small but long stream, rising in the Wet Mountain range, flowing in a narrow valley with precipitous walls, and emptying into the Arkansas from the south 2 miles above Cañon City. The water is clear and cold, temperature 66°. The current is swift and the bottom of sand and gravel without weeds. It is about 6 feet wide, 12 inches deep, with a few pools. In the deep places is *Rhinichthys dulcis*. No other fishes were seen. It is said that trout occur some 18 miles up the creek, but not in abundance. Four-Mile Creek, below the town, is a similar stream. Some seventeen years ago, we are informed, this stream was full of trout, but in a dry summer it was reduced to a series of pools. The settlers gathered the trout then with dip-nets and the herons took all that were left. Since then no trout have been seen there.

8. *Arkansas River* at Pueblo.—At Pueblo the river becomes warm, 80°, and dark gray in color. It is about 4 rods wide and 2 to 5 feet deep, with swift current. The bottom is gravelly, with stretches of gray mud. There are no deep pools or quiet reaches and no water plants. Fishes are plentiful, especially in the shoals. Collections were made at Good Night Ranch, 5 miles west of Pueblo, above and below Mr. Bell's residence. Close along the river the banks are green, but the region about is a hot, barren mesa, with scanty vegetation. Fishes from Pueblo are marked P in the list which follows.

9. *Fountain Creek* at Pueblo.—Fountain Creek is a long stream rising in the mountain brooks about Pike's Peak. It is formed at Manitou Springs by the union of two streams, the Ruxton, rising on Pike's Peak, and the Font-qui-Bouille, which rises in Ute Pass. The Ruxton, a mountain torrent, is without fish, but into a tributary pond eastern trout have been introduced. The Font-qui-Bouille, also without fish, has in its course both iron springs and water-falls. The iron springs give the water a red tinge. The waters of Fountain Creek are chiefly consumed by the irrigating ditches. At Pueblo it is a clear shallow stream, 6 feet wide by 4 inches deep, in a wide sandy bed. Temperature, 70°. Species from Fountain Creek are marked F.

10. *Arkansas River* at Wichita, Kans.—A collection comprising 27 species was made for us at Wichita by Mr. Sherman Davis. The river at Wichita is broad and muddy, with soft bottom, and the species obtained are mostly those of the muddy or sandy prairie streams of Kansas.

FISHES OF THE ARKANSAS BASIN.

A.—UPPER ARKANSAS ABOVE THE CAÑON.

1. *Catostomus teres sucklii* Girard. G., T. (*Catostomus alticolus* Cope; *Moxostoma trisignatum* Cope.)

Abundant in Lake Creek, and more or less common in the Twin Lakes. Similar to ordinary eastern specimens—var. *teres*—except that the lips are larger, and the upper lip has from four to six rows of papillæ. The fish called *Catostomus sucklii* by Girard belongs to this type, which may be known as var. *sucklii*.

2. *Rhinichthys dulcis* (Girard). L., T., G.

Abundant in all the streams tributary to the Upper Arkansas, in company with the trout, although not ascending the brooks as far as the lakes.

3. *Cottus* sp.

It is said that a species of *Cottus* is occasionally found in the Upper Arkansas, but we saw no specimens.

4. *Salmo mykiss macdonaldi* (Jordan and Evermann). The yellow-finned trout of Twin Lakes. (Plate I, Fig. 1.)

Besides the common green-back trout another trout has long been known to anglers to exist in Twin Lakes, and Messrs. Gordon Land and George R. Fisher have in one way or another at different times called attention to it.

Mr. Fisher accompanied me from Leadville in search of the fish, and a morning of fly-fishing secured for us about ten fine specimens. These represent a very distinct form or variety of the mountain trout, which we recognize as a distinct subspecies under the name of *Salmo mykiss macdonaldi*. We have taken pleasure in naming the yellow-fin for the U. S. Fish Commissioner, the Hon. Marshall McDonald, in recognition of his services in connection with the propagation of the American Salmonidæ.

It is not unlikely that this may prove to be a desirable variety for introduction into gravelly ponds and lakes in other regions.

Description.—Head, 4 to 4 1.10 in length; depth, 4 1.5 to 5. D. 2, 12. A. 1, 11. B. 10. Scales, 40–184–37; about 125 pores. Length of types, 6 to 10 inches.

Body more elongate and more compressed than usual among the trout. Head long, compressed, the snout moderately pointed; mouth rather large, the jaws subequal, the maxillary extending beyond the eye, $1\frac{3}{4}$ to 2 in head; hyoid teeth present, small; opercle longer than usual, its greatest length $4\frac{1}{2}$ in head, somewhat greater than eye, its posterior margin strongly convex. Eye $5\frac{1}{2}$ in head; snout $4\frac{1}{2}$; gill-rakers short, $x + 10$ in number.

Scales quite small and regularly placed. Pectoral fin moderate, $1\frac{3}{8}$ in head; ventrals 2. Caudal moderately emarginate, the lobes equal, $1\frac{3}{8}$ in head.

Color, silvery olive; a broad lemon yellow shade along the sides, lower fins bright golden yellow in life, no red anywhere except the deep red dash on each side of the throat, which is never wanting in *Salmo mykiss*. Body posteriorly and on dorsal and caudal fin profusely speckled with small pepper-like spots, smaller than the nostril and smaller than in any other of the forms of the *Salmo mykiss*. Occasionally these spots extend forward to the head, but they are usually sparse on the anterior half of the body.

The yellow-fin trout is largely on the gravels and about the north or sunny side of the lake. It is not often taken in deep water.

It spawns in spring, and the suckers devour the spawn in the streams and spawning beds. The trout, however, feeds freely on young suckers, and sometimes on young trout.

This species has the lower fins bright yellow; there is a broad yellowish lateral shade, by which the species can be recognized in the water. The black spots are numerous and very small. There is little red under the throat and none at all elsewhere. The flesh is paler and more watery than that of the green-back trout, which is usually regarded as the better food-fish. This paleness of color may be associated with its feeding habits, the trout which feed on crustacea having the redder flesh.*

5. *Salmo mykiss stomias* (Cope). Green-back Trout. (Plate I, Fig. 2.)

This trout is very common in all the upper tributaries of the Arkansas River and in the Twin Lakes. From the common trout of the upper Missouri region it seems to differ somewhat, being of a greener color, with less red, and with redder flesh, all matters of very slight importance from the point of view of the systematist. The black spots are larger than in any other of our trout. The mouth is rather small and the scales are smaller than usual among these trout.

These facts seem to indicate a distinction from the ordinary *Salmo mykiss* sufficient to justify the recognition of a subspecies, although the differences are small, and some of them may be inconstant. The trout taken by us in tributaries of the Platte seems to be identical with the "green-back trout" of the Arkansas. The name *Salmo stomias* was given by Cope to specimens at first stated by him to have come from the "Platte River, at Fort Riley." Later he stated that these came "not from the Platte, but from the Kansas, a very different river." Fort Riley is a town on the Kansas River, east of the center of the State of Kansas. The Kansas River rises in the sage plains of Eastern Colorado. It contains no trout anywhere. In fact, there are probably no waters in which trout can live within 500 miles of Fort Riley. It is safe to presume that the types of *Salmo stomias* did not come from Fort Riley. It is probable that

* Since this report was sent to the printer, I have received from Mr. George R. Fisher, of Leadville, a very fine specimen of the yellow-fin trout. Mr. Fisher writes under date of June 2, 1890:

"I returned to Leadville in the spring and was here when the yellow-fins gathered at the mouth of the creeks immediately after the ice left the lakes waiting for the first rise in the streams. They appeared in schools at first but as the water raised they paired off, and went to the spawning beds in pairs.

"Before they mated they would take a trolling spoon or fly, and I believe grubs or minnow bait, but after pairing (they were nearly ready to spawn then) they would take nothing, and could only be taken with a grab-hook or spear. The largest yellow-fin taken this spring of which I know personally weighed 8 pounds 11½ ounces, and I believe that was the heaviest taken. This fish had been dressed before I knew of its capture or I would have sent it to you.

"I got one from two fishermen named Tyler and McDonald which weighed something over 7 pounds when first taken from the water, though I can't give the exact weight. This fish I have put in alcohol sealed up in a tin box and sent to you by express.

"It was kept on ice four days before putting in the alcohol and weighed at that time 6 pounds 14 ounces.

"This weight was carefully made and I know was correct.

"I have kept the fish here just one week since it was put in the alcohol and I see it has lost a good deal of the yellow color on the fins and throat."

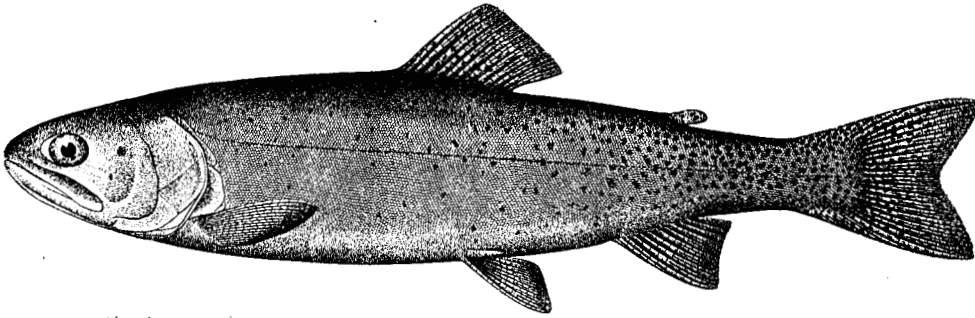


FIG. 1. YELLOW-FINNED TROUT (*Salmo mykiss macdonaldi*). (See page 11.)

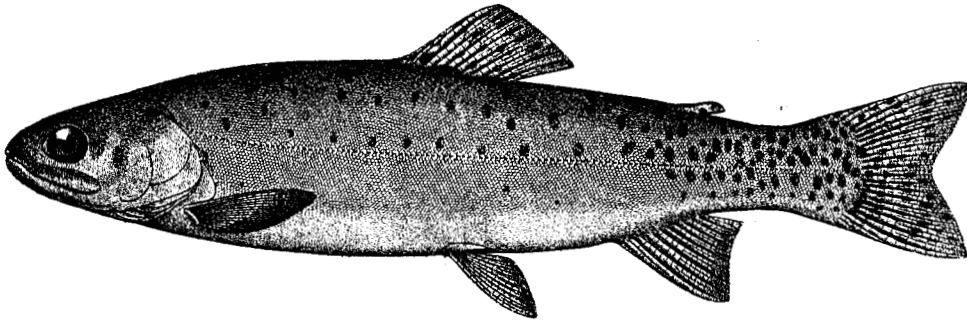


FIG. 2. GREEN-BACK TROUT (*Salmo mykiss stomias*). (See page 12.)

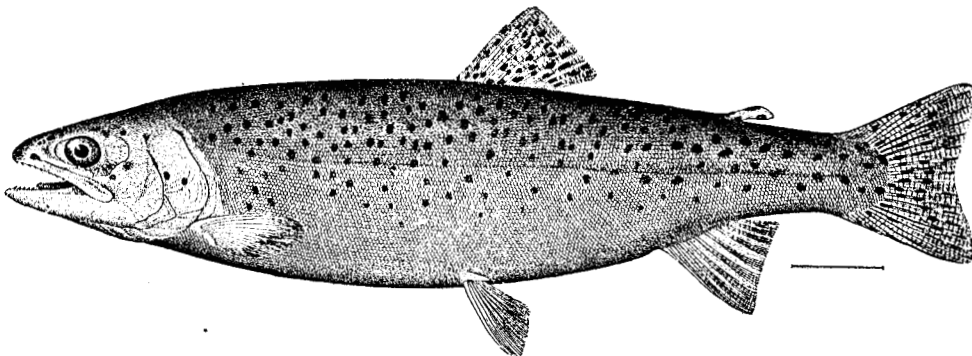


FIG. 3. RED-THROATED TROUT (*Salmo mykiss*). (See page 13.)

they came from some point on the South Platte, and on this supposition I have adopted the name *stomias* for the trout of the Platte.

The green back trout seldom exceeds three-fourths of a pound in weight. It is very abundant in the streams of the Upper Arkansas as well as in the Twin Lakes. It spawns in spring, in snow-water if possible, and it will leave spring-water to find snow-water. In winter, however, they seek for warmer waters. It is said that when the winter breaks up, the trout are too blind to see bait. In color, the green-back is green, or even almost black on the back. The lower fins and the throat are bright red, but there is not much trace of the red lateral band. The black spots are large and mostly confined to the posterior part of the body. In some cases these spots are ocellated with paler. At the spawning time, in May and early June, the males have much red, but later the sexes become similar. In specimens found about pools, there is often much red even in the summer. Those from the deeper parts of the lakes are always bright green, with a little red.

At the hatchery of Dr. Laws it appears that this trout will not willingly eat young suckers or minnows, its food being largely young crustacea.

The flesh in these trout is extremely red, this color being probably heightened by the character of its food. In the specimens from Arkansas River the body is plumper and softer than in those from Twin Lakes.

In connection with our study of these two forms I have had occasion to compare a large number of trout from various streams in the Rocky Mountains and westward. Besides the rainbow trout, *Salmo irideus*, which is chiefly confined to California, and the steel-head trout, *Salmo gairdneri*, found chiefly about the river-mouths in Oregon and northward, both of which species are characterized by the large size of the scales (from 130 to about 140), all our other western trout of the genus *Salmo* seem to belong to a single species. For this species the oldest scientific name is that of *Salmo mykiss* Walbaum (1792). To this name *Salmo purpuratus* (Pallas, 1811) and *Salmo clarkii* (Richardson, 1836) must give precedence.

This species is distributed from Kamtschatka and Alaska, southward to the mountains of Chihuahua, and eastward along the flanks of the Rocky Mountains so far as the clear water of the mountain goes. It seems to be absent in southern California, its place being taken by the *irideus*, but in all other suitable waters, excepting some streams in northwestern Wyoming, where water-falls keep it back, this trout may be found.

Several well-marked varieties occur in isolated lakes, and in general large streams or streams with a large food supply yield larger trout than small streams or streams with scanty food. All forms of *Salmo mykiss* have distinct hyoid teeth in life. All have a red dash below the lower jaw, from which comes the vernacular name of "cut-throat trout," and all show a small diffuse dark spot behind the eye.

