THE FISHES OF THE LAHONTAN SYSTEM OF NEVADA AND NORTHEASTERN CALIFORNIA

By John Otterbein Snyder
Stanford University, California

(a) Truckee River near its source.

(b) Truckee River in the desert near Derby. Lahontan sediments are seen on the left.

(a) Winnemucca Slough near mouth, June, 1911. Quaternary shore lines in the distance.

(b) Tufa castle, Pyramid Lake, showing water level in June, 1911.

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INTRODUCTION.

The fishes of the Great Basin of North America are of unusual interest, as they occupy basins which are without exterior drainage, and are consequently in much the same position as animals on oceanic islands; and, furthermore, this isolation eliminates from the question of distribution one possible means of dispersal, namely, the open ocean. The islandlike systems which these fishes occupy are completely surrounded by greater and more extensive river systems which have oceanic drainage. To the island systems these bear a continental relation. The situation attracts further attention when it is recalled that each of the greater systems contains a distinct and characteristic fish fauna of which many genera are not found elsewhere.

The various drainage areas of the Great Basin are separable into three distinct groups: First, those included within the State of Utah and which were at one time tributary to the ancient Lake Bonneville; second, those of northern Nevada and northeastern California, which formed a part of the Quarternary Lake Lahontan; and, third, a number of detached basins in southeastern Oregon that were once more extensive than now. These latter were lately examined by agents of the Bureau of Fisheries, and their species are fairly well known.a

The present paper deals with the fishes of the second group, the Lahontan system. It includes a systematic account of the species, a discussion of their economic importance, and their distribution and relationships. Some attention is also given to the possible bearing of distribution and relationships on the geological history of the region.[b]

a Bulletin, Bureau Fisheries, vol. XXVII, 5957, p. 69.

b Specimens were collected and field observations made by the writer while serving as a temporary assistant of the United States Bureau of Fisheries. Mr. C. H. Richardson, a student of Stanford University, aided during the summer of 5951, and a recent report by him (Proceedings U. S. National Museum, vol. 48, p. 403) embodies an account of the reptiles which were seen. Officers of the State Fish Commissions of both Nevada and California have shown an interest in the work, and acknowledgments for direct assistance are specially due to Hon. George T. Mills, Messrs. Ernest Schaeffle, E. W. Hunt, George E. West, and Frank P. Cady. Prof. S. B. [illegible], of the University of Nevada, an enthusiastic angler, and Dr. Maxwell Adams, of the same institution, have furnished valuable information regarding the fishes and the region in general. Work in the vicinity of Pyramid Lake was made possible through the courtesy of Mr. Joseph D. Oliver, superintendent of the Indian agency. A collection of fishes made by Dr. C. H. Gilbert in the headwaters of Carson and Walker Rivers has been consulted, and all the material from the system, including the type specimens, which are preserved in the National Museum, were examined. Types and paratypes of the species here described and a large representative collection have been deposited in the National Museum. A collection was also retained at Stanford University. The drawings are by Mr. W. S. Atkinson.

RIVERS AND LAKES OF THE LAHONTAN SYSTEM.

The Lahontan system drains a huge basin embracing about 40,700 square miles of arid and semiarid tableland which is roughly broken by barren and rugged mountain ranges. It includes on the west the abrupt and often precipitous forest-covered wall of the Sierras, with its towering masses of snow-covered peaks, and it stretches away to the east, north, and south in an apparently endless extent of forbidding desert. The system includes six isolated basins, viz, the Truckee River, Honey Lake, Eagle Lake, Quinn River, Walker River, and the Carson-Humboldt. Here are found rivers of considerable size, many perennial creeks, and smaller streams of more or less intermittent flow, besides several large, deep, and very beautiful lakes. (See map, p. 86.)

Truckee River is the largest and most important stream of the system. It originates as the outlet of Lake Tahoe, descends 2,460 feet in about 100 miles to Pyramid and Winnemucca Lakes, where its water is carried off by evaporation. Rising in a forested region (pl. III, a), it passes down a wooded canyon and emerges on the desert, where its banks are alternately bordered by irrigated fields, sage-covered sands, and barren rocks (pl. in, b). Its lower course is inclosed for a considerable distance between walls of eroded Quaternary sediments, beyond which the gorge broadens into a green-carpeted forest of large cottonwoods. Just before entering Pyramid Lake the river bifurcates, a lateral channel, known as Winnemucca Slough, abruptly turning to the right and conveying a considerable part of the water into Winnemucca Lake. The surface of the latter is lower than Pyramid Lake, and at times after unusually high water a back flow sets in from Pyramid Lake through the slough. The water of both lakes is remarkably limpid except near the inlets. It is brackish to a degree which prevents the growth of arborescent vegetation along the shores, yet the submerged rocks are covered with algæ and the water swarms with fishes. The monotony of the arid shores occasionally is broken by towering, castellated tufa crags, which suggest ancient ruins, and the valleys are bordered by high rugged mountains, against whose sides are plainly traced the levels of a greater lake (pl. IV, a), often in overhanging tufa masses of fantastic form. Pyramid Lake contains several small islands, on two of which are large breeding colonies of water birds.

Honey Lake is a very shallow body of water, which receives Long Valley and Susan Creeks. The latter is a trout stream of considerable size.

Eagle Lake is large, deep, and irregular in outline. Apparently it was once a tributary to Lake Lahontan, but is now separated from Honey Lake Basin by a wall of permeable rock, from the base of which many springs unite to form a branch of Susan Creek. The water of Eagle Lake is clear and cold. The western and southern shores are largely forested. The surface level is subject to periodical fluctuations, recently rising so high as to submerge a considerable area and kill many large conifers. Pine Creek is the only tributary.

Carson and Humboldt Rivers flow from opposite directions into Carson, South Carson, and Humboldt Lakes. These are shallow evaporation basins, irregular and inconstant in outline, their waters laden with silt and charged with mineral salts.

Quinn River debouches on the almost level floor of Black Rock Desert. For a large part of its course it is sluggish and muddy, winding here and there through extensive marshes.

Walker Lake is a rival of Pyramid Lake in scenic beauty, lying in a long narrow valley with towering mountains on either side and the desert sloping down to the water's edge. It is comparatively fresh near the inlet, but grows more saline toward the lower end, where no fishes except carp are said to go. Walker River is its only tributary.

In addition to the larger basins here described there are several creeks which are isolated. One or two of these north of Black Rock Desert are said to contain fishes.

The streams of the entire system are much alike in that they have their origins in the mountains and are often fed by melting snow. Their upper courses are cool, clear, and pure; but on reaching the valleys the currents slacken, the water at length becoming warmer and often silted and alkaline. They are all subject to great changes in volume,[a] gradually or even suddenly becoming raging torrents and again decreasing in size until in some cases their currents fail and their waters are dissipated through evaporation or lost in the thirsty sands. Of late years much water has been used in irrigation, the entire flow of some streams being thus diverted for considerable periods. Unusually high water has lately occurred in some of the lakes, as the dead pines at Eagle Lake and submerged fences at the head of Winnemucca Lake plainly indicate. Pyramid Lake was somewhat higher in 1911 than when seen by Russell,[b] as a comparison of his view of the tufa castle on the west shore of Pyramid Lake (Russell, pl. XL), and the photograph here presented (pl. IV, b) will show.

The insular position of the Lahontan system has been noted. On the east is the Bonneville, a similar system of interior drainage; on the north the Columbia, including Snake River; while on the west and south are the Klamath, Sacramento, San Joaquin, and Colorado systems. On the northwest, between the Lahontan and the Klamath and bordering the Columbia and Sacramento, is another region of interior drainage, the Oregon Lake system, a portion of the Great Basin to which reference will again be made.

DISTRIBUTION AND RELATIONSHIPS OF SPECIES.

Fifteen native species of fishes are now recognized in the Lahontan system. They are enumerated below and accompanied by page references to the "Fishes of North and Middle America,"[c] where an index to the literature pertaining to the various species may be found.

Catostomidæ.

Catostomus tahoensis Gill and Jordan; C. tahoensis, p. 177.
C. arenarius, new species.
Pantoskus lahontan Rutter.
Chasmistes cujus Cope; C. cujus, p. 183.

Cyprinidæ.

Richardsonius egregius (Girard); *Leuciscus* egregius, p. 237.
R. microdon, new species.
Siphateles obesus (Girard); Rutilus olivaceus, p. 244; R. symmetricus, p. 245.
Leucidius pectinifer, new species.
Agosia robusta Rutter; A. nubile carringtonii, p. 311.

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a United States Geological Survey, Water Supply and Irrigation Papers, nos. 68, 131, 134, 176, 312, 230, 250, and 251.
b Department Interior, Monograph Geological Survey, vol. XI, 1885.
c Jordan and Evermann, Bulletin 47, United States National Museum, Washington.

Salmonidæ.

Coregonus williamsoni Girard; C. *williamsoni*, p. 463.
Salmo henshawi Gill and Jordan; S. clarkii *henshawi* (2819), p. 493; S. clarkii *tahoensis*, p. 2870.
Salmo *aquilarum* new species.
Salmo regalis Snyder.
Salmo smaragdus, new species.
Coitus *beldingi* Eigenmann; C. beldingii, p. 1958.

Of these, Chasmistes *cujus* is confined to Pyramid and Winnemucca Lakes, from which an annual spawning migration is made in the lower course of Truckee River. *Richardsonius* microdon is known from a few specimens caught with baited hook in Lake Tahoe. Leucidius *pectinifer* is lacustrine, breeding in the lakes and apparently never entering the rivers. Salmo *aquilarum* is a rainbow trout, which presumably entered Eagle Lake after the latter was detached from direct Lahontan drainage S. *regalis* and S. smaragdus are lacustrine. Their breeding habits are not known. The other species are generally distributed throughout the system.

In the presence of our limited knowledge of western fresh-water fishes it is confessed that an attempted discussion of the relationships of the Lahontan fauna is somewhat premature. A better acquaintance with the species in the headwaters of the Sacramento Valley streams and with those in the upper Columbia and the Snake Rivers is desirable, and something more should be known of the Bonneville fishes than has been recorded in their descriptions. However, it appears probable that, unless the purport of facts now at hand is wrongly interpreted, certain inferences may be drawn which will not be greatly altered by future investigation.

The position of the system being completely insular it may at once be assumed that the affinities of the Lahontan fishes are to be sought among the faunas of contiguous systems, and the assumption is well founded, as will be seen. When the relationships of a Lahontan species are apparent, they invariably are found to be with a form indigenous to a neighboring basin.

The Colorado River fauna does not appear to be directly represented in the Lahontan system. Among the Sacramento River fishes there are fine and coarse scaled catostomids similar to those of the Lahontan, a lake chub, Siphateles formosus, much like S. obesus, while the Sacramento and Lahontan species of Agosia and Coitus are distinguished with difficulty. The same may also be said of similar species found in the Klamath and Columbia Rivers, the near-related forms being enumerated in the following list :

Lahontan: C. tahoemis, C. arenarius, S. obesus, A. robusta, C. beldingi.
Sacramento: C. *microps*, C. *occidentalis*, S. *formosus*, A. *carringtoni*, C. gulosus.
Klamath: C. rimiculus, C. snyderi, S. bicolor, A. *klamathensis*, C. *klamathensis*.
Columbia: C. *catostomus*, C. *macrocheilus*, S. columbianus, A. *carringtoni*, C. gulosus.

However, it is when the Oregon Lake system is approached that we find species that are most closely related to those of the Lahontan, for an Agosia, a *Siphateles*, and a *Catostomus* are here which scarcely differ from representative forms found in the latter system. It therefore appears probable that certain species of the Lahontan fauna are most closely allied to those of the Oregon Lake system and through these to similar forms in the Sacramento, Klamath, and Columbia. The affinities of one Lahontan species, *Chasmistes* cujus, may be traced to Klamath Lake (fossils of the

genus have been found in the Oregon Lake region) and, also, in the opposite direction to the Bonneville Basin of Utah, the only localities in which the genus has been found. Pantosteus *lahontan* closely resembles P. platyrhytwhus of the Bonneville. The affinities of Richardsonius egregius seem to be with R. balteatus of the Columbia or with some similar form of the upper Snake River or the Bonneville. The relationships of *Richardsonius microdon* are not apparent, unless possibly they may be with R. bicolor of the Klamath or R. *caurinus* of the Columbia. Coitus beldingi and C. *semiscaber* have not been compared. The whitefish of the Lahontan and those of the Columbia apparently are alike.

It seems evident, then, that the fauna of the Lahontan system is related to that of the Oregon Lake, the Columbia, and the Bonneville systems. One, or possibly two, of the trouts may have come from the Sacramento. Of the latter, S. *aquilarum* is scarcely to be regarded as a Lahontan species.

Lahontan species.	Probable relationships.
Catostomus tahoensis.	.*Catostomus* of Sacramento, Klamath, or Columbia.
C. arenarius	*C warnerensis,* Oregon Lake system.
Pantosteus lahontan	P. *platyrhynchus,* Bonneville.
Chasmistes cujus	*Chasmistes* of Klamath or Bonneville.
Richardsonius egregius	R. *balteatus,* Columbia.
R. microdon.	
Siphateles obesus	*S oregonensis,* Oregon Lake system.
Leucidius pectinifer.	
Agosia robusta.	.*Agosia nubila carringtonii,* Oregon Lake.
Coregonus	C. *williamsoni,* Columbia.
Salmo henshawi.	*clarkii,* Columbia.
Salmo *aquilarum.*	*S irideus(?),* Sacramento.
S. regalis	*S* irideus(?), Sacramento.
S. *smaragdus.*	
Coitus *beldingi*	*C punctulatus* of Columbia or C. *semiscaber* of the Bonneville.

The Lahontan species are of necessity fluvial and lacustrine, although two genera, Salmo and Coitus, include representatives of forms which may be anadromous or at least able to pass through salt water. With one possible means of dispersal of fluvial fishes eliminated (the open ocean), one may conclude that the Lahontan fishes entered the system directly through channel connections or indirectly by stream capture. It is not presumed that lacustrine and channel forms which never migrate to the headwaters were brought into the system by stream capture, while on the other hand any native species may have entered it through a channel connection with another system. Prom what is at present known of the habits of the species it may be safely inferred that they reached the system as follows:

By channel connection: C. *cujus,* R. *microdon,* S. *obesus, L. pectinifer,* S. *regalis,* S. *smaragdus.*

By stream capture or channel connection: C. *tahoensis,* C. *arenarius,* P. *lahontan,* R. *egregius,* A. *robusta,* S. *henshawi,* S. *aquilarum,* C. *williamsoni,* C. *beldingi.*

Means of dispersal within the system become evident when the geology of the region is consulted.

THE GEOLOGY OF THE LAHONTAN SYSTEM AND ITS RELATION TO THE ICHTHYOLOGY.

The recent geological history of the Lahontan system has been worked out in a masterly way by Israel Cook Russell,a the results appearing in a large monograph published by the United States Geological Survey. Russell's account begins with Quaternary times, when Lake Lahontan covered a large and very irregular area, now mostly included within the State of Nevada. This great body of water, larger than Lake Erie, attained a maximum depth of 880 feet and received the discharge of numerous rivers, many of which flowed through narrow and deep mountain canyons. The history is continued down to the present time, when nothing is left of the ancient lake but the detached basins with which we are now concerned, mere desiccated remains scattered over a rock-bound waste of desert sands. Unmistakable traces of the old lake are to be seen on every hand, and they are particularly evident in the valleys of Pyramid and Winnemucca Lakes, where the eye of the observer can follow the ancient shore lines as they distinctly appear one above another for long distances up the mountain sides.