A comparison of many specimens leads us to the recognition of the eight subspecies or varieties besides two others which I am scarcely able to define. It will be interesting to find out to what extent these forms will interbreed, and to what degree their peculiar characters will prove to be permanent when they are transplanted to other waters.

a. *Salmo mykiss* (Walbaum.) (Plate I, Fig. 3.)

The typical (*i. e.*, first known) form of the species, found in the waters, both fresh and salt, of Alaska and Kamtschatka.

Large, black-spotted, both fore and aft, and reaching a weight of 10 to 25 or 30 pounds. Sea-run specimens are much paler in color and grow larger.

b. *Salmo mykiss clarki* (Richardson). "Cut-throat Trout."

The common trout of both sides of the Cascade Range, profusely and usually rather finely spotted, the spots scarcely more numerous behind than before.

c. *Salmo mykiss lewisi* (Girard). Trout of the Upper Missouri. (Plate II, Fig. 4.)

This large trout seems to have the spots, on the average, larger than on those west of the mountains, but even this difference is questionable, and doubtless neither form requires a varietal name.

d. *Salmo mykiss henshawi* (Gill and Jordan). The trout of Lake Tahoe and neighboring waters. (Plate II, Fig. 5.)

A fine large trout, distinguished mainly by its longer and more conical head. Spots large, equally distributed, extending on head and belly. Scales rather small, about 180.

e. *Salmo mykiss pleuriticus* (Cope). Colorado River Trout. (Plate II, Fig. 6.)

The common trout of the basin of the Colorado, its range extending to the mountains of Arizona. Variable in color, size, and form, with its surroundings, and in most respects substantially identical with *lewisi*, the chief difference being that in this form, as in *spilurus*, *stomias*, and *macdonaldi*, the black spots are usually much more numerous on the posterior part of the body, while the head is usually free from spots. This is, however, not universally true.

In one specimen, from Trapper's Lake, the entire body from head to tail is closely and coarsely spotted. Generally the black spots are rather large, but in some specimens the spots are small, smaller than in any of the other forms except var. *macdonaldi*.

In a considerable number taken in Eagle River, Colorado, the spots are as small and as close set as in var. *macdonaldi*, and the usual red color of the lower fins is in these specimens changed to pale orange.

Although the coloration is almost that of *macdonaldi*, there are other differences, the most notable being in the short opercle, $4\frac{3}{4}$ to 5 in head ($4\frac{1}{2}$ in *macdonaldi*). The body is also less elongate than in *macdonaldi*.

In var. *pleuriticus* there is almost always a very distinct red lateral band, and the lower fins are more or less red.

f. *Salmo mykiss spilurus* (Cope). The Trout of the Rio Grande. (Plate III, Figs. 7 and 8.)

Abounding in all its tributaries and extending southward in the mountains to northern Chihuahua. This form is apparently wholly identical with var. *pleuriticus* except that in the specimens examined the scales are less crowded forward, so that the number in a lengthwise series is less. I count 155 to 160 in Rio Grande specimens; 185 to 190 in those from the Colorado. From the trout of the Great Basin (*virginalis*), *spilurus* differs chiefly in the arrangement of its spots.

g. *Salmo mykiss virginalis* (Girard). (*Salmo utah* Suckley.) The Trout of Utah Lake. (Plate III, Fig. 9.)

The trout of the Great Basin are profusely and not very coarsely spotted, the spots being numerous anteriorly as well as posteriorly, confined to the back rather than to the tail. In several examined, the scales are a little larger than in any of the other forms, 140 to 150 in a lengthwise series, the scales on the anterior part of

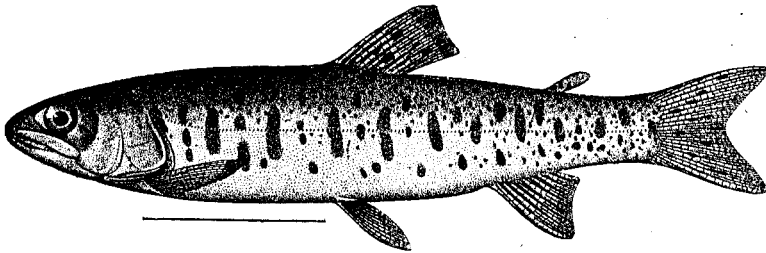


FIG. 4. RED-THROATED TROUT (*Salmo mykiss lewisi*). Young. (See page 14.)

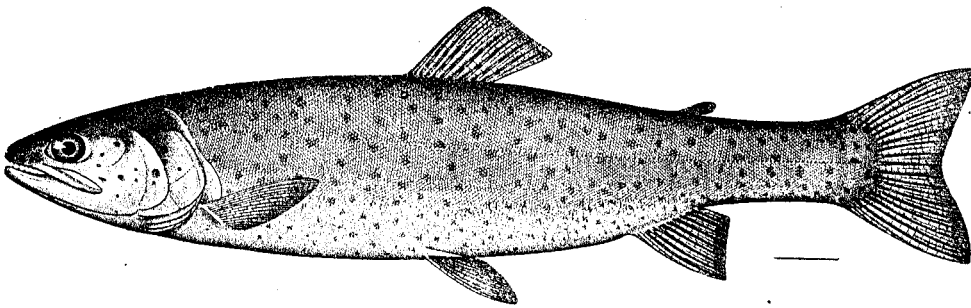


FIG. 5. LAKE TAHOE TROUT (*Salmo mykiss henshawi*). (See page 14.)

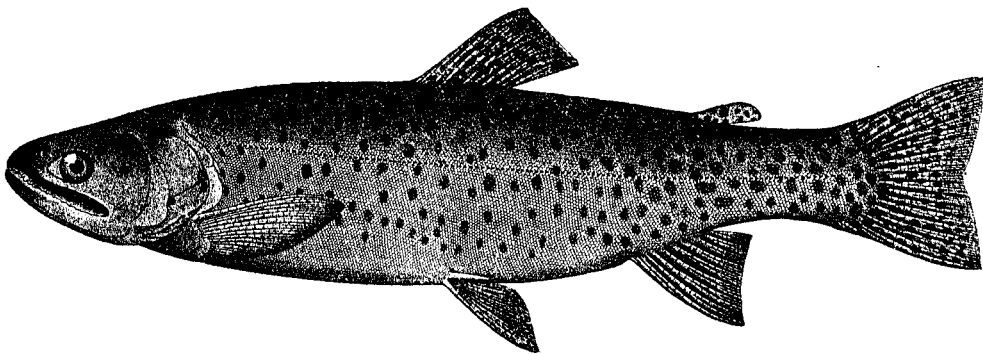


FIG. 6. COLORADO RIVER TROUT (*Salmo mykiss pleuriticus*). (See page 14.)

the body being less crowded than in *spilurus* and *stomias*. In other respects *virginalis* scarcely differs from *clarki*.

The large fishes from Utah Lake are very pale in color, the dark spots few and small, much as in var. *macdonaldi*, but fewer, and more on the back. This pale coloration is characteristic of lake and sea trout in general. It is doubtless partly due to the alkaline character of the waters of Utah Lake.

h. *Salmo mykiss stomias* (Cope). (Plate I, Fig. 2.)

Arkansas and Platte Rivers. A small trout, with very large black spots and small scales. It closely approaches *lewisi* and *spilurus*. The black spots are always larger than in any of these, and mostly gathered on the tail.

i. *Salmo mykiss macdonaldi* Jordan and Evermann. Yellow-finned Trout. In Twin Lakes. (Plate I, Fig. 1.)

The most strongly marked of these varieties so far as color and general appearance are concerned. The head is long and the opercles longer than in most of the others. Probably an early off-shoot, perhaps inhabiting these lakes prior to the advent of var. *stomias* in the same region. The nearest relative is *pleuriticus*, from which I think it is descended.

k. *Salmo mykiss bouvieri* (Bendire). (Plate IV, Fig. 10.)

In Waha Lake, in Washington, a mountain lake without outlet; a peculiar form, with short, blunt head, large eye, moderate (160) scales, and the spots confined to the posterior half of the body. This form seems to be an off-shoot from *clarki*.

The following table was taken from a number of specimens of partly grown trout, most of them from 8 inches to a foot in length (those from Utah Lake, Henry Lake, and Riddle Lake being larger). In the size of fins, number of gill-rakers, dentition, etc., no differences of any importance have been noticed.

	Head in length.	Depth in length.	Eye in head.	Maxillary in head.	Scales.	Spots.
Trapper's Lake (<i>spilurus</i>).....	4 $\frac{2}{3}$	4 $\frac{2}{3}$	5	1 $\frac{5}{8}$	180.....	Large, close, and chiefly posterior.
Gunnison River (<i>pleuriticus</i>).....	4 $\frac{1}{2}$	4 $\frac{1}{2}$	5	2	188 (125 pores)	Large; chiefly posterior; a few on head.
Rio Florida (<i>pleuriticus</i>).....	4 $\frac{1}{2}$	4 $\frac{1}{2}$	4 $\frac{3}{4}$	2	185.....	Same; anterior spots smaller.
Rio Grande (<i>spilurus</i>).....	4	4	5 $\frac{1}{2}$	1 $\frac{1}{2}$	155 (115 pores)	Large; chiefly on tail.
Rio Grande (<i>spilurus</i>).....	4 $\frac{1}{2}$	3 $\frac{3}{4}$	5	2	160.....	Same.
Wallawalla (<i>clarki</i>).....	3 $\frac{5}{8}$	4 $\frac{1}{2}$	4 $\frac{3}{4}$	1 $\frac{3}{4}$	177.....	Rather large; scattered almost equally.
Henry's Lake, Idaho (<i>clarki</i>).....	4 $\frac{1}{2}$	3 $\frac{3}{4}$	5	1 $\frac{3}{4}$	178.....	Small; very closely set, especially behind.
Riddle Lake, Wyoming (<i>lewisi</i>)...	4 $\frac{1}{2}$	4 $\frac{1}{2}$	5	1 $\frac{3}{4}$	170.....	Rather large; not close set; more numerous behind, but not confined.
Utah Lake (<i>virginalis</i>).....	3 $\frac{3}{4}$	4 $\frac{1}{2}$	5	1 $\frac{5}{8}$	148 (150 pores)	Small; mostly confined to back; few on tail.
Provo River (<i>virginalis</i>).....	3 $\frac{5}{8}$	4 $\frac{1}{2}$	5	2	145 (121 pores)	Rather large; scattered equally.
Provo River (<i>virginalis</i>).....	4	4 $\frac{1}{2}$	5	2	141.....	Same.
Bear Creek, near Denver (<i>stomias</i>)..	4 $\frac{1}{2}$	4 $\frac{1}{2}$	4 $\frac{1}{2}$	2	180.....	Large; largest on tail.
Twin Lakes (<i>stomias</i>).....	4 $\frac{1}{2}$	4 $\frac{2}{3}$	4 $\frac{3}{4}$	2	193 (140 pores)	Very large; well defined; largest on tail.
Twin Lakes (<i>macdonaldi</i>).....	4 $\frac{1}{10}$	4 $\frac{1}{2}$	5 $\frac{1}{2}$	2	184.....	Very small; smaller than nostril; most numerous behind.
Waha Lake (<i>bouvieri</i>).....	4	4 $\frac{1}{2}$	4 $\frac{3}{4}$	1 $\frac{3}{4}$	183.....	Very small; most numerous behind.
Eagle River (<i>pleuriticus</i>).....	4 $\frac{1}{2}$	4 $\frac{1}{2}$	3 $\frac{3}{4}$	2	160.....	Large; all on the tail!
Eagle River (<i>pleuriticus</i>).....	4 $\frac{1}{10}$	3 $\frac{3}{4}$	4 $\frac{3}{4}$	1 $\frac{3}{4}$	175.....	Very small; most numerous behind.

Besides the native trout, *macdonaldi* and *stomias*, the following trout have been introduced into the Twin Lakes.

Salvelinus fontinalis (Mitchill).

This species does well, growing faster than the native trout. It seems to prefer the colder waters of the upper lake.

Salmo irideus Gibbons.

This species is doing well, and is already becoming common.

Salmo salar sebago (Girard).

The land-locked salmon was introduced about 1885. They grow very slowly in the Twin Lakes, and rarely exceed one-half pound. They are occasionally taken.

ARKANSAS RIVER, BELOW THE CAÑON.

1. **Ameiurus melas** (Rafinesque). P.

Rather scarce.

2. **Catostomus teres** (sucklii Girard). A., P.

Everywhere common.

3. **Campostoma anomalum** (Rafinesque). A.

Scarce. *Campostoma aikenii* Cope, from Pueblo, is identical with *C. anomalum*.

4. **Pimephales promelas confertus** (Girard). A., P., C., F.

Very common in muddy shallows.

5. **Notropis scylla** (Cope). P.

In the river channel. Not common. This is the species recorded by Dr. Gilbert from Kansas as *Notropis deliciosus lineolatus*. *Notropis chlorus* (Jordan) is probably the same species. Agassiz's *lineolatus* may be this or some of the related species. The short description is insufficient to permit identification, and the name should not be used. The same remarks apply also to Rafinesque's name *microstomus*, which I have elsewhere used instead of *stramineus* and the still older name *deliciosus*. *Notropis phenacobius* Forbes is identical with *N. scylla*, as I am informed by Dr. Gilbert, who has examined Dr. Forbes's types. *N. scylla* is close to *N. deliciosus*, but stouter in body with a shorter, blunter, and deeper head. Its scales are larger, but those before the dorsal are smaller and more crowded. Mouth small with subequal jaws, the cleft somewhat oblique. Head $3\frac{3}{5}$ - $4\frac{1}{4}$; depth 4 - $4\frac{1}{4}$; scales 31-33; 14-15 before dorsal; maxillary equal to eye, $3\frac{1}{5}$ - $3\frac{1}{2}$ in head; snout 4. Pectoral nearly reaching ventral. Color pale, a dusky shade before dorsal and one on each side of the fin, as in *N. deliciosus*; some dark dots on side of snout; a faint dark lateral shade. In *N. deliciosus* the scales are 34-38, 12 before dorsal; eye, 3 in head; body and head more slender. Renewed comparison of specimens from White River, Indiana, with others from Rio Comal in Texas, confirms my belief in the complete identity of *N. deliciosus* and *N. stramineus*.