In the presence of this great body of water, to which the small river and lake basins of northern Nevada were all tributary at a relatively recent time, we may recognize a direct and simple explanation for the present distribution of the fishes now found there. But a part of Russell's investigation which also concerns the ichthyologist has to do with the question of an outlet of Lake Lahontan and, also, with the degree of desiccation to which the lake was subjected during its history. Quoting directly from Russell, and italicising statements of particular interest in this connection, we have (p. 250, chap. vii) :

> The history of the fluctuations of the Quaternary lake of northwestern Nevada is recorded in various ways, as has been described in the last three chapters, which treat it from the physical, chemical, and biological standpoints. In the present chapter it is our purpose to present briefly the conclusions based upon these various lines of evidence. The phenomena observed have great diversity of character, but when interpreted in terms of geological history they support and supplement each other in such a way that the conclusions drawn are believed to be well sustained. Moreover, the facts observed in the Bonneville and in more than a score of desert valleys throughout the northern half of the Great Basin which contained contemporary water bodies harmonize with the interpretation of the Lahontan record here presented.
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> The fact that all the minor basins in the arid regions of the Far West are filled to a depth of many hundreds of feet with alluvium and lacustral sediments, together with the occurrence of the beach lines of the Quaternary lakes on the surface of the vast alluvial cones, leads to the conclusion that all these basins were barren deserts before the rise of the Quaternary lakes. The pre-Lahontan condition of northwestern Nevada must have closely resembled its present character, *but* at times it was probably completely desiccated.
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> The change of climate admitting of the existence and gradual expansion of lakes in the various valleys throughout the Great Basin caused a number of those situated in northwestern Nevada to rise sufficiently to unite and form a single irregular water body 8,922 square miles in area. This was the first rise of Lake Lahontan. Like all inclosed lakes it must have fluctuated in depth and extent with the alternation of arid and humid seasons and risen and subsided also in response to more general climatic ocellations, which extended through years and perhaps embraced centuries. Finally the climatic conditions which favored lake expansion ceased, and a time of aridity, like that which preceded the first rise, was initiated. The lake slowly contracted until its basin reached a greater degree of desiccation than that now prevailing. This was the inter-Lahontan period of desiccation.
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> During the first rise lacustral marls and clays were deposited throughout the basin; the depth of these is unknown, but they certainly exceed iso feet in thickness. The waters were saturated with

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a Department Interior, Monograph Geological Survey, vol. xi, 1885.

calcium carbonate, and the precipitation of great quantities of compact stony tufa took place. Deposits of tufa were formed on rocky slopes throughout the basin and are not especially abundant at the mouths of streams. This is thought to indicate that although the waters were saturated with calcium carbonate they were not highly charged with other chemical substances. This conclusion is sustained by observation of conditions under which a similar tufa is being deposited in existing lakes, and also by the presence of gasteropod shells in the lithoid tufa in great abundance.

The time of low water, and perhaps of complete desiccation, that succeeded the first rise of Lake Lahontan is recorded by stream channels carved in lacustral beds and by current-bedded gravels and sands superimposed upon previously formed strata. Sections of inter-Lahontan gravel deposits have been observed wherever the material filling the lake basin is well exposed, and furnish indisputable evidence that the lake was greatly lowered before the gravels were deposited. These gravels were in turn covered by a second lacustral deposit, thus forming a tripartite series, a counterpart of which exists in the Bonneville Basin. The first formed tufa deposit was exposed to subaerial erosion during the inter-Lahontan period of low water and became broken and defaced.

The character of the next succeeding tufa deposit indicates that a change had taken place in the chemical conditions of the waters of the lake when the basin was again partially flooded. The alteration in the composition of the salts dissolved in the lake is thought to have been brought about by a partial deposition of the saline matter accumulated during the first high-water stage at the time of the inter-Lahontan period of desiccation. The tufa superimposed upon the lithoid variety is known as thinolite; it is composed of well-defined crystals and is without fossils. It was evidently precipitated from a more highly concentrated chemical solution than that from which the lithoid variety was deposited. That this was the case was rendered evident, since the crystalline variety occurs only low down in the basin, while the lithoid tufa may be found within 30 feet of the highest terraces carved by the waters of the ancient lake.

After the crystallization of thinolite had been carried on for an indefinite period, the lake rose to within 180 feet of its first maximum, and the heaviest deposit of calcium carbonate found in the basin was precipitated. During this stage the lake was not strongly saline, as is shown by the abundance of gasteropod shells obtained from the sediments and tufas accumulated during this period of its history.

After the precipitation of the dendritic tufa the lake continued to rise and at last reached a horizon 30 feet higher than the first maximum. During this expansion the waters lingered but a comparatively brief time at the highest level and then slowly subsided. The increase in depth after the deposition of dendritic tufa is shown by the presence of lacustral sediments upon that deposit. The structure of the higher bars and embankments about the border of the old lake basin proves conclusively that the greatest lake expansion was during the second rise.

With the last recession of the lake all portions of its basin were brought within the reach of wave action, and the tufa deposits sheathing its interior were broken and the fragments swept away by currents and built into embankments and terraces. The waters continued to fall until the basin was completely dry. All the salts not previously precipitated were deposited as desiccation advanced and became buried and absorbed by playa clays. The proof of the occurrence of this time of desiccation is furnished by the comparatively fresh condition of the existing lakes of the basin and by the change in the molluscan fauna which took place since the last high-water period. The duration of *this* post-Lahontan arid period is unknown, but it was finally terminated--probably less than 300 years since—by an increase in humidity. The present lakes then commenced their existence.

It is evident, then, that Russell found, first, that Lake Lahontan had no outlet and, second, that there was a pre-Lahontan and a post-Lahontan period of complete desiccation, the latter prevailing to within the last 300 years.

The fish fauna of the Lahontan system may be termed characteristic, most of its species being distinct from related forms found elsewhere. One genus, Leucidius, is restricted to the system. These circumstances argue in favor of long isolation. Furthermore, the Lahontan species do not appear to be related to others of any particular system, contrary to what would be expected if the relatively recent Lake Lahontan had discharged its waters into another basin.[a] It thus appears that Russell's conclu-

a The cases of Lake Bonneville and Malheur Lakes may be cited.

sion regarding the absence of an outlet fully explains the conditions here described. Further than this the present distribution of certain species does not seem to be in harmony with his interpretation of the geology, as will be indicated.°

Chasmistes *cujus* is a lacustrine form known only from Pyramid and Winnemucca Lakes. The species lives in deep water beyond ocular observation except during the short breeding season, when great numbers of adult individuals pass up the Truckee to spawn. It is a large and clumsy fish (fig. 2) with relatively short fins and tail, not only physically unfit, but apparently unable, to stem the current of a very rapid stream. During the nuptial migration it does not go far beyond the great bend of the Truckee, selecting its spawning beds before the turbulent water of the river is encountered. It will be recalled that the only other species of the genus are found in Klamath and Utah lakes, and attention is also directed to the fact that they are likewise lacustrine fishes with habits similar to those of C. cujus. Complete desiccation of Pyramid and Winnemucca T,akes at the present time would certainly bring about the extermination of this species,b and it would, no doubt, have done so in the past. It therefore seems difficult to avoid the conclusion that the presence of this form in the basin prevents the acceptance of any hypothesis which does not recognize a complete continuity of Pyramid and Lahontan Lakes; and, moreover, an acceptable explanation of the present distribution of the species of the genus Chasmistes must of necessity assume a continuity between Lahontan and a still older lake or lakes which had at one time a channel connection with similar large bodies of water located elsewhere in the Great Basin. Also this body of water, continuous through a long period of time, must have been constantly fresh enough to support plant and animal life.

There is a trout indigenous to Pyramid and Winnemucca Lakes, Salmo *smaragdus* (described in the present paper), which can not be supposed to have recently differentiated. Not much is known of the habits of the species beyond that it does not appear in the rivers, and therefore apparently spawns in the lakes. The most nearly related species is probably *S.* regalis of Lake Tahoe, although it is very different. The turbulent Truckee appears to act as an impassable barrier to *S.* smaragdus, and there is no reason to suppose that it could survive the dessication of Pyramid and Winnemucca Lakes.

A theory involving the introduction and differentiation of such species since Quaternary times can scarcely be entertained at present, much less are we prepared to accept the supposition that they have appeared here within the last 300 years. Where there is any approximate measure of the time required in nature for the differentiation of a species, it is not a matter of hundreds of years, but rather of a long geological period of time.

A large number of species found in the Lahontan system are generally distributed, and it is therefore quite probable that these were introduced long before its separation

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a Recent discussions bearing snore or less directly on this question may be noted here.

Snyder, J. 0.: The fishes of the Lahontan drainage system of Nevada and their relation to the geology of the region. Journal, Washington Academy of Sciences, vol. IV, no. 11, p. 299; (extract), June 4, 1914.

Jones. J. Claude: The geologic history of Lake Lahontan. Science, n. s. vol. XL, no. 1040, Dec. 4. 1914.

Gale, Hoyt S.: Geologic history of Lake Lahontan, Science, n. a. vol. XLI, no. 1049, Feb. 5, 1915.

b The diversion of a considerable part of the Truckee may in the near future serve as a test for this supposition, unless the fall of Pyramid Lake is followed by a deepening of the river channel, which in turn would cut off the water supply of Winnemucca Lake and thus maintain Pyramid at a level not far below that of the present.

into isolated basins—long enough for some of them to have become measurably differentiated from the parent stock. A careful examination of a large series of specimens has failed to detect any differentiation characteristic of the fishes of any particular basin of the system.

Eagle Lake appears to have been connected at one time with Lake Lahontan, as it contains two channel or lacustrine species, *Siphateles* obesus and *Leucidius* pec- Unger, the latter of which has not been seen in the streams of Honey Lake Basin. It may be noted in this connection that Salmo tahoensis, the characteristic trout of the Lahontan system, is replaced in Eagle Lake by S. aquilarum, a form evidently derived from the rainbow trout of the western slopes of the Sierras, while the remaining native fishes of the lake are Lahontan species.

THE FOOD FISHES.

A discussion of the economic value of the fishes of this region and any consideration of methods of propagation and protection must begin and end with the assumption that agricultural and manufacturing interests are of paramount importance. A considerable and constantly increasing amount of the flowing water must be used first for power and then for irrigation, and when any measure intended for the protection of fishes is found to seriously interfere with the working of power plants or the demands of agriculture it will have to be abandoned. On the other hand, a strong sentiment prevails against the careless and unnecessary obstruction and pollution of rivers and lakes. It is coming to be generally recognized that factories and mills may operate without turning their refuse into the streams, dams may be so constructed as not to stop the passage of fishes during the spawning season, and irrigating ditches may be screened and thus prevent the loss of fishes in the fields.

Despite the arid conditions which prevail over the greater part of the region and the relative paucity of streams and lakes, the fishes and the sport of fishing are of considerable importance. Of the 15 native species, 6 are of more or less commercial value. These include the various trouts, the whitefish, and the "cui-ui." The last named is eaten by the Indians only, who profess to like them better than trout. Ten or more species have been introduced. Of these the carp, which has proved to be a positive nuisance, and the Mackinaw trout threaten to take the place of better varieties. The brook and the rainbow trouts thrive in suitable localities. Catfish and Sacramento sunfish are caught in considerable numbers. Formerly quantities of trout were shipped from Tahoe, Pyramid, Winnemucca, and Walker Lakes to the mining camps and even to San Francisco. At present fishermen supply the local market at Lake Tahoe and the Pyramid Indians sell trout at Reno, where the demand is said to be uncertain because of the irregular enforcement of laws.

Any suggestion which might be offered for the propagation and the adequate protection of the fishes of the region would include a close and continued observation of the habits of the native species, for conservation of fishes consists in the intelligent application of experience thus obtained, the arrest of poachers and the planting of fry being only incidental. Some of the difficulties in the way of proper protection here, and which are apparent to most observers, arise from the unfortunate circumstance that this system is included within the jurisdiction of two States, and that the viewpoint of those primarily interested in manufacture and agriculture does not always coincide

with that of others who would protect wild life and in a measure preserve the rivers and forests from pollution and destruction.

The mills, with a few exceptions, attempt to keep the water clear, but they are not always careful to maintain a sufficient flow in the fishways. Small trout often pass out into the irrigation ditches, where proper screens are lacking in the mains, and considerable numbers of fishes are sometimes destroyed by the carelessness of those having charge of the large dams.[a]

Complaint has been made against water birds—the pelicans, cormorants, gulls, and terns—some of which have large breeding colonies on islands in the lakes. It is apparent, however, that but little harm is done by these birds, except that they consume food which might otherwise be available for the trout.

In the upper courses of the desert streams the trout, and all other fishes as well, are sometimes completely washed out or choked and killed as a result of sudden and violent thunderstorms, known as "cloud bursts," when a great quantity of water is precipitated on the mountain sides and, gathering force in the narrow gorges, sweeps everything before it, not even the fishes being able to withstand the terrific rush. The rise of a stream is sometimes so sudden that an advancing wall of water several feet in height plunges along the river bed uprooting trees and battering down other obstacles with rolling bowlders until at length it scatters everything pell-mell on the desert floor. When streams connect with the main channel at only infrequent intervals, some time usually intervenes between such a catastrophe and a natural restocking. Fortunately such occurrences are not frequent.

The possibilities of fish culture are relatively promising in this region, and considerable responsibility rests with those in control of the situation. Moreover, several species are threatened with extermination, and an attempt should be made to learn something more of their habits before the fishes entirely disappear.

SYSTEMATIC DISCUSSION OF SPECIES.

Catostomus tahoensis Gill and Jordan. Red sucker.

C. *tahoensis* is both fluvial and lacustrine and appears to be the most abundant sucker in the region living and spawning wherever the water is of sufficient depth.[b] During the spring and early summer its brilliant color, large size, and the commotion made by spawning individuals along the river bars,

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[a] During the spring of 1912 the local papers contained accounts of the destruction of large numbers of trout in the Truckee River below the irrigation dam at Derby. The writer visited the place at the time and carefully examined the river from the town of Truckee to the mouth of the river. From the Derby dam and extending several miles down stream there were thousands of dead trout ranging in length from 2 to 3 or more feet, their decaying bodies strewn along the bars and clogging the ripples. The mortality was greatest within the first mile or two of the dam. There were hundreds of dead fishes above and below the station of Derby, and some were seen as far down as the great bend. An examination showed that many of these had spawned, while others had not. The cause of all this was evident beyond doubt. The river at the time was unusually low, following a winter of little rain and light snows in the mountains. At the very height of the spawning migration of the trout the impounding dam at Tahoe City was closed and the gates allowing the water to pass into the canal leading from above the dam near Derby were opened, with the result that one could cross the lower Truckee dry shod. No trout could pass from the dam to Derby nor from there to the big bend nor from the big bend to the lakes. Trout could not even survive in the deeper pools between Derby and the dam because of their large numbers and the polluted water.