6. **Notropis lutrensis** (Baird and Girard). P., F.

Very common at Pueblo; some specimens highly colored; bodies blue, fins crimson.

7. **Rhinichthys dulcis** (Girard). P.

Abundant and large in the river and in Grape Creek. Fins often red.

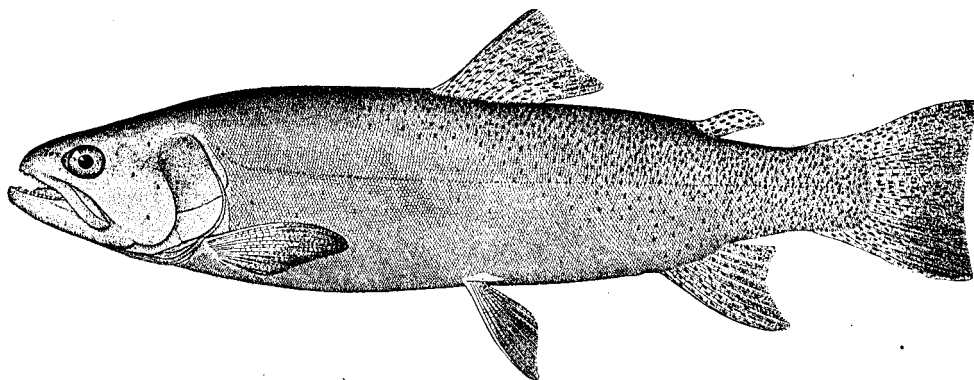


FIG. 7. RIO GRANDE TROUT (*Salmo mykiss spilurus*). Adult. (See page 14.)

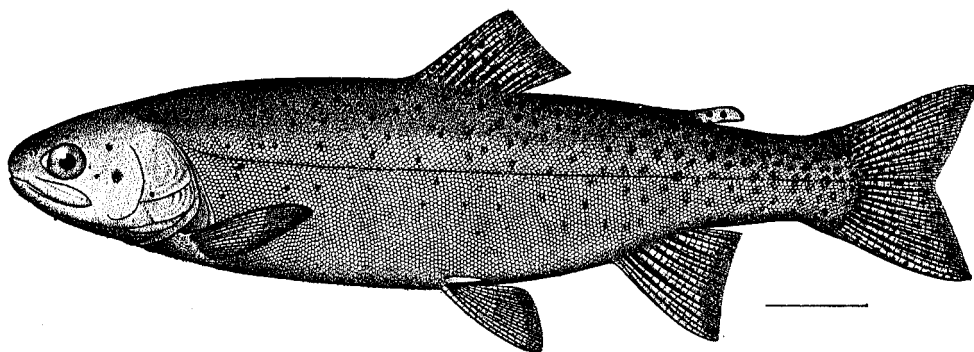


FIG. 8. RIO GRANDE TROUT (*Salmo mykiss spilurus*). Young. (See page 14.)

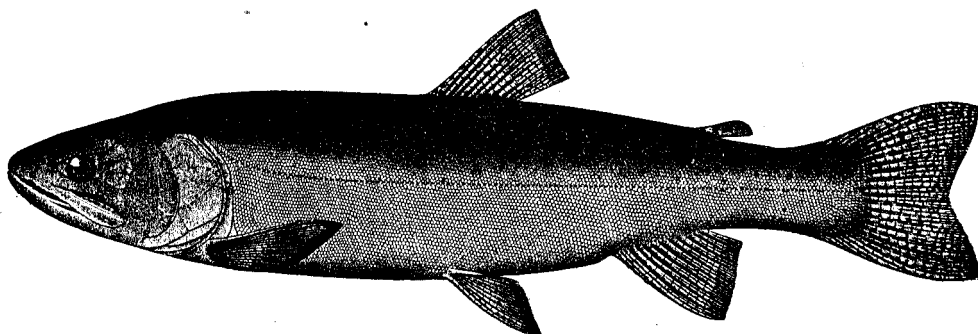


FIG. 9. UTAH LAKE TROUT (*Salmo mykiss virginalis*). (See page 14.)

8. *Platygobio physignathus* (Cope). A., F.

Very common, the most abundant species in the river. This species is a true *Platygobio*, not a *Couesius*. It differs from *P. gracilis* in having the head shorter, narrower, and blunter, less depressed above. Anterior profile forming a nearly even curve, which is everywhere convex. Head $4\frac{3}{8}$ in length, depth $4\frac{3}{8}$, scales 6-48-5, 20 scales before dorsal, snout 3 in head; teeth with distinct grinding surface. In *P. gracilis* the broad head is concave in profile above the eye. *P. pallidus* Forbes may be a valid species, but from the description I can not tell it from the young of either of the others. Our specimens from St. Joseph, Mo., seem to be *P. gracilis*.

9. *Hybognathus nuchalis* Agassiz (var. *placita*). P.

Not rare in the river.

10. *Hybopsis tetranemus* Gilbert. P.

One specimen of this singular little fish. Barbels long, the second pair nearly as long as the eye. Some of the specimens from the Arkansas basin, recorded by Jordan & Gilbert as *Hybopsis aestivalis*, belong to the species.

11. *Fundulus zebrinus* Jordan & Gilbert. F., C.

Very common in brooks and the pond; not seen in the river.

12. *Lepomis cyanellus* (Rafinesque). C.

One found in the pond at Cañon City.

13. *Etheostoma cragini* Gilbert. C.

Very abundant in the pond at Cañon. Head naked; fins with brick-red shades; body with blue specks in life; body and fins profusely punctulate with black.

C.—ARKANSAS RIVER AT WICHITA.

1. *Ameiurus melas* (Rafinesque).2. *Ictalurus punctatus* (Rafinesque).3. *Ictiobus bubalus* (Rafinesque).4. *Ictiobus difformis* (Cope).

Numerous specimens; the dorsal rays low, little longer than head and stout at base. Eye $4\frac{1}{2}$ in head. Snout short, very blunt.

5. *Moxostoma duquesnei* (Le Sueur).

Head $4\frac{2}{3}$ in length in one example, and head $4\frac{1}{4}$ in another.

6. *Campostoma anomalum* (Rafinesque).7. *Hybognathus nuchalis* Agassiz.

Numerous examples of the ordinary type.

8. *Pimephales promelas confertus* (Girard).

Scarcely if at all different from the common *promelas*.

9. *Pimephales notatus* (Rafinesque).10. *Chiola vigilax* Baird & Girard.11. *Notropis scylla* (Cope).

Abundant.

12. *Notropis cayuga* Meek.

Abundant. This is a widely diffused species, allied to *N. heterodon*, from which it is easily known at sight by the absence of black on the chin. Head, $4\frac{1}{8}$ in length; depth, $4\frac{1}{2}$; scales, 36; 14 before dorsal; lateral line wanting on some scales; mouth

very small, anterior, the maxillary not reaching to eye; eye large, equal to snout, $3\frac{1}{2}$ in head; jaws, subequal; scales above, dark-edged, very sharply defined; a black stripe through snout and eye, with a dusky lateral shade and a small caudal spot. *Notropis fretensis* (Cope) may be this species, but the short description applies as well to *N. heterodon*. Some of the references to *heterodon* may belong to *N. cayuga*. Among the specimens taken by Dr. Gilbert and the writer in Rio Comal at New Braunfels, Tex., is one not mentioned in our paper (Proc. U. S. Nat. Mus., 1886, 23) closely resembling *N. cayuga*, but with the snout a little more blunt in profile; the scales, form, and coloration being the same. Another in Dr. Gilbert's collection (Long Lake, Ill., Harrison Garman) agrees fully with this one, but we are unable to decide whether the species they represent is different from *Notropis cayuga*.

13. *Notropis camurus* Jordan & Meek.

Very abundant.

14. *Notropis bubalinus* (Baird & Girard).

One example. More elongate than the species described, but if the variations in this species are the same as in the allied *lutrensis*, this has little significance. Head, 4 in length; depth, $3\frac{1}{2}$; scales 36; 18 before dorsal. Closely related to *N. camurus*, but the dorsal without black blotch; scales a little smaller and less closely imbricated; head a little smaller.

15. *Notropis lutrensis* (Baird & Girard).

16. *Notropis umbratilis* (Girard).

17. *Notropis topeka* Gilbert.

A few specimens.

18. *Phenacobius mirabilis* (Girard).

Typical; scales, 49; their outlines obscure.

19. *Hybopsis storerianus* (Kirtland).

Abundant.

20. *Hybopsis tetranemus* Gilbert.

Seven examples.

21. *Dorosoma cepedianum* (Le Sueur).

22. *Labidesthes sicculus* Cope.

Common.

23. *Lepomis humilis* (Girard).

Common.

24. *Lepomis cyanellus* (Rafinesque).

25. *Lepomis megalotis* (Rafinesque).

Specimens small, and with a black spot on last ray of dorsal, as in Texan examples.

26. *Etheostoma caprodes* Rafinesque.

27. *Etheostoma lepidum* Baird & Girard.

A few; head scaleless.

C.—RIO GRANDE BASIN.

The Rio Grande rises in the Saguache and Sangre de Cristo Mountains, at the head of San Luis Park. Its headwaters and its various tributaries are clear and cold, flowing through grassy mountain pastures, and being well stocked with trout. Of its upper tributaries, the following are all noted as trout streams, although the lower waters of all are consumed by the irrigating ditches: Saguache, San Luis, Madenha, Crestone, Piedras, Alamosa, La Jara, Conejos, Pinos, Ute, Sangre de Cristo, Trinchara, Costilla, Culevra, and Chama. In these streams thousands of trout are destroyed each year by the irrigating ditches, especially at the time of their downward migration in the fall. It is stated that nine-tenths of the trout in the San Luis Park have been thus destroyed. The streams of the northeastern part of the park (Madenha, Crestone) sink into the great sand dunes, the water rising from below as artesian springs, while the waters of the Saguache and the San Luis are lost in the alkaline San Luis lakes. Collections were made at the following points:

1. *Rio Grande* at Del Norte.—The Rio Grande here is a clear, full stream, with numerous trout, as well as chubs, minnows, and suckers. Temperature, 59°. The best trout fishing is found still higher up, about Wagon Wheel Gap. More trout are destroyed in ditches about Del Norte than anywhere else in Colorado. Species from Del Norte are marked D.

2. *Rio Grande* at Alamosa.—The stream here is quiet, with a bottom of adobe. The water is clear and rather cold (62°). In summer the stream is reduced to the seepage of irrigating ditches. In the deeper parts are multitudes of suckers and chubs. Species from Alamosa are marked A.

3. *Rio Conejos* at McIntyre's Ranch, about 15 miles south of Alamosa.—The clear stream is here 10 to 20 feet wide and 2 inches to 6 feet deep. The bottom is gravelly; the temperature 65°. Species taken here are marked C.

4. *Rio Chama* at Chama.—A clear, cold mountain stream, among those in southern Colorado best suited for trout.

5. *San Luis Lakes*.—Some 20 miles northeast of Alamosa there is a large depression in the plain. Into this flow several trout streams, the chief of these being the Saguache, San Luis, Madenha, and Crestone. The lower parts of this depression are occupied by the San Luis Lakes, but in ordinary summers none of these streams reach the lakes, the water either sinking into the sand or else being used in irrigation. The lakes are some six in number, ranging from 50 rods to 1 mile in length, filling one after another from the rains and from the soakage of the streams. They are connected by a broad ill-defined channel, usually dry, which extends to the Rio Grande, below Alamosa. The lakes are all strongly alkaline. The two examined were strongly impregnated with soda, and without fishes or any other animals. The uppermost is said to be less alkaline, but evidently all are worthless for fishes.

FISHES OF THE RIO GRANDE.

1. *Pantosteus plebeius* (Baird & Girard) D., G., A.; *Catostomus guzmaniensis* Girard; (*Pantosteus jarrovii* Cope & Yarrow; not *Minomus jarrovii* Cope).

Very abundant everywhere, especially in the deeper places and eddies, reaching a length of about a foot.

This is the species well figured by Cope and Yarrow under the name of *Pantosteus*

jarrovi, from the Rio Grande. The original *Minomus jarrovi* of Cope is from Provo, Utah, and is the species described by Girard as *Acomus generosus*, and by Cope as *Minomus platyrhynchus*. The original *Catostomus guzmaniensis* and the original *Catostomus plebeius* are from Lake Guzman, in Chihuahua, a lake without outlet, but belonging to the Rio Grande Basin.

Among the many specimens of *Pantosteus* examined by us we recognize three species, each one, so far as our own collections show, confined to a distinct river basin. The following analysis shows the principal characters of each of these:

- a. Scales moderate, 80 to 90 in the lateral line, 28 to 30 in a cross series between dorsal and ventral; mouth and lips of moderate size; dorsal rays usually 9.
- b. Head comparatively short and small, $4\frac{1}{2}$ to 5 in length of body; body slender, the depth $\frac{5}{8}$ to $5\frac{1}{8}$ in length; 45 to 50 scales before the dorsal; scales 15-18-14. Great Basin of Utah (*generosus* Girard=*platyrhynchus* Cope=*jarrovi* Cope) *Generosus*.
- bb. Head comparatively large, $4\frac{1}{2}$ to $4\frac{3}{4}$ in body; body more robust, the depth $4\frac{1}{2}$; dorsal fin a little higher and pectoral a little longer. Rio Grande Basin and Lakes of Chihuahua (*plebeius* Baird and Girard=? *guzmaniensis* Girard=*jarrovi* Yarrow, not of Cope) *Plebeius*.
- aa. Scales very small, 95 to 103 in the lateral line; 20 to 33 in a cross series between dorsal and ventral; mouth large, with very full lips; head rather short, $4\frac{1}{2}$ to $4\frac{3}{4}$ in length; tail very slender, the caudal long; 50 scales before dorsal; depth of body about 5 in length; scales 16-96 to 99-14. Basin of Colorado River (*delphinus* Cope=? *bardus* Cope=? *virescens* Cope=? *guzmaniensis* Jordan Cat. Fish. N. A., 1885, probably not of Girard) *Delphinus*.

These three species are certainly distinct from each other and are very common, each in its respective hydrographic basin. If other species exist they are unknown to us.

2. *Leuciscus pulcher* (Girard). C., A., D.

(*Gila pulchella* Baird & Girard, Proc. Ac. Nat. Sci. Phila., 1854, 29, Rio Mimbres, Lake Guzman, Chihuahua, not *Leuciscus pulchellus* Storer; *Tigoma pulchra* Girard, Proc. Ac. Nat. Phila., 1856, 207, Chihuahua R.; *Clinostomus pandora* Cope, Hayden's Geol. Survey Montana for 1871, 475, 1872, Rio Grande in New Mexico.)

The chub or "Pescadito" is everywhere abundant, reaching a length of 6 or 8 inches. It is found in eddies and deep places with the preceding species. The synonymy of the species is given above. There seems to be little room for doubting the identity of *pulchella*, *pulchra*, and *pandora*, and no other species of this genus has yet been authentically recorded from the basin of the Rio Grande. The earliest name, *pulchellus*, is preoccupied in the genus *Leuciscus*.

Head $4\frac{1}{2}$ in length; depth $4\frac{2}{5}$; scales 15-67-10; axils red in the male. Teeth often irregular in number, sometimes 1, 4-4, 1.

NOTE ON THE GENERIC NAME LEUCISCUS.

For a number of years American writers have referred our species with the teeth 1 or 2, 4-5, 2, and with hooked tips, to the genus *Squalius* Bonaparte.

Comparing the American species with the European representatives of this type, we find that while there is a general agreement in technical characters the European species have much larger and looser scales, and the scales have the radiating striae more prominent. The European species have in fact the same squamation as our genus *Notemigonus*. The teeth in *Squalius* proper are 2, 5-5, 2, in all species, so far as examined,

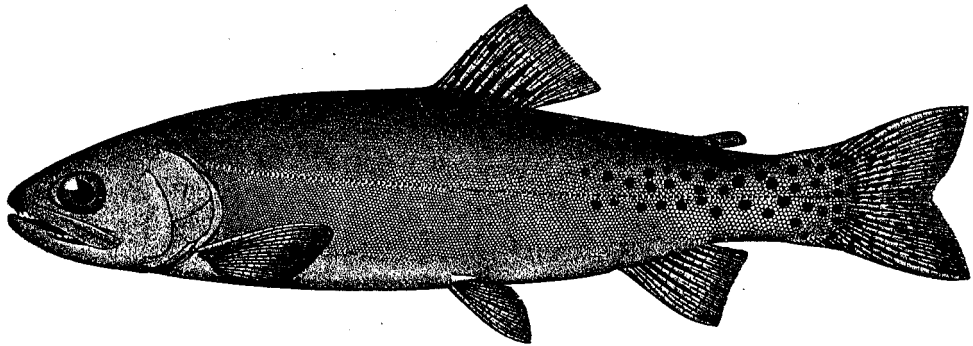


FIG. 10. WAHA LAKE TROUT (*Salmo mykiss bowvieri*). (See page 15.)

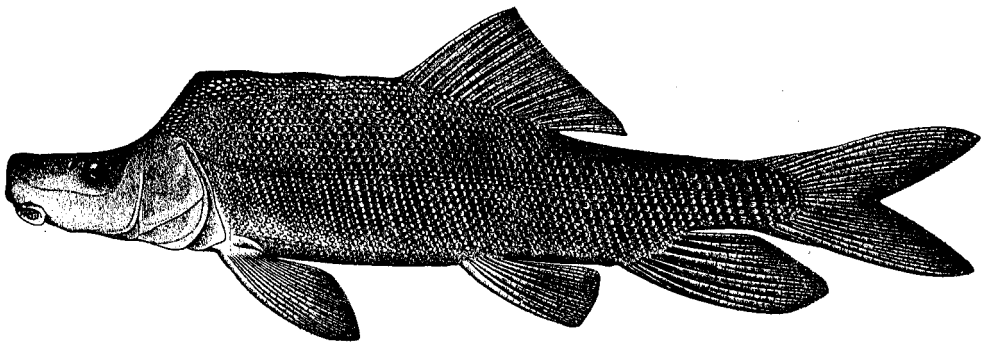


FIG. 11. HUMP-BACK SUCKER (*Xyrauchen cypho*). (See page 26.)

There is, however, in Europe a subgeneric group called *Telestes* by Bonaparte, which approaches much more nearly to the American forms. The scales in *Telestes* are small, ranging from 60 to 80, and the teeth are 2, 4-5, 2. I know of no character by which the American species called *Tigoma* can be set off from *Telestes*, nor does any definite character exist by which *Siboma*, *Cheonda*, and *Clinostomus* can be separated from *Tigoma*. *Protoporus* Cope is apparently also based on a young *Tigoma*.

It is, however, true that European writers generally hold the distinctions between *Telestes* and *Squalius* as of very slight value, and the figures and specimens accessible to us seem to show a pretty regular graduation from one type to the other. Nevertheless, no American species of this type is a near ally to *Squalius cephalus*, and none have the pharyngeal bones equally armed with 5 teeth in the main row so far as we know. For the present we may unite *Tigoma* with *Telestes* and *Squalius* as forming a single genus.

It seems to me, however, that the name *Leuciscus* should be used instead of *Squalius* for the group typified by *Leuciscus cephalus* and *L. leuciscus*.

The generic name *Leuciscus* was first applied by Cuvier in 1817 to a group of Cyprinoids about corresponding to the *Leuciscinae* of present classifications. Five species are mentioned especially by Cuvier in his text, and several others are referred to incidentally in a foot-note. Among the five mentioned in the text the type of this genus *Leuciscus* must be chosen.

These species are *Cyprinus dobula* L., *C. rutilus* L., *C. leuciscus* L., *C. alburnus* L., and *C. phoxinus* L.

In the *Ichthyologia Ohiensis*, 1820, Rafinesque adds numerous American species to the genus *Leuciscus*, proposing for them the new generic names of *Minnilus*, *Luxilus*, *Plargyrus*, and *Pimephales*. At the same time he divides the European species into five genera, *Dobula*, *Rutilus*, *Leuciscus*, *Alburnus*, and *Phoxinus*, the names and order corresponding to the order of the species as given by Cuvier. These genera are each briefly defined, but no typical species is mentioned, except in one case, a page or two later, where he speaks of *Cyprinus rutilus* L. as the type of *Rutilus*.

By Rafinesque's arrangement *Cyprinus rutilus* is made the type of *Rutilus* and *C. leuciscus* that of the restricted genus *Leuciscus*.

Later, Agassiz, not noticing the work of Rafinesque, similarly restricted *Leuciscus* to the species having two rows of teeth, *Rutilus* having but one.

Still later, Bonaparte made *Cyprinus leuciscus* the type of his restricted genus *Leuciscus*, and added *Scardinius*, *Squalius*, and *Telestes* for other species, the group called *Squalius* practically corresponding to the *Dobula* of Rafinesque, which is doubtless identical also with Rafinesque's *Leuciscus*.

At about the same time Heckel made more thorough investigations of the characters of these fishes than any of his predecessors had done. In his arrangement, *Cypr. dobula* and *Cypr. leuciscus* were referred together to *Squalius*, while the name *Leuciscus* was transferred to *L. rutilus*. The system of Heckel has been generally followed by later writers, although by Günther and others all these groups have been regarded as simple sections or subgenera under *Leuciscus*.

It seems evident that *Cyprinus leuciscus* must stand as the type of *Leuciscus*, and that the generic name of *Cypr. rutilus* must be *Rutilus*.

The genera concerned would then be:

1. *Leuciscus* (Cuvier), Rafinesque, Agassiz, and Bonaparte=*Dobula* Rafinesque=

Squalius Bonaparte, (probably including *Telestes* Bonaparte=*Tigoma*, *Cheonda*, *Siboma*, and *Clinostomus* Girard and *Protoporus* Cope).

2. *Rutilus* Rafinesque (= *Leuciscus* Heckel, Günther = *Leucos* Heckel = *Pigus* Bonaparte; possibly should include *Myloleucus* Cope) species with the teeth 4-5 instead of 5-6 or 5-5, as in *Rutilus*.)

3. *Alburnus* Rafinesque = *Alburnus* Heckel.

4. *Phoxinus* Rafinesque = *Phoxinus* Agassiz.

For the present, at least, until better definitions can be given, we may refer the American species to the genus *Leuciscus* in which they form a subordinate group (*Tigoma* or *Telestes*) distinguished by the smaller number of teeth and the generally smaller scales.

3. *Rhinichthys dulcis* (Girard), A., D., C. (*Rhinichthys transmontanus* Cope.)

Very common. We are unable to distinguish our specimens from the Rio Grande, from those taken by us in the Arkansas, Platte, and Yellowstone. As the types of *Rhinichthys transmontanus* are from New Mexico, we regard the latter species as a synonym of *R. dulcis*. *Rhinichthys maxillosus* Cope, originally described from Kansas, is the same as *R. dulcis*.

4. *Salmo mykiss* Walbaum, D., C. (Var. *spilurus* Cope.)

Abundant in the upper Rio Grande, and in all tributary streams down to the level of the valley.

The Rio Grande trout have the dark spots rather large and more or less confined to the dorsal and caudal fins and the region between them, though often, especially in the young, extending on the head. They reach a fair size, a pound or two in weight, but are doubtless not as large as the trout of the Upper Colorado. The Rio Grande trout was first described as a distinct species by Professor Cope under the name of *Salmo spilurus*. The types of this nominal species came from the Saugre de Cristo.

D.—COLORADO BASIN.

The Colorado River is formed by the union of two large rivers, Green River and Grand River. Both of these have their source in the mountain streams of the western slope of the Rockies, and are very clear and cold in their upper courses. Lower down they become gradually turbid and yellow and finally the Colorado becomes one of our muddiest streams. The headwaters everywhere are full of trout, and all the tributary lakes, many of which exist in northwestern Colorado, are especially well stocked. The fish fauna of this great river is very scanty. In the highlands the trout is accompanied by *Agosia* only. Lower down the "Blob" appears; still lower the suckers, four species in all in the upper waters, and with them the Round-tail (*Gila robusta*) and the "White salmon" (*Ptychocheilus*). This is the largest and best food-fish of the Lower Colorado and the largest of the carp family in America. The Bony-tail (*Gila elegans*) is found still lower down, while in Arizona the fauna is further increased by the addition of three or four more suckers and of species of *Leuciscus*, *Meda*, and other genera of chubs and minnows. Collections were made by us at the following localities:

1. *Grand River*, at Glenwood Springs, Colo.—The Grand River rises in the middle of northern Colorado flowing southwestward through deep gorges. Glenwood Springs lies at the foot of its deepest cañon. The water is here yellow and muddy, but the

clay comes chiefly from the placer mining above. The stream at Glenwood is broad and swift, while the bottom is full of large boulders so that it can not be easily seined. Two large suckers (*C. latipinnis*) were taken here. It is said that these suckers in winter come here for the warmth of the Hot Springs.

2. *Sweetwater Lakes* in Eagle County, Colo.—Some 25 miles above Glenwood are the Sweetwater Lakes, noted for trout. Several specimens of these trout were procured from fishermen.

3. *Trapper's Lake*, in Garfield County, Colo.—This is a noted locality for trout fishing, in the mountains some 40 to 50 miles north of Glenwood. Several fine examples of these trout were procured from anglers.

4. *Eagle River*.—This is a very clear, cold stream, flowing into Grand River from the east. It is very well stocked with trout, large numbers being taken with the fly. At Gypsum, where our collections were made, the river is about 20 feet wide and 2 to 4 feet deep. The bottom is rather smooth, but the water is too cold for seining. At this point, besides trout, are found *Cottus*, *Pantosteus*, and *Agosia*, the *Cottus* being excessively abundant.

5. *Roaring Fork of Grand River*.—The Roaring Fork rises in the mountains, above Aspen, and enters the Grand from the south near Glenwood. It is very clear, but not very cold (temperature 67°). Its lower course is swift, its channel filled with boulders washed from the great moraine through which it breaks its way. It is about 2 rods wide and 2 to 4 feet deep. Seining is impossible. Suckers (*C. latipinnis*) and blob were taken here. The stream is said to be well stocked with trout.

6. *Cañon Creek*.—This is a small stream flowing into the Grand below Glenwood. Some trout from this stream were secured from a fisherman.

7. *Gunnison River*, at Gunnison, Col.—The Gunnison is the chief tributary of the Grand, entering it from the south at Grand Junction. The Gunnison rises on the west slope of the Main Divide. Its upper course is largely quiet, flowing through mountain pastures with willow-covered banks. Below Gunnison it cuts its way through the Black Cañon, one of the deepest in Colorado. Above the cañon the river is very clear and full of trout, but one other species (*Agosia*) going with it. Below the cañon the water is warmer and less clear; trout are scarce and suckers and round-tails become abundant. The river at Gunnison is swift, with gravelly or rocky bottom; some 3 rods wide and 2 to 4 feet deep. In the cañon are many rapids and pools 6 to 20 feet deep.

8. *Tomichi Creek*, near Gunnison.—This is a clear stream about 6 feet wide and 2 to 20 inches deep, flowing in many windings with little current and with grassy banks covered with small bushes. It is not so cold as the river (about 72°); its bottom has a good deal of black muck. White ranunculus and other water-weeds abound and the stream much resembles a New England trout brook.

The Eastern brook trout (*Salvelinus fontinalis*) was successfully introduced into Tomichi Creek about 1883. Both this and the native trout were abundant in the upper course of the stream, but at Gunnison the waters are crowded with *Agosia yarrowi* and have no other fish.

9. *Rio Cimarron*.—This stream flows into the Gunnison in the Black Cañon. In the pastures above Cimarron station (2 miles above its mouth) it is a good trout stream. At Cimarron the stream is clear and swift with a bottom of gravel and small boulders

about 12 feet wide and 1 to 4 feet deep. Temperature 68°. No fishes were obtained with the net.