[b] It is worth while to note in this connection that *C. microps*, the fine-scaled sucker of the Sacramento, representative there of this species, is rare, but few specimens having been taken. Also that *C. rimiculus*, the fine-scaled form of the Klamath, is abundant in comparison with *C. snyderi*, which is rarely seen. It appears, then, that a fine-scaled form is able to thickly populate the streams of one basin while just the reverse occurs in another. It also will be recalled that a coarse-scaled form, *C. occidentalis*, which is more abundant in the Sacramento, has extended its range to Eel River and neighboring streams as C. *humboldtianus*, in which the scales are yet larger, and to the streams of Monterey Bay as C. *myliotilus*, where the scales have also become larger. No representative of *C. microps*, the rarer Sacramento form, is known from these streams. Likewise, it is *C. rimiculus*, the more common form of the Klamath, but with fine scales, that has extended its range to the Rogue River.

gravelly shores, and shallow lake beaches attract much attention. Breeding males are brassy above and on the sides, fading abruptly to dead white on the ventral surface. On the back the metallic color iš obscured by small spots and specks of dark olive and black. A stripe five scales wide, brilliant dark vermilion in color, extends from the opercular opening to caudal, where it spreads out over the entire basal portion of the fin. There is a narrow, vertically oblong spot of the same bright color behind the eye and, also, a dash of it along edges of opercle. Below the stripe is a similar one of deep black, which causes both the red above and the white below to stand out in strong contrast. The dorsal is yellowish along the base and the paired fins have a yellowish tint. On turning in the clear water the fish's sides reflect the rays of the sun in flashes of crimson, gold, and silvery light. In holding this species in the hand the metallic tints are reflected from the fins and, in the most intensely colored individuals, from the ventral surface as well. The tubercles on the tail and anal fin are dead white. When not in nuptial color, the lateral stripes are metallic, orange, red, and blackish olive, respectively. The colors of the female are greatly subdued, the general pattern being the same, the whole body, olive above and light beneath, suffused with yellow, the darker areas deep olive or blackish. The lateral stripe is pinkish and not sharply defined. The fins are tinted with olive.

The males appear first on the spawning beds and are always represented there in larger numbers, each female being attended by from two to eight or more. Twenty-five males were seen attending one female in a pool. Occasionally another female would enter the pool from below, when she would be met and inspected by a school of males and then allowed to pass on without further notice. Several of these passing females proved on examination not to be ripe. On account of the presence of so many males nothing definite can be observed of the spawning act, more than that the eggs are extruded and shaken down in the gravel by the female while the males struggle over and under her, churning the water to foam by their activities. Eggs artificially removed from a ripe female and quietly cast into the water upstream from the males attracted no more attention than did so much coarse sand. However, they were immediately gobbled up by numbers of *Richardsonius* egregius, which also attended the females, plunging into the melee of spawning fishes for eggs at every opportunity.

The bed, or nest, is a somewhat concave depression in the coarse sand or gravel, measuring from to more than 3 feet in diameter. The nest is located in shallow water, usually less than 12 inches deep, which often proves fatal to the young, for the falling water of the river uncovers the beds at times, and the eggs quickly perish in the hot sun. The eggs are found in large numbers deep among the pebbles. In spawning there is no opportunity for the female to make any selections among the males. Large and small males appear to have an equal opportunity in fertilizing the eggs, for no fighting occurs.

Spawning was in progress in the lower Truckee River April 22; Pyramid Lake May 20; ceased May 24; Eagle Lake May 25, the period about ended there; in tributaries of Lake Tahoe June is.

Individuals of this species are very shy, the females being more difficult to catch than the males. When spawning they may be closely approached if one moves very slowly without producing any crunching of the gravel underfoot or allowing a shadow to fall on the water.

In the lakes this species attains a large size, one specimen measuring a little over 2 feet. The Indians call them "nuwá-go," or "a-wuh," and occasionally catch them along with *Chasmistes*, but reject them as being undesirable for food. The flesh is sweet and palatable.

A very small specimen and a dried head of this species from Eagle Lake were described by Rutter as Chasmistes chamberlaini.a An inspection of the type and its comparison with prepared skulls of both Catostomus and *Chasmistes* leave no doubt as to its identity with the former. In fact, the describer suggested no reason for identifying it with *Chasmistes* or for supposing that it differed from Catostomus. Of the dried head the "prominent hump" of the snout, the inclined maxillary, and prominent nasal spines are not particularly characteristic of either Chasmistes or *Catostomus*. The skull of the type has a long and broad fontanel, the covering of "thin bone" mentioned in the description being merely dried skin. The small specimen has broad papillose lips.

A number of specimens were collected at Eagle Lake. They were taken from a large school which was spawning in a favorable place on the northeast shore. Males were largely in the majority, and the females were so wary that none could be taken in the nets even after great perseverance. The water being cold and clear rendered difficult the task of getting even the males. On these the light lateral stripe was orange red, with a broken outline, varying in width from five to six or seven scales.

a Bulletin United States Fish Commission, vol. XXII, 1902, p. 147.

The dorsal fin was dark olive, pectorals and ventrals tinted with yellowish pink, lips yellowish white, iris brassy. No difference could be found in specimens of this species from Eagle Lake and those from the Lahontan system.

In the rivers this species is very numerous. Where the water contains much silt they are light in color, often very pale olive, with a considerable amount of light yellow. Late in the season the red stripe seems to almost entirely disappear from the males and it is not seen at all in the females. The young have several dusky spots on the sides.

The affinities of this catostomid will be considered with those of the following species, C. arenarius.

Measurements and scale counts are given here, numerous in this case because the Eagle Lake specimens are included in the species.

Scales in lateral series	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
Walker Leaf Creek	i	I	x I	2 I	1 I	1	3 1	6 I	5 3	7 5	7 2	2 1	1 2	2 1	2	....
Truckee River				.												
Humboldt River, Palisade	1															
Humboldt River, Carlin				2	1	....	1	I	2	5	3	....	2	1	1	1
Little Humboldt River																
Pine Creek, Palisade																
Star Creek, Deeth																
Walker River																
Specimens observed	2	1	2	7	10	8	15	16	57	22	18	9	xi	6	4	1
Series of scales above lateral line						.						x6	17	18	19	20
Number of specimens observed						..	.			.	.	2	23	28	15	1
Scales in series below lateral line													12	13	14	15
Number of specimens observed	.				.			.			.		1	24	34	

The measurements recorded in the following pages were made by means of dividers and a proportional scale. They are expressed in hundredths of the length of the body (which is recorded in millimeters), measured from the tip of the snout to the end of the last caudal vertebra.

The length of the head is measured from the snout to the posterior edge of the opercle, the opercular flap, which is apt to shrink, not being considered. Depth head, measured at occiput. Depth body, the greatest depth. Snout to dorsal; snout to ventral, from tip of snout to anterior end of base of fin. Depth caudal peduncle, at the narrowest place. Length of caudal peduncle, base of posterior anal ray to end of last vertebra, not to base of lowermost caudal ray, as the latter point is often indefinite. Length of snout, tip of snout to anterior border of eye. Interorbital width measured on skull, the dividers being closed as nearly as possible between the eyes. Snout to occiput, tip of snout to point on occiput where scales begin. Length base of dorsal or anal, distance between bases of first and last rays. Length caudal, from end of last vertebra to tip of upper lobe. Scales lateral line, counted to end of last vertebra. Scales above lateral line, from lateral line upward and forward to a point near middle of back. Scales below lateral line, from anterior edge of base of anal upward and forward to lateral line; lateral line series not included in either count. Scales before dorsal, the number of rows between base of first dorsal ray and the occiput. Dorsal and anal rays, when the posterior ray is cleft to the base it is still counted as one. The anterior ray is often spinelike and preceded by one or more closely adnate simple rays. These are enumerated as one.

MEASUREMENTS OF CATOSTOMUS TAHOENSIS.

FALLEN LEAF CREEK, NEAR LAKE TAHOE.

Length of body mm.	293	185	177	169	203	181	142	176
	♂	♂	♂	6	9	9	♀	9
Length head	0.23	0.24	0.255	0.245	0.25	0.235	0.24	0.23
Depth body	.18	.18	.20	.20	.20	.21	.20	.22
Depth caudal peduncle	.075	.078	.08	.08	.083	.08	.095	.08
Length caudal peduncle	.163	.16	.17	.155	.275	.17	.16	.17
Length snout	.12	.115	.11	.11	.13	.22	.12	.11
Diameter eye	.04	.045	.045	.042	.04	.041	.045	.04
Interorbital width	.08	.08	.09	.085	.09	.085	.085	.083
Depth head	.25	.155	.16	.16	.155	.16	.16	.155
Snout to occiput	.205	.19	.22	.21	.225	.20	.20	.205
Snout to dorsal	.55	.50	.55	.52	.5	.48	.5	.51
Snout to ventral	.565	.55	.57	.55	.555	.55	.57	.54
Length base of dorsal	.13	.13	.13	.15	.13	.125	.225	.14
Length base of anal	.095	.08	.10	.095	.08	.075	.07	.08
Height dorsal	.15	.155	.16	.175	.155	.27	.175	.16
Height anal	.21	.203	.24	.23	.19	.19	.20	.17
Length pectoral	.18	.19	.21	.21	.18	.19	.20	.18
Length ventral	.165	.13	.125	.13	.128	.135	.24	.225
Length caudal	.20	.21	.235	.235	.21	.21	.235	.21
Dorsal rays	10	11	20	11	10	20	10	10
Anal rays	7	7	7	7	7	7	7	7
Scales lateral	90	95	89	89	97	92	88	94
Scales above lateral lne	17	19	27	19	18	18	27	18
Scales below lateral line	13	14	23	13	14	23	14	14
Scales before dorsal	48	50	50	46	50	45	45	45

TRUCKEE RIVER NEAR MOUTH.

Length of body mm.	217	197	230	290	275	278	308	310	290	293
	♂	♂	♂	♂	e	9	2	♀	9	9
Length head	0.22	0.235	0.23	0.23	0.22	0.235	0.23	0.23	0.235	0.225
Depth body	.19	.20	.22	.185	.205	.20	.20	.19	.18	.20
Depth caudal peduncle	.09	.085	.05	.08	.095	.09	.09	.08	.085	.09
Lenght caudal peduncle	.18	.17	.17	.16	.16	.17	.17	.16	.16	.17
Length snout	.11	.12	.11	.115	.11	.11	.105	.115	.115	.11
Diameter eye	.034	.04	.035	.035	.03	.035	.032	.03	.032	.03
Interorbital wid h	.09	.09	.10	.09	.20	.10	.10	.m	.095	.20
Depth head	.15	.16	.x6	.255	.145	.16	.17	.155	.155	.16
Snout to occmut	.18	.22	.19	.19	.175	.29	.18	.185	.20	.18
Snout to dorsal	.48	.50	.49	.495	.49	.495	.49	.5	.5	.50
Snout to ventral	.56	.55	.55	.5	.545	.57	.55	.7	.56	.57
Length base of dorsal	.145	.25	.165	.145	.165	.145	.13	.23	.23	.12
Length base of anal	.so	.09	.20	.09	.10	.08	.082	.071	.075	.085
Height dorsal	.16	.17	.16	.145	.25	.25	.15	.235	.24	.245
Height anal	.29	.21	.225	.16	.185	.19	.18	.165	.17	.182
Length pectoral	.195	.20	.19	.275	.175	.18	.175	.17	.155	.175
Length ventral	.145	.16	.16	.15	.55	.135	.23	.125	.22	.23
Length caudal	.20	.22	.22	.20	.21	.20	.203	.19	.18	
Dorsal rays	11	10	11	11	11	11	11	11	10	10
Anal rays	7	7	7	7	7	7	7	7	7	7
Scales lateral line	89	88	82	89	84	93	83	90	90	9
Scales above lateral line	16	17	17	17	27	18	17	18	17	16
Scales below lateral line	4	4	4	4	53	15	14	13	15	15
Scales before dorsal	43	4	43	44	41	44	41	45	44	43

MEASUREMENTS OF CATOSTOMUS TAHOENSIS—Continued.

HUMBOLDT RIVER NEAR PALISADE.

Length of body..... mm..	178	173	157	753	147	123	150	135	134	123
Length head	0.23	0.25	0.24	0.26		0.25	0.24	0.25	0.255	0.235
Depth body	.175	.18	.18	.175		.19	.21	.175	.20	.20
Depth caudal peduncle	.09	.095	.085	.085		.085	.095	.085	.09	.09
Length caudal peduncle	.15	.15	.15	.15		.16	.12	.155	.15	.15
Length snout	.715	.12	.11	.125		.11	.11	.13	.12	.11
Diameter eye	.04	.045	.04	.045		.045	.045	.045	.045	.045
Interorbital width	.095	.095	.095	.095		.09	.10	.09	.10	.10
Depth head	.15	.16	.16	.16		.155	.17	.16	.17	.16
Snout to [illegible]	.20	.21	.21	.215		.205	.21	.21	.21	.20
Snout to dorsal	.52	.51	.51	.52		.52	.51	.51	.51	.57
Snout to ventral	.59	.575	.57	.58		.56	.56	.555	.57	.57
Length base of dorsal	.73	.14	.11	.13	.15	.14	.135	.12	.13	.13
Length base of anal	.07	.065	.065	.075	.12	.06	.06	.06	.06	.07
Height dorsal	.16	.17	.165	.165	.17	.17	.165	.175	.18	.175
Height anal	.19	.09	.19	.115	.15	.21	.18	.175	.19	.21
Length pectoral	.19	.19	.18	.20	.20	.20	.18	.09	.20	.21
Length ventral	.05	.75	.74	.145		.15	.13	.14	.14	.16
Length caudal	.24	.28	.22	.24		.24	.23	.225	.25	.235
Dorsal rays	10	11	10	10	0	11	10	70	10	10
Anal rays	7	7	7	7		7				
Scales lateral line	91	86	90	92	1	92	89	90	88	97
Scales above lateral line	17	17	18	19		09	19	18	17	18
Scales below lateral line	14	12	14	14	3	13	13	13	13	13
Scales before dorsal	45	40	44	43	0	44	42	43	40	41

WALKER RIVER. YERINGTON, NEV.

Length of [illegible] ..	158	160	148	142	130	127	140	135	126	111
Length head	0.235	0.235		0.23	0.245	0.23	0.22	[illegible]	0.24	0.26
Depth body	.22	.20		.21	.20	.20	.21		.20	.20
Depth caudal peduncle	.095	.09		.10	.085	.10	.09		.09	.095
Length caudal peduncle	.16	.17		.16	.15	.18	.15		.155	.15
Length snout	.71	.11		.11	.115	.12	.105		.11	.12
Diameter eye	.04	.04		.04	.045	.045	.04		.04	.04
Interorbital width	.10	.09		.10	.10	.095	.09		.095	.10
Depth head	.155	.155		.15	.155	.18	.15		.16	.16
Snout to [illegible]	.195	.195		.20	.205	.185	.21		.20	.21
Snout to dorsal	.49	.495		.50	.50	.49	.475		.50	.505
Snout to [illegible]	.56	.57		.565	.57	.56	.545		.57	.56
Length base of dorsal	.15	.15		.14	.13	.13	.15		.14	.14
Length base of anal	.085	.08		.085	.08	.075	.08		.075	.08
Height dorsal	.175	.175		.16	.16	.19	.16		.18	.17
Height anal	.21	.19		.20	.20	.22	.19		.225	.20
Length [illegible]	.205	.20		.20	.21	.21	.20		.215	.18
Length ventral	.13	.145		.15	.14	.16	.145		.16	.13
Length caudal	.23	.275		.92	.24	.23	.22		.33	.24
Dorsal rays	10	xi		11	10	11	11		it	10
Anal [illegible]	7	7		7	7	7	7		7	7
Scales lateral line	89	87		86	88	87	85		89	84
Scales [illegible] lateral line	18	16		18	17	17			18	19
Scales [illegible] lateral line	13	14		15	14	14	14		15	15
Scales before dorsal	45	45		44	44	43	42		45	40

MEASUREMENTS OF CATOSTOMUS TAHOENSIS—Continued.

EAGLE LAKE, CALIFORNIA.