10. *Gunnison River*, at Delta, Colo.—At Delta, some distance below the Black Cañon, the Gunnison is a large stream 3 to 4 rods wide and 2 to 5 deep, the waters clear and of a summer temperature of about 72°. Its current is swift, and in its broad channel are many islands. The bottom is gravelly or sandy, and in still places occasionally muddy. The fishes here are the "Razor-back" or "Hump-back sucker" (*Xyrauchen cypho*), the "Flannel-mouth sucker" (*Catostomus latipinnis*), the "Blue-head sucker" (*Pantosteus delphinus*), the "Bony-tail" (*Gila elegans*), the "Round-tail" (*Gila robusta*), the "White Salmon" (*Ptychocheilus lucius*), the "Bull-head" (*Cottus bairdi punctulatus*) and the minnow (*Agosia yarrowi*).

11. *Uncompahgre River*.—This stream rises in the wild Uncompahgre Pass, above Ouray. In its upper course, it has few or no fishes, for it flows through wild and deep ravines with many cascades. Besides this, it has iron springs among its feeders, and trout seldom or never live in iron waters. Above Ouray, are some hot springs, and at Ouray stamp-mills render the water impure. Below Ouray are some trout, but probably not many.

Between Ouray and Montrose, the stream leaves the mountains, and from Montrose to its mouth at Delta, it is very sluggish and its waters are largely drawn off by the irrigating ditches. The plain is largely alkaline, and the banks of the stream are lined with greasewood (*Sarcobatus vermiculatus*), the sure indication of an alkaline soil. At Delta the only water left is from the seepage of ditches. This is grayish yellow, and forms a succession of pools with bottom of gravel or mud, some of them 5 or 6 feet deep. Temperature 78°. The water is full of fishes of the species enumerated above as found in the Gunnison. *Gila elegans*, *Agosia*, and *Cottus* were not seen in the Uncompahgre. On the other hand, a single specimen of what seems to be a new species of *Xyrauchen* was taken in the little pond close to the station at Delta.

12. *Green River*, at Blake City (Green River Station), Utah.—At this point the river flows through a barren desert, its course largely bounded by high cliffs. Its waters are yellow, and except on certain rocky shallows deep and sluggish. At low water the river is about 500 feet wide and 3 to 8 feet deep. In August the water was moderately clear, but at the time of the spring floods it becomes a paste of red mud. We seined the stream along the west side from the railroad bridge to the foot of the shallows about one-fourth mile below. *Xyrauchen cypho* is very abundant, reaching a weight of 10 pounds, and is a good food-fish. *Catostomus latipinnis* reaches 3 to 5 pounds. Besides these we obtained *Gila elegans*, a small fish regarded as worthless because full of bones. The trout do not descend Green River much if any below the boundary of Wyoming Territory.

13. *Price River* flows into the Green River from the west. It rises near the summit of the Wahsatch range. It soon becomes gray and muddy and when it strikes the desert at the eastern foot of the mountains its waters are all used for irrigation. Although a long river, its waters are nearly all lost in summer, and it is worthless for fish. It is said that trout occur in some ponds on the eastern slope of the Wahsatch.

14. *San Juan River*.—The San Juan is one of the chief tributaries of the Colorado, having its source in a considerable number of large, clear mountain streams, which head in the mountains of southwestern Colorado (Sierra San Juan, etc.), to the west of

the Main Divide. All these streams are well stocked with trout, their fauna being precisely like that of the Gunnison.

The lower San Juan enters the desert country and receives large numbers of "sand arroyos," dry beds flooded with mud after a rain. The water becomes warm, thick, and yellow, although all the upper sources of the river are clear and cold.

It is thought that the lower San Juan and the Colorado would be well suited for the growth of the larger cat-fishes as *Leptops olivaris*, *Ameiurus nigricans*, and perhaps *Ictalurus punctatus*. It would be well to make a plant of these at Green River Station, and one on the San Juan at Arboles.

15. *Río de las Animas Perdidas*.—The Animas River is the largest tributary of the San Juan. It rises in the mountains above Silverton. Above its cañon of "Lost Souls," it is clear, shallow, and swift, flowing through an open cañon with a bottom of rocks. In its upper course it is said to be without fish, one of its principal tributaries, Mineral Creek, rising in Red Mountain and Uncompahgre Pass, being highly charged with salts of iron.

In the deep and narrow "Cañon de las Animas Perdidas" are many very deep pools, said to be full of trout. Below the cañon is "Hermosa Park," in which, for some 15 miles, the river flows over sandy bottom, with many deep holes and slight current. In these holes are many trout, and with them *Pantosteus delphinus*, *Agosia yarrowi*, and *Cottus bairdi punctulatus*.

At Animas City, above Durango, the stream enters a stony mesa, a glacial moraine, which, by its dam, has formerly made a lake of Hermosa Park. From this point, for miles below, the bottom is so covered with boulders that seining is impossible. At Durango the river is 2 to 3 rods wide and 2 to 4 feet deep; in the deeper holes, 6 to 8. The temperature is about 68°. The stream was seined at various places from Animas City to a point about 5 miles above Durango.

At Durango it is said that the larger suckers (*X. cypho*, *C. latipinnis*) and the "White salmon" (*Ptychocheilus*) ascend the river in the spring, going back to deep water after spawning in the summer.

16. *Leitner's Creek*, at Durango.—This is a little stream entering the Animas opposite Durango. In summer it is 2 to 3 feet wide, shallow, clear, and warm (72°) with sandy bottom. It contains *Cottus bairdi punctulatus* and *Agosia yarrowi*. Higher up its deeper pools are said to contain small trout.

17. *Río Florida*.—This is a clear, cold stream, flowing into the Animas below Durango. It was seined at several points above the bridge about 8 miles east of Durango and north of Florida Station. It flows through a wooded valley over round boulders and with few deep places. Trout are abundant; also *Pantosteus delphinus*, *Agosia yarrowi*, and *Cottus bairdi punctulatus*. The last-named species lurks under every stone in the river.

18. *La Plata River*.—West of the Animas River is the Rio la Plata. It rises in the mountains above Fort Lewis, but the water mostly sinks in the sand and gravel below the fort. There are some trout here, but it is said that the stream contains too much iron to be well adapted for fish. It was not visited by us.

19. *Río de los Pinos* (seen at Ignacio), the next river east of Rio Florida, is a clear, swift stream, with gravelly bottom, 2 rods wide and 1 to 3 feet deep. It runs through a broad valley which may become valuable for agriculture. I am told that Patrick

Brothers have a trout hatchery further up the river at Los Pinos. Like the Animas, this is an excellent trout stream.

20. *Ignacio Lakes*.—Near Los Pinos River are the San Ignacio Lakes, one of 60 acres, one of 40 acres, at 8,000 feet elevation. They are fed by springs and have no outlet. They have no fishes but are said to be "full of dog-fish (*Amblystoma*?) which devour the young trout which have been several times placed in the lakes." We were unable to verify this statement which was made by a citizen of Durango.

21. *Rio de las Piedras*, said to be the best trout stream in the San Juan basin, is similar to Los Pinos, but smaller.

22. *Rio Navajo*, which flows into the San Juan near Juanita, is also similar; a clear stream with gravelly bottom and wooded banks.

23. *Rio San Juan*, which receives the waters of all these, is, when crossed by the railroad at Arboles, about the size of Los Pinos at Ignacio. Its water is warm and not quite clear; the bottom of gravel and stones. About Pagosa Springs, above Arboles, it is a trout stream. Below Arboles it becomes very yellow, and at last it bears a volume of very muddy water into the Colorado.

FISHES OF THE UPPER COLORADO BASIN.

1. *Catostomus latipinnis* (Baird & Girard). *Flannel-mouth Sucker*.

Very common in the Grand River at Glenwood Springs, in the Gunnison and Uncompahgre at Delta, and in Green River. It reaches a length of $1\frac{1}{2}$ to 2 feet and a weight of 3 to 5 pounds. Dorsal rays usually 11, sometimes 12 or even 13. Caudal peduncle slender, and the fins all high; these characters especially marked in old males. Large specimens, in life blackish, olive above, abruptly paler below; sides bright creamy orange, deepest on the tail; snout and cheeks pale orange; belly pure white; lower fins all more or less orange; upper fins dusky olive, tipped with orange; pectoral dusky, orange above, creamy below; axil blackish; lips very thick and large. Female specimens have the same color, the only difference being that the male has the anal and lower lobe of caudal tuberculate. Stomach full of confervæ and other vegetation.

Catostomus discobolus Cope, from Green River in Wyoming, is probably based on the young of *Catostomus latipinnis*. The fishes from Idaho, formerly recorded by me as *Catostomus discobolus*, are probably different.

2. *Xyrauchen cypho* (Lockington). *Razor-back Sucker*; *Hump-back Sucker*. (Plate IV, Fig. 11.)

This remarkable fish is very abundant in the river channels of the Colorado Basin. It reaches a weight of 8 to 10 pounds, and is largely used for food. Specimens were taken by us at Delta, both in the Gunnison and the Uncompahgre, and in Green River.

Specimens of 8 inches have the depth equal to length of head, $3\frac{3}{4}$ in length. Scales 13-72, 73, or 74-13; D., 14. First dorsal ray, $1\frac{1}{2}$ in head; base of the fin, $1\frac{1}{7}$. Least depth of caudal peduncle, 3 in head; $1\frac{1}{2}$ in distance from last anal to first caudal ray. Nuchal crest much elevated, commencing by a prominence close to the nape, and with no scales before it; nuchal crest nearly or quite naked on the median line.

3. *Xyrauchen uncomphgre* Jordan & Evermann, sp. nov. (Plate V, Fig. 12.)

A single young specimen of *Xyrauchen*, about 7 inches long, taken in the Uncompahgre River, close to the railway station at Delta, differs much from the others, and probably represents a distinct species of the same singular genus.

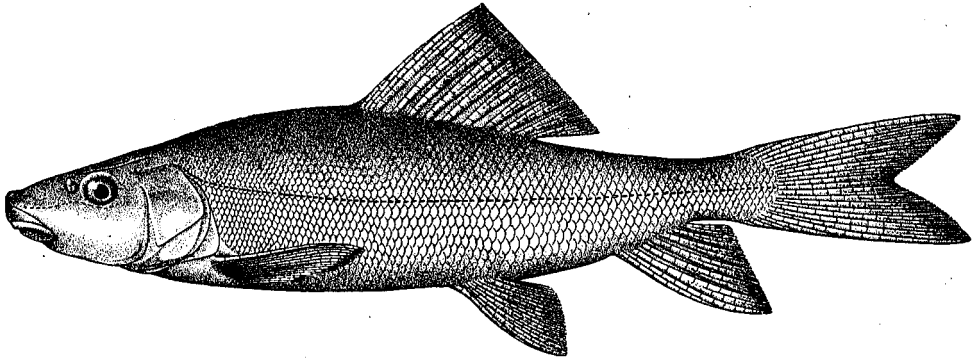


FIG. 12. UNCOMPAHGRE SUCKER (*Xyrauchen uncompahgre*). (See page 26.)

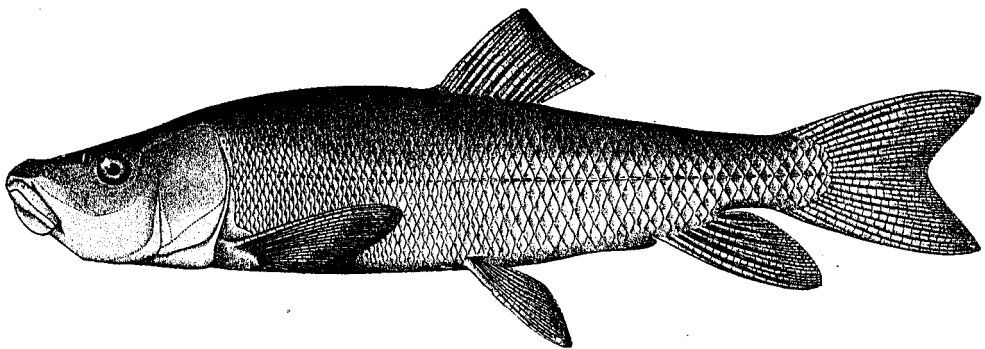


FIG. 13. THE "SUCKER" (*Chasmistes liorus*). (See page 31.)

Head, 4; depth, $4\frac{1}{2}$; D. 12; A. 7. Scales 16-80 to 83-13.

Body more elongate than in *X. cypho* of the same size, the form resembling that of a *Gila*; head flattish above, narrower and less depressed than in *X. cypho*, the snout sharper than in *X. cypho*, projecting considerably beyond the small mouth; lips rather small, but rather larger and more coarsely tuberculate than in *X. cypho*, the upper with three rows of papillæ, the lower deeply incised.

Nuchal hump, formed by the expanded interneurals, much lower than in *X. cypho*, but forming a sharp keel. This does not extend forward to the nape, there being about thirteen scales before it. Surface of nuchal keel scaly.

Eye, $5\frac{1}{2}$ in head; snout, $2\frac{1}{4}$; interorbital space, $2\frac{3}{8}$. Scales smaller than in *X. cypho*, small anteriorly, growing larger backward; breast naked; caudal peduncle slender, much slenderer than in *X. cypho*, its least depth $1\frac{1}{3}$ in its length and $3\frac{2}{3}$ in head. Caudal fin large, deeply forked, a little longer than head. Dorsal lower than in *X. cypho*; the longest ray, $1\frac{1}{2}$ in head; base of fin, $1\frac{1}{4}$. Pectoral, $1\frac{1}{2}$ in head, not reaching ventrals; the latter to vent.

Color bluish above, pale below. Peritoneum black.

Type in the U. S. National Museum.

4. *Pantosteus delphinus* (Cope). *Blue-head Sucker*.

Common, especially near the mountains. Specimens taken in Eagle River, Gunnison River at Delta, Uncompahgre River, Rio de las Animas Perdidas, and Rio Florida. This species reaches a length of about a foot and is well characterized by its small scales and its large lips. Many die in the rivers after spawning.

In life, bluish, olive, or gray; lower fins dull orange; several round dashes of red along the lateral line, forming an interrupted red band. Scales 96 to 105.

5. *Gila robusta* (Baird & Girard.) *Round-tail*.