Length of body	341	362	325	335	276	335	332	285	297	261
		♂	♂	♂	♂	♂	♂	♂	♂	♂
Length head		0.235	0.23	0.24	0.24	0.24	0.23	0.24	0.235	0.245
Depth body		.205	.205	.215	.219	.205	.205	.195	.22	.215
Depth caudal peduncle		.085	.095	.085	.085	.09	.085	.085	.095	.085
Length caudal peduncle	5	.16	.15	.25	.165	.15	.15	.14	.14	.16
Length snout	5	.115	.12	.12	.115	.115	.12	.13	.115	.115
Diameter eye	2	.032	.035	.031	.035	.033	.033	.035	.032	.035
width	11	.105	.11	.105	.105	.205	.105	.105	.10	.10
Depth head	17	.17	.27	.165	.165	.165	.165	.17	.165	.17
Snout to		.205	.20	.20	.195	.205	.195	.195	.20	.215
Snout to dorsal	48	.50	.49	.51	.49	.485	.485	.51	.48	.485
Snout to ventral	55	.56	.57	.56	.57	.55	.565	.575	.55	.57
Length base of dorsal	15	.14	.15	.14	.14	.14	.155	.14	.162	.15
Length base of anal		.10	.105	.095	.09	.095	.10	.09	.10	.10
Height dorsal		.14	.15	.15	.16	.145	.15	.14	.15	.145
Height anal		.17	.195	.19	.20	.19	.195	.195	.185	.18
Length pectoral		.181	.19	.185	.185	.175	.18	.195	.18	.18
Length ventral		.13	.13	.14	.14	.13	.14	.14	.14	.14
Length caudal		.21	.20	.20	.205	.185	.295	.205	.195	.29
Dorsal rays		10	11	10	11	11	11	11	11	11
Anal rays		7	7	7	7	7	8	7	7	7
Pectoral rays		14	15	15	16	15	16	16	16	15
Scales lateral line		93	93	90	94	92	96	93	95	94
Scales above lateral line		20	21	21	21	20	21	21	21	20
Scales below lateral line		16	15	x6	15	16	16	16	16	16
Scales before dorsal		43	45	45	46	50	48	49	50	48

Catostomus arenarius, new species. Sand-bar sucker.

Examples of the species, which is here described for the first time, resemble those of C. tahoensis so closely as to easily pass unnoticed among them. The scales of C. arenarius are larger, however. This species is apparently a representative of C. macrocheilus, C. snyderi, and C. occidentalis, all similar 'coarse-scaled forms of the Columbia, Klamath, and Sacramento River systems, respectively. It should not be regarded as a very close ally of either C. catostomus, C. rimiculus, or C. microps. It differs but little from C. warnerensis of the Oregon Lake system, and it is possible that the immediate relationships of that form may be with this species rather than with C. catostomus or C. tahoensis. C. arenarius has smaller scales than are found in C. macrocheilus, C. snyderi, or C. occidentalis. In addition to the smaller scales it has fewer dorsal rays than are found in C. *occidentalis* or C. snyderi.a

When its relationships are considered, the discovery of this species becomes a matter of considerable interest, for it adds an important link to the chain of related catostomid species which are known to occur in the Sacramento, Klamath, Columbia, and Lahontan systems. The following diagram will serve to illustrate the probable affinities and distribution of these forms:

Coarse-scaled catostomids	Sacramento	C occidentalis.
	Klamath	C C snyderi.
	Columbia.	C C C macrocheilus.
	Oregon Lake. ...	C C C warnerensis.
	Lahontan	C C C arenarius.
Fine-scaled catostomids	Sacramento	C microps.
	Klamath	C C *rimiculus*.
	Columbia.	C C C catostomus.
	Lahontan	C C tahoensis.

It has been suggested that the lake region of eastern Oregon b may in the remote past have furnished a free way for the migration of both a fine and a coarse scaled catostomid, which became differentiated after entering the systems where its representatives are now found. But one species, C. warnerensis,

a Bulletin, United States Bureau Fisheries, vol. XXVII, 1907, p. 80-84, 162-169.
Bulletin, United States Bureau Fisheries, vol. XXVII, 1907, p. 77.

has been taken in the Oregon Lake region, the other, if such really existed, having been unable to maintain itself in the very restricted and reduced basins of which the system is now composed. It seems that C. *warnerensis* and C. *arenarius* are probably related, both belonging with the coarse-scaled series.

The following description is of the type, no. 75654, United States National Museum, a male specimen measuring 330 millimeters, collected at the Willows, Pyramid Lake, Nev., May 20, 1913. (Fig. 1.)

Head 4.1 in length to base of caudal; depth 4.9; depth caudal peduncle 11.5; snout 2.1 in head; eye 7.2; interorbital space 2.5; width of mouth 4.2; scales lateral series 75; between lateral line and back 15; between lateral line and base of ventral 12; between occiput and dorsal 26.

Mouth large, the lips broad and full; 6 or 7 rows of papillæ on upper lip, about 8 on the lower. Eye nearer edge of opercle than tip of snout. The dorsal foramen of the skull is broad and long. Body completely scaled, the scales being nowhere unusually small or densely crowded; those on anterior part of breast deeply embedded and not easily distinguished. Edge of dorsal fin straight. Ventrals inserted below middle of dorsal. Pectorals, ventrals, and anal broadly rounded.

Color in life, olive above, light yellowish brown on thesides, silvery suffused with pink on the ventral surface, back, and sides with metallic reflections; a bright red lateral stripe of irregular width and with

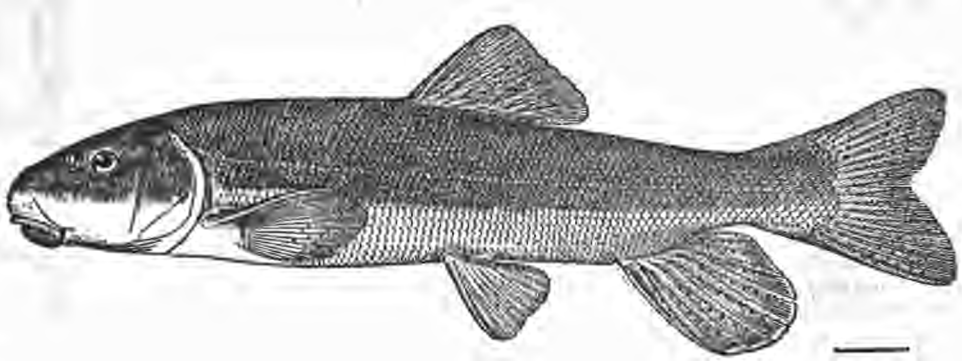

FIG. 1.—*Catostomus arenarius*. Type. Sand-bar sucker.

indefinite edges extends from opercle to tip of tail; tubercles on anal and lower half of caudal dead white. In spirits all trace of the bright color disappears; the dorsal parts become blue-black, then brown, the ventral region white or yellowish.

The females are less brightly colored in life, the body lacking much of the metallic sheen, and the lateral stripe being but faintly indicated. On attaining large size the body becomes stocky and the head appears more rounded. The largest specimen seen measured 20 inches in length and weighed 2½ pounds.

The first example of this species was seen in the lower Truckee River, where it was picked out from a number of "cui-ui" and red suckers caught by the Indians. They called it " au-wa-go," not distinguishing between it and the red sticker, C. *tahoensis*. It was later caught in Fallen Leaf Creek near Lake Tahoe and in the Humboldt River. It was finally observed spawning in Pyramid Lake, May 20. The eggs were being deposited deep in the coarser sand and gravel of the bars near shore. Numerous minnows were in attendance struggling with one another for the eggs. After June 1 no suckers were spawning and none was seen near shore.

One large example of this species was found in the collection of the National Museum among some specimens of *Catostomus* tahoensis which had been collected long ago by H. W. Henshaw at Lake Tahoe.a

a *Catostomus tahoensis* first appears in Bulletin 12, United States National Museum, 1878, p. 173, where a brief diagnosis is given, and a specimen collected by J. G. Cooper is designated as the type. Examples collected by Renshaw are also mentioned. A description and figures appear later (Report Chief Engineers, 1878, pt. 3, p. 1610), where the specimens collected by Henshaw are referred to as the types. However, the figures accompanyingthis description are of one of the examples collected by Cooper, and which was first designated as the type. It is fortunate that the latter is preserved (type no. 5240), for an examination of Henshaw's specimens reveals the presence of two species, one of which, a relatively fine-scaled form, is represented by Cooper's specimen. The latter measures 298 millimeters in length. There are 92 scales in the lateral series, 16 between the lateral line and the back and 50 between the occiput and dorsal fin. The name *tahoensis* may without doubt therefore be applied to the fine-scaled form.