Generally common at the foot of the mountains; replaced by *Gila elegans* in the river channels. Found in the Uncompahgre, and in the Gunnison at Delta.

The species of *Gila* are very similar to each other and are probably reducible to three, *G. elegans*, *G. robusta*, and *G. seminuda*. The last-mentioned I have not seen.

Our specimens from the Gunnison evidently correspond to *Gila robusta*. *Gila grahami* B. & G. seems to be the same. I can not distinguish *Gila affinis* Abbott from *Gila robusta*. This species has been reported from the Kansas and the Platte, but the types doubtless came from Green River, as no recent collectors have found any species of this type anywhere except in the basin of the Colorado and Gila Rivers. *Gila gracilis* B. & G. is not evidently different from *G. robusta*. *Gila naecea* Cope, from Green River, Wyoming, is evidently the young of *Gila robusta*. Dr. Gilbert has reached independently similar conclusions as to the synonymy of these species.

Gila robusta reaches a length of more than a foot. It is full of small bones and is regarded as worthless for food. The males in life have the lower fins and lower side of the head red, and there is a vertical dash of red on the cheeks. Scales 79 to 82 in the lateral line, those above and below smaller.

6. *Gila elegans* Baird & Girard. *Bony-tail*.

One specimen taken in the Gunnison at Delta; five in the Green River. Apparently not ascending the streams so far as the preceding.

Comparing specimens of similar size, *Gila elegans* has a higher nape and back, more depressed head, slenderer caudal peduncle, larger fins, and smaller scales on

back and below, although the number in the lateral line is about the same as in *G. robusta*. Scales along middle line of back before dorsal obsolete or nearly so; mouth a little larger than in *Gila robusta*. Least depth of caudal peduncle, $1\frac{2}{3}$ in maxillary ($1\frac{1}{4}$ in *G. robusta*). *Gila emoryi* Baird & Girard seems to be the young of *G. elegans*.

7. *Ptychocheilus lucius* Girard. *White Salmon*.

This species is generally common, specimens having been taken by us in the Gunnison River at Delta, in the Uncompahgre and in Green River. It reaches a weight of 80 pounds or more in the large streams, and is justly regarded as a good food-fish.

The young have always a black caudal spot, the fins are slightly reddish, and there is a slight trace of a pale lateral band below a darker one.

The scales are about 87 instead of 104 as shown in Girard's figure. Maxillary $2\frac{3}{5}$ in head.

8. *Agosia yarrowi* Jordan & Evermann, sp. nov., *Minnow*. (*Apocope oscula* Cope and Yarrow; not *Argyreus osculus* Girard).

This species is very abundant in the small streams in the mountain meadows. In the larger streams it is less common, and in the rivers below the mountains it is rare. Our specimens are from Tomichi Creek, Gunnison River at Gunnison and at Delta, Uncompahgre River, Green River, Eagle River at Gypsum, Rio de las Animas Perdidas, Rio Florida, and Leitner's Creek.

Description from specimens from Tomichi Creek. Head $4\frac{1}{8}$ in length; depth 5 to $5\frac{1}{2}$; D. 7; A. 7; scales 74, 80, 77, 80, 83, 80, 83, 79, 75, 76, 74, 74, 80, 82, in 14 specimens, the average being about 16-80-13. Length from 2 to 5 inches.

Body little compressed, elongate; head long and rather heavy, bluntish; snout short, obtuse, $2\frac{3}{8}$ to $2\frac{3}{4}$ in head; eye small, $5\frac{1}{2}$ to 6; barbel small but distinct. Upper lip, in about half the specimens, separated from the skin of the snout by a fold, as usual in *Agosia* and most other *Cyprinidae*. In the rest of the typical examples the upper lip is joined mesially to the snout by a distinct frenum. These specimens, although to all appearance specifically identical with the others, would belong to the genus *Rhinichthys*, as now defined. The frenum is, however, considerably narrower than in *Rhinichthys*, and this fact may for the present serve to separate the species from that genus. Lips full; maxillary about $3\frac{1}{2}$ in head; scales small; lateral line complete; dorsal fin well backward, its insertion about midway between base of caudal and eye. Pectoral $1\frac{1}{3}$ in head, usually not quite reaching to ventrals, the latter reaching past vent. Caudal large. Color dark olive, more or less mottled above with black; sides with two ill-defined dark lateral bands, the interspace paler. Axils of fins mostly crimson in life as in related species. This species seems to differ from *A. nubila* and *A. adobe* in its smaller scales, these species having less than 70. Its scales are larger than in *Agosia oscula*.

In the type of *Argyreus osculus*, from Rio Babocomori, in Arizona, there are 90 scales. In the types of *Apocope ventricosa* Cope, from "Arizona and New Mexico," there are 89. We have therefore been compelled to regard our specimen as different from the original *Argyreus osculus* = *ventricosa*.

We have named this species for our friend, Dr. Henry O. Yarrow, in recognition of his work on the fishes of the Rio Colorado.

9. *Salmo mykiss* Walbaum (var. *pleuriticus* Cope).

Trapper's Lake, Eagle River, Cañon Creek, Sweetwater Lakes, Gunnison River, Rio Florida.

Trout are very abundant in all the headwaters of the Colorado and its tributaries wherever the waters are clear and cold. These trout have for the most part the dark spots large and chiefly confined to the posterior part of the body. One specimen from Trapper's Lake is coarsely and closely spotted from head to tail. Others from Eagle River at Gypsum are finely spotted on tail only, repeating the coloration of var. *macdonaldi*, from which they differ mainly in the shorter opercle and the less elongate body.

As a whole, the trout from the Colorado approach most nearly to those from the Rio Grande, but in the specimens counted by me the scales are a little longer in the Rio Grande fish.

Coloration in life of trout from Trapper's Lake, olivaceous; lower fins red, sides with a crimson-red band on level of pectoral, present in every one of eleven specimens. Flesh mostly salmon red. Black spots large, varying much in number, in some much more numerous on the tail; others are closely spotted even to tip of snout. Some with the head spotted, others not. Spots extending low on the sides, usually some on the anal; dorsal and caudal profusely spotted in all.

The trout from Cañon Creek seem to be the young of these; smaller, paler, the spots more confined to the tail. Red markings rather orange than crimson. All show traces of a red lateral band and have the lower fins red. All have much red under the throat and on branchiostegals and opercle. Some of them show round orange blotches on lateral line anteriorly.

Trout from Sweetwater Lake are like those from Trapper's Lake, but with the spots encroaching more on the belly.

Trout from Eagle River show more resemblance to the yellow-fin of Twin Lakes in the small size of the spots and the plain coloration. Their place seems, however, to be in var. *pleuriticus* with the others from the Colorado Basin.

10. *Cottus bairdi punctulatus* (Gill). Bullhead.

Our specimens correspond with *Uranidea punctulata* Gill, from the head of Green River, except that the dark spots on the body are very irregularly developed and often wanting. They differ from most Eastern examples in the form of the head, which is blunter, lower, and more rounded, and without a distinct medial depression. The black bars usually found in Eastern examples is wanting in these, and in these there are no prickles on the skin behind the axil, nor anywhere else. The specimens found in the headwaters of the Missouri in Yellowstone Park seem to be fully identical with ours from the basin of the Colorado.

Cottus punctulatus may prove to be a species distinct from *C. bairdi* (= *C. richardsoni*, etc.), but some specimens examined by us (Toch Lake, Michigan) seem to be intermediate. Var. *punctulatus* is thus far known from the Upper Missouri and the Upper Colorado. Specimens were obtained by us in Eagle River, Roaring Fork, Gunnison River, at Delta, Rio Florida, Leitner's Creek and Rio de las Animas Perdidas. In the Eagle and Florida it is excessively abundant, as in the streams of the Yellowstone Park.

U T A H.

To the east of the Wahsatch Mountains, Utah is chiefly an arid desert, with little rain-fall, scarcely any vegetation, and no permanent streams of any importance except the Colorado itself. The whole surface is made up of adobe hills and barren mesas,

deeply scored by the erosion of the brief rainy season. Except in the Colorado and in a few brooks and ponds near the crest of the Wahsatch, there are no fishes in eastern Utah. West of the divide of the Wahsatch lies the Great Basin. This is a high, arid plain, largely alkaline, and crossed by numerous short but abrupt mountain chains.

E.—SALT LAKE BASIN.

The lowest part of this basin is occupied by the Great Salt Lake, while other depressions are occupied by other lakes or alkaline sinks, also without outlet. The largest of these in Utah is Sevier Lake. Into these lakes and sinks flow the waters of multitudes of clear streams and springs having their source in the mountains. Most of these streams are well stocked with trout and whitefish in their upper courses. The water farther down is now nearly all consumed by the irrigating ditches of the Mormon settlers, and in Utah, as in Colorado, millions of young trout are each year destroyed by venturing out into these ditches, whence they are scattered over the fields and left to perish. All the valleys of western Utah were formerly covered by the waters of a great post-glacial lake known to geologists as Lake Bonneville. The evidences of the former existence of this lake are everywhere visible in the form of terraces on the sides of the mountains at a considerable height above the present levels of Utah Lake and the Great Salt Lake. Lake Bonneville had probably its outlet to the north through the Snake River. The former connection of the now isolated lakes in the Great Basin must explain the close similarity in the fish fauna, but we can not tell how close this resemblance is until the fishes of the Great Basin of Nevada, the bed of the former Lake Lahontan, are thoroughly investigated. Collections were made by us at different points in the Salt Lake Basin and in the basin of the Sevier River at Juab.

1. *Utah Lake*.—Utah Lake is about 25 miles long by 10 broad, of irregular form, and surrounded by high mountains. It is shallow near the shore but deep in the middle and in its channels. The surface water is in summer quite warm, while on the bottoms it is very cold. The lake is extremely low in summer, there being but little water running in the outlet. The water is then of a milky blue color and decidedly alkaline. Our collections were made with a long seine, kindly furnished to us by Peter Madsen and his sons, of Provo. This seine was used in a deep channel in the southwestern part of the lake below the mouth of the Spanish Fork. Fishes taken in the lake are marked U in the following list.

2. *Provo River*.—The Provo River is a considerable stream, the largest rising in the Wahsatch range. In the upper course it contains no fishes except trout. Where it leaves the cañon at the foot of the Wahsatch it is very clear and icy cold (temperature about 53°). It flows over a bottom of rounded shingle and small boulders. In and immediately below the cañon it contains only trout and some whitefish. The bottom has no vegetation. Lower down towards the town of Provo the water becomes gradually warmer; the bottom is covered with plants and the banks lined with bushes. The bottom is here of fine gravel and the temperature about 63°. The species taken at this point above the city are marked P in the list. Still lower down the water is all drawn off for irrigation, and only the seepage fills the river bed. Near the mouth of the river, near Madsen's farm, the bottom is of fine gravel, sand, and mud; the water is sluggish and warm (temperature about 78°). The fishes found here are marked M. In Mr. Madsen's carp pond, a muddy pond formed from artesian water, we found *Leuciscus atrarius* and *Hemitremia phlegethontis* very abundant. They had come in

through the overflow of the pond and the chub has proved very mischievous, devouring the eggs and fry of the carp and checking all increase.

3. *Jordan River*.—Jordan River is the outlet of Utah Lake. It is a clear or slightly milky stream, rather warm in summer with moderate current and a bottom of sand and adobe. Chubs, suckers, and sometimes whitefish are everywhere plenty. Trout were common before they were excluded by the dams of the irrigating ditches. These now consume all the water of Jordan River in summer, the river bed being filled up by seepage and by the overflow from the numerous artesian wells. Jordan River was seined at a point just below a dam 4 miles southwest of Salt Lake City. The stream is here about 2 rods wide and 2 to 5 feet deep, the bottom being of adobe; temperature about 63°. Species found in Jordan River are marked J.

4. *Great Salt Lake*.—The waters of the lake are intensely salt and no fishes ever enter them. The only living thing in the water is a small brine shrimp.

FISHES OF THE SALT LAKE BASIN.

1. *Catostomus ardens* Jordan & Gilbert. U., J. "Red Horse Sucker;" "Mullet."

This species is the common sucker of Utah Lake, existing in millions and far outnumbering all the other species combined. The young are very abundant in Jordan River. This species reaches a weight of about 2 pounds. It is very close to *Catostomus teres*, almost the only tangible differences being in the rather smaller scales, the usually longer mandible, 3 to 3½ in head in the adult in *C. ardens*, 3½ to 3¾ in *C. teres*, and in the broader upper lip.

Upper lip rather small, with four or five rows of coarse papillæ. Snout forming a moderate "nose;" mandible little oblique or nearly horizontal; scales 63 to 71. Dorsal rays 12 or 13, the fin longer, lower, and less straight on the free edge than in *C. fecundus*. Base of dorsal in adult, 1½ to 1¾ in head; longest ray, 1½ to 1 in base of fin; head, 4 in length; eye, small; snout, 2½ in head, pectoral and caudal rather short.

Color of specimens in the lake darker than that of *C. fecundus*, the lower fins dusky. Spawns in March.

2. *Catostomus fecundus* Cope and Yarrow. Webug.

The "Webug" sucker is found only in the lake. It is much less abundant than the preceding, and reaches a smaller size, rarely weighing more than a pound.

It has a small mouth at the end of a long, projecting snout, which forms a distinct nose; mandible very oblique, almost as in *Chasmistes*, its length 2¾ to 2½ in head. Snout 2½.

Lips wide but smoothish, the upper with about four rows of large papillæ. Scales 64; D. 11 or 12. Dorsal fin shorter and usually higher than in *C. ardens*, its base in the adult 1½ in head, its longest ray usually a little shorter than the base of the fin. Lower fins long. Color rather pale.

3. *Chasmistes liorus* (Jordan). The "Sucker." U. (Plate V, Fig. 13.)

Abundant in Utah Lake, reaching a weight of 3 pounds. It spawns in June.

Mouth very large, oblique, with full lips, which are non-papillose. A distinct nose; mandible 2¾ in head. D. 13. Scales, 66. Fins large. Dorsal low, its free margin a little concave. Longest ray ⅝ base of fin, which is 1½ in head.

4. *Pantosteus generosus* (Girard). Mountain Sucker. P., J.

Very common in the upper Provo and in the Jordan. Not exceeding 8 inches in

length; the specimens all slender, with short small head, corresponding to *P. platyrhynchus* of Cope.

5. *Rhinichthys dulcis luteus* (Garman). P., J.

Abundant in the Jordan and Provo with the preceding. It is possible that some of the species of *Apocope* of Cope were based on this, which is certainly the commonest species of this type about Provo. Some of the specimens recorded by me as *Apocope vulnerata* (Proc. U. S. Nat. Mus., 1880, 462) belong to it, as I find on re-examination. The Utah fish is almost or quite identical with the ordinary *dulcis*, but the number of scales below the lateral line seems on an average to be slightly greater (usually about 14 above ventrals, while *dulcis* has 11 or 12).

6. *Agosia nubila* (Girard). P.

Rather scarce, and seen only at Provo. These specimens seem to agree fully with those taken in Heart Lake, in the Yellowstone Park. Body robust; head blunt and short; the snout 3 in head, little projecting beyond the mouth. Head $4\frac{1}{5}$ in length; depth, 5. Eye $4\frac{2}{3}$ in head; pectoral rather short, not reaching ventrals. Scales, 72; 65 in two specimens. This species seems to correspond to *Apocope carringtoni*, *vulnerata* and *rhinichthyoides* of Cope, and the *Apocope henshavi* and *couesi* are not evidently different. The species of this genus are distinguished with great difficulty. The following analysis gives the chief characters which I am able to find. This arrangement is provisional only, and further study may reduce the number of recognizable forms.

- a. Scales very small, about 90; snout obtuse, little projecting. Gila River and Lower Colorado Basin.
 (*notabilis* = *ventricosa*) *Oscula*.
- aa. Scales small, about 80; snout blunt and heavy, $2\frac{2}{3}$ to $3\frac{1}{2}$ in head; upper lip often joined to the snout by a narrow mesial frenum; eye small. Upper Colorado Basin. (? *oscula* Cope & Yarrow, not Girard)..... *Yarrowi*.
- aaa. Scales moderate, 60 to 70.
- b. Head short, blunt, and heavy, 4 to $4\frac{1}{2}$ in length; snout short, high, obtuse, $3\frac{1}{2}$ to $3\frac{3}{4}$ in head, its tip scarcely projecting beyond mouth; eye large, about $4\frac{2}{3}$ in head, more than half snout; lateral line broken in the young. Great Basin and Upper Columbia River. (*Carringtoni* = *vulnerata* = *rhinichthyoides* = ? *henshavi* = ? *couesi*) *Nubila*.
- bb. Head long, $3\frac{2}{3}$ to $3\frac{5}{6}$ in length, with long, rather low, broad snout, pointed in profile, $2\frac{2}{3}$ to $2\frac{3}{4}$ in head; eye small, 5 to 6 in head; little more than half snout, lateral line complete. Sevier River..... *Adobe*.

7. *Leuciscus montanus* (Cope). Silver-side Minnow. P., J.

(*Clinostomus montanus* and *C. tania* Cope; ?*Phoxinus clevelandi* Eigenmann & Eigenmann.)

This is the most abundant fish in the Provo River above the city of Provo. It reaches a length of about 4 inches, and is useful as food for the trout. In form, color, size, and habits, this fish bears a strong analogy to *Notropis coccoyensis* of the Alleghany region. I can not separate *L. tania* from *L. montanus*. The anal rays vary from 10 to 13, the usual number being 10 or 11. Dr. Gilbert has examined the types of both species and finds no difference. *Phoxinus clevelandi* Eigenmann & Eigenmann (West. Amer. Scient., Nov., 1889, 149), from Napa Springs, California, agrees perfectly with *L. montanus*, but the locality is remote. In life, *L. montanus* is greenish blue below the eye; a red band below lateral line, ceasing at front of anal. Dark lateral band almost blue.

8. *Leuciscus copei* Jordan & Gilbert. Leather-side Minnow. P. (*Squalius alicia* Jouy.)

Abundant in the Upper Provo. There is no difference between *Squalius copei* from Bear River, a tributary of the Great Salt Lake and *S. alicia* described soon after from

Provo River. To this species belongs *Gila egregia* of Cope from Beaver River, but the specimens called *Gila egregia* from the Rio Grande, by Cope & Yarrow, must be some other fish. The type of *Tigoma egregia* Girard has 66 scales. *L. copei* has the scales about 80. It is not unlikely that this species is the original of *Tigoma gracilis* Girard. The types of *Tigoma gracilis* are, however, lost, and the description is too vague to permit identification. The name *gracilis* is also preoccupied in *Leuciscus*. The axils in the males are deep scarlet in *Leuciscus copei*.

9. *Leuciscus atrarius* (Girard). Chub. M. U., J. (*Siboma atraria* Girard; *Tigoma obesa* Girard; *Tigoma squamata* Gill; *Squalius rhomaleus* Jordan and Gilbert; *Squalius cruoreus* Jordan and Gilbert; ? *Hybopsis bivittatus* Cope; ? *Hybopsis timpanogensis* Cope.)

Excessively common in all waters of the Great Basin except the coldest. It reaches a length of more than a foot, and is very destructive to the young trout, which it captures as they descend the rivers. Reaching a larger size than most of the other chubs, it becomes a food fish of some importance. As the fish grows older, the head becomes proportionately more depressed, and the back more prominent. Such large specimens have become the type of *Squalius rhomaleus*. These large chubs swarm in Utah Lake, and may be taken in the seine, with trout and suckers. Young specimens of the same species were named *Squalius cruoreus*. I have re examined the types of the latter species and find them to be the young of *L. atrarius*. The two species described as *Hybopsis bivittatus* and *H. timpanogensis* Cope are doubtless young chubs, and probably also of this species.

Dr. Gilbert has compared the types of *Tigoma obesa* with those of *Squalius cruoreus* and finds the two identical. The types of *obesus* are bloated by poor alcohol. The name *obesus* is preoccupied by *Leuciscus obesus* Storer.

The species of *Leuciscus* taken by us during the present summer may be thus compared:

- a. Scales very small; lateral line 80; body rather elongate, the depth about 4 in length; anal small, with 8 rays; olivaceous, dark-punctate, sides more or less silvery..... *Copei*.
- aa. Scales moderate, 52 to 67.
 - b. Anal fin rather small, its rays about 8.
 - c. Scales rather small, 60 to 67; head rather pointed, the mouth moderate; depth about 4½ in length..... *Pulcher*.
 - cc. Scales larger, 52 to 58.
 - d. Scales before dorsal 23 to 28; back becoming elevated with age; dorsal over or rather behind ventrals..... *Atrarius*.*
 - bb. Anal fin large, its rays 10 to 13; scales 55 to 58; body more or less compressed.
 - e. Anal rays usually 10 or 11; snout rather blunt; jaws equal; eye large, about 3 to 3½ in head; depth about 4; sides with a dusky lateral band; sides and belly crimson in the male..... *Montanus*.
 - ec. Anal rays usually 12 or 13; its base 6½ in body; snout rather sharp; the lower jaw projecting; eye moderate, 4 to 6 in head in adult; depth 3¼ to 4 in length; sides with a plumbeous lateral band, with red above and below it in the males.

Hydrophlox.

* It is not unlikely that *Protoporus dominus* Cope is based on an immature example of this species. The type is from the Snake River at Fort Hall, Idaho. It was 2 inches long, and had the lateral line incomplete.

10. *Hemitremia phlegethontis* (Cope). M.

Extremely common in the pools of water about the mouth of Provo River and in the carp-ponds. It reaches a very small size, none being seen more than $1\frac{1}{2}$ inches in length.

Head, $3\frac{3}{4}$; depth, $3\frac{1}{4}$. Scales, 36; 17 before dorsal, 11 between dorsal and ventrals. Lateral line obsolete, not a pore being developed. Body short, deep, compressed; head short, compressed, with blunt snout. Mouth short, oblique, the lower jaw projecting; maxillary reaching to front of eye; pectorals about reaching ventrals, the latter to past front of anal.

Color, dark olive; a dark vertebral streak; a dusky streak along side and a very faint caudal spot; scales covered with dark dots. Males in life with fins and sides yellow; axil red; sides of belly dashed with red.

Three of the American species referred to the genus *Phoxinus*, *vittatus* (*flammeus* Jordan & Gilbert), *phlegethontis* and *milnerianus*, differ notably from the European *Phoxinus phoxinus* (L.) in the size of their scales. These are 36 to 45 in these species, while in *Ph. neogaeus* the scales are about 80, and *Ph. phoxinus* still smaller.

For these large-scaled species, we may retain the name of *Hemitremia*, originally proposed for *Hemitremia vittata*, by Professor Cope. The name *Hemitremia* was wrongly associated with *Notropis heterodon* and its allies, before the relations of the typical species were understood.

11. *Salmo mykiss* Walbaum, var. *virginalis* Girard. Trout. P., V. (*Salmo virginalis* Girard; *Salmo utah* Suckley.)

Very abundant in Utah Lake; spawning in the shallow parts of the lake and in the tributary streams which it ascends to the headwaters. The Utah lake trout have the coloration of the Oregon trout, var. *clarki*, but the dark spots are usually somewhat smaller. The only differential character lies in the greater size of the scales, the number of these in a horizontal series being usually about 150.

The large trout of the lakes are deep green in color, the sides silvery, and the dark spots small and faint. Lower fins red. Upper fins yellowish. The usual red dash under the throat is never absent in this species. An excellent account of the habits and economic value of the Utah Lake Trout has been given by Dr. Henry C. Yarrow, (Rept. Lieut. Wheeler, Expl. W. 100th Meridian, V, Zool., pages 685, 693).

No better trout for the table exist than those of the Utah Lake variety. They reach a weight of 3 to 10 pounds. In a single haul of the large seine made in a channel on the south side of the lake, fifty trout ranging from 2 to $3\frac{1}{2}$ pounds were taken. With these were taken six June suckers (*Chasmistes liorus*) weighing about 3 pounds each, two hundred "Mullet" (*Catostomus ardens*) weighing about 2 pounds each, one webug (*Catostomus fecundus*) weighing 1 pound, and about two hundred chubs (*Leuciscus atrarius*), the largest weighing $1\frac{1}{4}$ pounds. This list gives a fair index to the relative abundance of the larger fishes of the lake. The "Sucker," and "Webug" are, however, at times proportionately more abundant.

12. *Coregonus williamsoni* Girard. P., J. Mountain Herring (*White fish*.)

This pretty little fish is common in the Provo River above the city, where it may be readily taken with the hook. It is also occasionally taken in the Jordan. One specimen was procured by us with the seine in the Jordan and several in the colder Provo. It is not a lake fish, being chiefly found in the running waters. Our specimens agree

fully with others from Walla Walla, and differ from those taken in the headwaters of Madison River in the deeper body, longer head, larger scales, and higher fins.

The following gives the measurement of a number of specimens:

Locality.	Head.	Depth.	Scales.	D. longest ray in head.	P. in head.	V. in head.
Jordan River	4 $\frac{1}{2}$	4 $\frac{1}{2}$	77	1 $\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$
Provo River	4 $\frac{1}{2}$	4 $\frac{1}{2}$	76	1 $\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$
Madison River	4 $\frac{1}{2}$	5	82-85	1 $\frac{3}{4}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$

13. *Cottus bairdi punctulatus* Gill. P. (*Uranidea wheeleri* Cope.)

A few specimens, dark in color and much mottled; axil a little rough, otherwise like specimens from the Colorado basin and from Gibbon River.

14. *Cottus semiscaber* (Cope).

Not rare in the Provo; distinguished from the preceding by its prickly skin; also paler in color, with much black mottling. D. VII, 16. This species is well described by Jordan & Gilbert, Synopsis, p. 695.

FISHES OF THE SEVIER RIVER.

The Sevier River rises in Panquitch Lake, in southern Utah. This lake is in the mountains and is noted for its trout and whitefish. The river, after leaving the mountains, flows northward through a desert country. Its largely alkaline waters are drawn off for irrigation and are reduced by evaporation. It is ultimately lost in a large alkaline pool or sink known as Sevier Lake. In this lake are no fishes.

The Sevier River was seined about the railroad bridge, some 7 miles west of the village of Juab. The river has here a bottom of gravel and firm sand or adobe. It is about 2 rods wide and 1 to 4 feet deep. The water is somewhat muddy, warm (73°), and full of small fishes. It is said that trout (*Salmo mykiss virginalis*) and whitefish (*Coregonus williamsoni*) descend the river in the spring as far as Juab.

In this and similar streams through the Great Basin catfishes might be placed to advantage.

Chicken Lake is a shallow alkaline pond, about a mile long by half a mile broad, between Juab and the Sevier River. It is muddy and full of bulrushes where shallow, and of *Conferva* and *Myriophyllum* where deep. It is fed by springs. Its outlet is a small brook which flows into the Sevier at the railroad bridge. The waters of Chicken Lake are alive with chubs (*Leuciscus atrarius*) and there are some suckers (*Catostomus*).

1. *Pantosteus generosus* (Girard).

Very abundant.

2. *Catostomus ardens* (Jordan and Gilbert).

Abundant, as in Jordan River.

3. *Leuciscus montanus* (Cope).

Common; very pale, as all fishes are in alkaline waters; no red and no black lateral stripes.

4. *Leuciscus atrarius* (Girard).

Exceedingly abundant; none seen large.

5. *Leuciscus copei* (Jordan & Gilbert).

Common; axil in male deep scarlet.

6. *Agosia adobe* Jordan and Evermann, sp. nov.

Very abundant in the Sevier River.

The *Agosia* of the Sevier River seems to be certainly distinct from *Agosia nubila* and from all the other species known to me. I am utterly unable to identify it with any of the species described by Cope, nor can I see how most of these species differ from each other or from *A. nubila*. We therefore propose a new name for the Sevier species in allusion to the color of the fish and the bottoms it frequents.

Head $3\frac{3}{8}$ to $3\frac{5}{8}$ in length; depth $4\frac{1}{2}$ to 5. D. 8; A. 7. Scales 12-63 to 70-10. Length of types 2 to 4 inches.

Body rather slender and elongate, formed as in *Rhinichthys*. Head long and low, sharp in profile, the anterior profile forming an even and gentle curve from tip of snout to front of dorsal. Snout sharp, long, more than $\frac{1}{3}$ of head, $2\frac{3}{8}$ to $2\frac{5}{8}$, usually $2\frac{3}{8}$, its tip projecting considerably beyond the thick upper lip. Mouth rather larger than in *A. nubila*, the maxillary extending to behind nostril; barbel well developed. Eye small, about two in snout, 5 to $5\frac{1}{2}$ in head. Lateral line complete. Dorsal inserted midway between front of eye and base of caudal. Pectoral usually shortish and not reaching ventrals, but sometimes passing them. Fins rather high. Caudal well forked, the lower lobe slightly longest.

Color grayish-olivaceous above with a dark lateral band, fins and belly pale; back with some dark dots.

7. *Cottus bairdi punctulatus* (Gill). (*Uranidea wheeleri* Cope.)

Abundant in Sevier River. Color clay-gray, everywhere finely reticulate with olive, the pattern on head very fine. Skin perfectly smooth. These specimens agree fully with others from Gibbon River, except in the shade of the ground color, which in the Sevier corresponds to the bottom of adobe.

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INDEX.

	Page.		Page.
<i>Acomus generosus</i>	20	Cañon City, pond at	10
<i>lactarius</i>	7	Creek.....	23, 28, 29
<i>Agosia</i>	22, 23, 24, 28, 36	of Lost Souls.....	25
<i>adobe</i>	25, 36	<i>Catostomus</i>	35
<i>nubila</i>	28, 32, 36	<i>alticolus</i>	11
<i>oscula</i>	28	<i>ardens</i>	31, 34, 35
<i>yarrowi</i>	5, 23, 24, 25, 28	<i>catostomus</i>	7
<i>Alamosa</i>	19	<i>discobolus</i>	26
<i>Alburnus</i>	21, 22	<i>fecundus</i>	31, 34
<i>Amblystoma</i>	26	<i>griseus</i>	5, 7
<i>Ameiurus melas</i>	16, 17	<i>guzmaniensis</i>	19, 20
<i>nebulosus</i>	6	<i>latipinnis</i>	5, 23, 24, 25, 26
<i>nigricans</i>	25	<i>plebeius</i>	20
<i>Animas City, Colo.</i>	25	<i>retropinnis</i>	7
River.....	25	<i>sucklii</i>	11
<i>Apocope</i>	32	<i>teres</i>	5, 7, 9, 11, 16, 31
<i>carringtoni</i>	32	Chama, N. Mex.....	19
<i>henshavi</i>	32	Chasmistes	31
<i>oscula</i>	28	<i>liorus</i>	31, 34
<i>ventricosa</i>	28	Cheonda.....	21, 22
<i>vulnerata</i>	32	Chicken Lake	35
<i>Arboles, Colo.</i>	25, 26	Chihuahua, lakes of.....	20
<i>Argyreus osculus</i>	28	Cimarron River	23
<i>osculus ventricosa</i>	28	Station.....	23
Arizona.....	22, 28	<i>Clinostomus</i>	21, 22
Arkansas River	9, 10, 13, 15, 17, 22	<i>montanus</i>	32
Basin.....	9, 17	<i>pandora</i>	20
fishes of	11	<i>tænia</i>	32
Aspen, Colo.....	28	<i>Cliola vigilax</i>	17
Bear Creek.....	7	Colorado River	22, 24, 25, 26, 27, 29, 30
River	32	Basin.....	14, 22, 26, 29
Beaver River.....	32	streams.....	3
Black Cañon	23, 24	Columbia River	32
Blake City, Utah.....	24	Conejos	19
Bonneville Lake.....	30	Confervæ	35
Boulder, Colo.....	7	<i>Coregonus williamsoni</i>	34, 35
Brown, J. F.....	1	Costilla.....	19
<i>Campostoma aikeni</i>	16	Cottus.....	11, 23, 24
<i>anomalum</i>	16, 17	<i>bairdi</i>	29
Cañon City, Colo.....	10	<i>punctulatus</i>	5, 24, 25, 29, 35, 36

	Page.		Page.
<i>Cottus punctulatus</i>	29	Grape Creek	10, 16
<i>richardsoni</i>	29	Great Basin	14, 30, 32, 33, 35
<i>semiscaber</i>	35	Salt Lake.....	30, 31, 32
<i>Couesius</i>	17	Green-back trout, description of	12
Crestone.....	19	Green River	22, 24, 26, 27, 28, 29
Culevra.....	19	Station.....	25
Cyprinidæ.....	28	Gunnison, Colo.....	23, 25, 27
<i>Cyprinus alburnus</i>	21	River	23, 24, 26, 27, 28, 29
<i>dobula</i>	21	Guzman Lake.....	20
<i>leuciscus</i>	21	Gypsum, Colo.....	23, 28, 29
<i>phoxinus</i>	21	Hartsel's Hot Springs, Colo.....	7
<i>rutilus</i>	21	Heart Lake.....	32
Davis, Bradley M.....	1	Hemitremia	34
Davis, Sherman.....	10	<i>phlegethontis</i>	30, 34
Delta, Colo.....	24, 26, 27, 28	<i>vittata</i>	34
Denver, Colo.....	7	Henry Lake	15
<i>Dorosoma cepedianum</i>	18	Hermosa Park	25
Eagle County, Colo.....	23	Hot Springs.....	23
River	14, 23, 27, 28, 29	<i>Hybognathus nuchalis</i>	8, 17
<i>Etheostoma caprodes</i>	18	<i>Hybopsis æstivalis</i>	17
<i>cragini</i>	17	<i>bivittatus</i>	33
<i>lepidum</i>	18	<i>storerianus</i>	18
<i>nigrum</i>	8	<i>tetranemus</i>	17, 18
Evergreen Lakes, Colo.....	9	<i>timpanogensis</i>	33
Evermann, Barton W.....	1	Ichthyologia Ohiensis, cited.....	21
Fesler, Bert.....	1	<i>Ictalurus punctatus</i>	6, 17, 25
Fisher, George R.....	1, 9, 12	<i>Ictiobus bubalus</i>	17
Fishes of Colorado.....	5	<i>difformis</i>	17
Florida Station.....	25	Ignacio	25, 26
Fort Hall, Idaho.....	33	Lakes.....	26
Lewis, Colo.....	25	Itinerary of summer's work.....	2
Fountain Creek.....	10	Jordan River	31, 32, 34
<i>Fundulus zebrinus</i>	17	Juanita.....	26
<i>Gammarus</i>	9	Kansas River	27
Garfield County, Colo.....	23	<i>Labidesthes sicculus</i>	18
Garman, Harrison.....	18	Lahoutan Lake.....	30
Gay, John.....	1	Lake Creek.....	9
Gibbon River.....	36	Fork.....	9
Gila.....	27	Land, Gordon.....	1
<i>affinis</i>	27	Laws, John.....	13
<i>egregia</i>	32, 33	Leadville, Colo.....	9
<i>elegans</i>	22, 24, 27, 28	Leitner's Creek.....	25, 28, 29
<i>emoryi</i>	28	<i>Lepomis cyanellus</i>	17, 18
<i>gracilis</i>	27	<i>humilis</i>	18
<i>grahami</i>	27	<i>megalotis</i>	18
<i>nacrea</i>	27	<i>Leptops olivaris</i>	6, 25
<i>pulebella</i>	20	<i>Leuciscinae</i>	21
River	27, 32	<i>Leuciscus</i>	21, 22, 33
<i>robusta</i>	6, 22, 24, 27, 28	<i>atrarius</i>	30, 33, 34, 35
<i>seminuda</i>	27	<i>cephalus</i>	21
Gilbert, C. H.....	16, 18, 27	<i>cheonda</i>	33
Glenwood Springs, Colo.....	22	<i>copei</i>	32, 33, 36
Grand Junction, Colo.....	23	<i>leuciscus</i>	21
River.....	22, 23	<i>meda</i>	22
Granite, Colo.....	9	<i>montanus</i>	32, 35

	Page.		Page.
Leuciscus, note on	25	Pantosteus plebeius.....	5, 19
obesus.....	33	Patrick Brothers	25
puleher.....	6, 20	Phenacobius mirabilis.....	18
rutilus.....	21	Photogenis piptolepis.....	8
tænia.....	32	Phoxinus.....	21, 22
Long Lake, Ill.....	18	clevelandi.....	32
Los Pinos River.....	26	neogæus.....	34
Lower Colorado Basin.....	32	phoxinus.....	34
River.....	22	Pimephales.....	21
Luxilus.....	21	notatus.....	17
McDonald, Marshall.....	1, 11	promelas confertus.....	16, 17
McIntyre's Ranch.....	19	Pinos.....	19
Madenha.....	19	Plargyrus.....	21
Madison River.....	35	Platte River.....	15, 22, 27
Madsen, Peter.....	1, 30	Basin.....	6
Main Divide.....	23, 25	fishes of.....	7
Middle Boulder Creek.....	7	Platygobio.....	17
Mineral Creek.....	25	gracilis.....	17
Minnilus.....	21	pallidus.....	17
Minomus jarrovii.....	19, 20	physignathus.....	17
platyrhynchus.....	20	Price River.....	24
Missouri River.....	29	Protoporus.....	21, 22
Morrison, Colo.....	7	domninus.....	33
Moxostoma duquesnei.....	17	Provo River.....	30, 31, 32, 34
trisignatum.....	11	Utah.....	20, 32, 35
Myloleucus.....	22	Ptychocheilus.....	22, 25
Myriophyllum.....	35	lucius.....	6, 24, 28
Nevada, Great Basin of.....	30	Pueblo, Colo.....	10, 16
North Platte River.....	6	Rathbun, Richard.....	1
Notemigonus.....	20	Red Mountain.....	25
Notropis bubalinus.....	18	Rhinichthys.....	28, 36
camurus.....	18	cataractæ.....	8
cayuga.....	17, 18	dulcis.....	5, 8, 9, 10, 11, 16, 22
chlorus.....	16	luteus.....	32
coccogenis.....	32	luteus.....	8
deliciosus.....	16	maxilloso.....	8, 22
lineolatus.....	16	ocella.....	8
fretensis.....	18	transmontanus.....	8, 22
gilberti.....	8	Riddle Lake.....	15
heterodon.....	17, 18, 34	Rio Babocomori.....	28
lutrensis.....	8, 16, 18	Rio Chama.....	19
megalops.....	8	Cimarron.....	23
phenacobius.....	16	Colorado.....	28
scylla.....	8, 16, 17	Comal, Tex.....	16, 18
stramineus.....	16	de las Animas Perdidas.....	25, 27, 28, 29
topeka.....	18	de las Piedras.....	25, 26
umbratilis.....	18	Florida.....	25, 27, 28, 29
Oscula.....	32	Grande River.....	14, 19, 22, 29, 33
Ouray.....	24	Basin.....	19, 20
Panquitch Lake.....	35	fishes of.....	19
Pantosteus.....	20, 23	In Plata.....	25
delphinus.....	5, 24, 25, 27	Mimbres.....	20
generosus.....	31, 35	Navajo.....	26
jarrovii.....	19, 20	San Juan.....	26
platyrhynchus.....	32	Roaring Fork.....	29

	Page.		Page.
Roaring Fork of Grand River.....	23	Spanish Fork.....	30
Rocky Mountains.....	13	Squalius.....	20, 21, 22
Rutilus.....	21, 22	aliciae.....	32
Saquache.....	19	cephalus.....	21
Mountains.....	19	copei.....	32
St. Joseph, Mo.....	17	cruoreus.....	33
Salmo clarkii.....	13	rhomaleus.....	33
gairdneri.....	13	Streams examined.....	1
irideus.....	6, 13, 16	Sweetwater Lakes.....	23, 28, 29
mykiss.....	5, 13, 22, 28, 34	Tahoe Lake.....	14
bouvieri.....	15	Telestes.....	21, 22
dimensions of.....	15	Tigoma.....	21, 22
clarki.....	14	ogregia.....	33
henshawi.....	14	gracilis.....	33
lewisi.....	14	obesa.....	33
macdonaldi.....	11, 15	pulchra.....	20
description of.....	11	squamata.....	33
pleuriticus.....	14	Tomichi Creek.....	23, 28
spilurus.....	14	Torch Lake, Michigan.....	29
stomias.....	12, 15	Trapper's Lake.....	14, 23, 28, 29
virginalis.....	14, 35	Trinchara.....	19
purpuratus.....	13	Twin Lakes.....	9, 13, 15, 29
salar sebago.....	6, 16	Uncompahgre Pass.....	24, 25
spilurus.....	22	River.....	24, 26, 27, 28
stomias.....	12	Upper Arkansas River.....	11, 13
utah.....	14, 34	Colorado River.....	22, 29
virginalis.....	34	Basin, fishes of.....	26
Salt Lake City.....	31	Missouri River.....	29
Basin.....	30	Provo River.....	32
fishes of.....	31	Uranidea punctulata.....	29
Salvelinus fontinalis.....	6, 16, 23	wheeleri.....	36
Sangre de Christo.....	19, 22	U. S. National Museum.....	27
Mountains.....	19	Utah Basin.....	20
San Ignacio Lakes.....	26	Lake.....	15, 30, 31, 34
Juan River.....	24, 25, 26	trout.....	34
Luis.....	19	streams of.....	29
Lakes.....	19	Ute.....	19
Park.....	19	Wagon Wheel Gap.....	19
Sarcobatus vermiculatus.....	24	Waha Lake, Washington.....	15
Scardinius.....	21	Wahsatch.....	30
Semotilus atromaculatus.....	8	Mountains.....	24, 29
Sevier Lake.....	30, 35	Walla Walla River.....	35
River.....	35, 36	White River, Indiana.....	16
fishes of.....	35	Wichita, Kans.....	10, 17
Siboma.....	21, 22	Xyrauchen cypho.....	5, 24, 25, 26, 27
atraria.....	33	Yarrow, Henry C.....	28, 34
Sierra San Juan Mountains.....	24	Yarrowi.....	32
Silverton.....	25	Yellowstone Park.....	29
Snake River.....	30, 33	River.....	22
South Park, Colo.....	7	Zygonectes floripinnis.....	8
Platte River.....	6, 13		