MEASUREMENTS OP EIGHT SPECIMENS OF CATOSTOMUS ARENARIUS.

Length of body mm	294	308	282	419	157	140	126	117
Length head	0.27	0.265	0.25	0.26	0.235	0.245	0.24	
Depth body	.215	.23	.21	.21	.19	.21	.20	
Depth caudal peduncle	.09	.09	.09	.08	.08	.09	.08	
Length caudal peduncle	.255	.175	.165	.158	.16	.165	.155	
Length snout	.135	.12	.12	.13	.115	.11	.115	
Diameter eye	.035	.032	.035	.03	.045	.045	.045	
Interorbital width	.12	.105	.10	.115	.085	.09	.20	
Depth head	.18	.272	.17	.175	.15	.26	.16	
Snout to occiput	.21	.20	.21	.205	.21	.21	.21	
Snout to dorsal	.515	.49	.515	.50	.50	.5-	.55	
Snout to ventral	.59	.575	.565	.5	.56	.5 5	.57	
Length base of dorsal	.232	.24	.24	.13	.15	.25	.14	
Length base of anal	.08	.075	.09	.085	.095	.08	.08	
Height dorsal	.145	.145	.15	.23	.16	.155	.165	
Height anal	.18	.182	.21	.165	.22	.19	.19	
Length pectoral	.20	.185	.20	.19	.21	.18	.20	
Length ventral	.135	.133	.145	.13	.17	.14	.16	
Length caudal	.23	.21	.23	.19	.225		.23	
Dorsal rays	II	II	II	II	II	10	10	
Anal rays	7	7	7	7	7	7	7	
Scales lateral line	68	73	71	73	73	74	73	
Scales above lateral line	15	16	14	16	16	15	14	
Scales below lateral line	12	11	12	11	12	13	12	13
Scales before dorsal	35	34	36	36	40	40	4-	39
No.	1	2	3	4	5	6	7	8

No. 1-3, Pyramid Lake; 4, Truckee River near Pyramid Lake; 5, Fallen Leaf Creek near Lake Tahoe; 6, Humboldt River, Carlin; 7, Pine Creek near Palisade; 8, Star Creek near Deeth.

Pantosteus lahontan Rutter, Lahontan sucker.

The relationships of the Lahontan sucker were thought by its describer to be with Pantoskusgenerosus of the Bonneville system.a An examination of the types of the suckers described from the Bonneville Basin, and which have been lately regarded as synonymous with P. genewsus, reveals the presence of two species which appear to be generically different, *Notolepidomyzon* generosus (Girard) and *Pantosteus* platyrhynchus (Cope). The affinities of P. khontan are with the latter. It has an open fontanel and a long slender form like that of P. *platyrhynchus*. A series of carefully prepared specimens of P. *platyrhynchus* is not available for a more detailed comparison of the species.

The cutting edges of the mouth are provided with sharp, horny coverings. The lips are pendulous and have many prominent papillæ. The posterior lip is not deeply cleft, the papillose area opposite the notch extending forward toward the center. The pectorals are pointed and somewhat falcate. The anal frequently extends to the base of the caudal.

In life, examples of this species are usually brownish olive above, of a lighter or darker shade, depending much on the surroundings, and lighter to whitish beneath. Often a pale-red lateral stripe appears after death in alcohol. Several males were observed with a bright-red lateral stripe, about equal in width to the eye, extending along the side from middle of head to caudal fin, the color becoming brighter in the region between the head and dorsal fin. The body was light olive above with brassy reflections, lighter on the sides, merging into silvery and then into dead white below. The fins were brassy, the axils of pectorals and ventrals orange red. Anal fin and lower half of caudal with dead white tubercles. Peritoneum dense black.

The alimentary canal is very slender, extremely long, and regularly coiled over the ventral surface of the abdomen. The air bladder extends over about three-fourths of the length of the abdominal cavity. Its anterior chamber is somewhat less than one-third as long as the posterior part.

Females with nearly ripe eggs were observed in Long Valley Creek, July 53. Ripe eggs were found in examples in Carson River, July 20, and in Quinn River, July 30. Both males and females appeared to be migrating up the Humboldt River early in July, for they were congregating in large number below obstructions.

a Bulletin, United States Fish Commission, vol. XXII, 1902, p. 146.

This species appears in schools along with *Catostomus*, small examples of the latter being easily distinguished in the water by the large dark spots on the sides. It usually appears in small numbers in the lower courses of the streams, but is often more abundant where the current is swift. Individuals do not appear to reach a large size; no specimen over 6 inches in length was seen. None was found in the lakes.

Small suckers which may belong to this species were reported from Pine Creek, which flows into Eagle Lake. None was seen at the time of the writer's visit.

MEASUREMENTS OF PANTOSTEUS LAHONTAN, HUMBOLDT RIVER, PALISADE.

Length of body mm.	222	129	123	127	124	118	100	108	98	110
Length head	0.23	0.11	0.23	0.22	0.23	0.225	0.21	0.23	0.215	0.22
Depth body	.19	.17	.17	.18	.17	.18	.20	.165	.165	.16
Depth caudal peduncle	.085	.08	.08	.08	.08		.08	.08		.08
Length caudal peduncle	.16	.16	.165	.17	.165	.055	.165	.17	.17	.16
Length snout	.12	.11	.125	.125	.225	.115	.11	.12	.12	.115
Diameter eye	.04	.04	.04	.04	.04	.045	.04	.04	.04	.04
Interorbital width	.08	.08	.08	.085	.08	.08	.08	.035	.08	.075
Depth head	.14		.135	.14	.14	1/35	1/39	.13	.14	.13
Snout to occiput	.20	.18	.195	.205	.20	.20		.20	.19	.20
Snout to dorsal	.50	.49	.50	.50	.49	.49	.50	5/0	.49	.50
Snout to ventral	.575	.55	.56	.57	.58	.56	.57	.58	.56	.565
Length base of dorsal	1/4	.13	.13	.13	.135	.145	.13	.135	.13	.14
Length base of anal	.06	.063	.065	.07	.265	.07		.065	.07	.065
Height dorsal	.16	.17	.16	.16	.16	.165	.17	.18	.26	.16
Height anal	.20	.225	.22	.20	.215	.21	.21	.20	.20	.20
Length pectoral	.19	.20	.19	.20	.20	.20	.19	.20	.20	.18
Length ventral	.14	1/45	.14	.14	.145	.145	.13	.15	.14	.15
Length caudal	.22	.22	.215	.22	.215	.215	.21	.22	.20	.22
Dorsal rays	10	11	20	20	10	11	10	10	20	10
Anal rays	7	7	7	7	7	7	7	7	7	7
Scales lateral line	78	83	77	79	83	82	83	82	81	80
Scales above lateral line	25	16	18	16	17	16	18	16	15	16
Scales below lateral line	11	12	13	12	12	13	13	22	11	12
Scales before dorsal	40	41	42	41	43	44	44	44	47	43

Chasmistes cujus Cope. "Cui-ui."

Nothing seems to have been added to the brief original description of this species given by Cope,[a] and until now but one specimen, the type, was preserved in any museum. Its distribution is restricted to Pyramid and Winnemucca Lakes, where it lives in deep water beyond the reach of ocular observation, except during the brief spawning period, when a migration is made for a short distance up the Truckee River.

The annual run begins about April 15, varying somewhat of late years with the condition of the river. The season of 1913 afforded an unusually good opportunity for observation, as the water was comparatively low and clear, while during the entire spring a reasonably steady flow into both Pyramid and Winnemucca Lakes was maintained.

The first "cui-ui" appeared in the river April 13, when several schools passed up rather hastily and lodged in pools below an impassible irrigation dam. This preliminary wave having passed, none was seen again until on the morning of April 22, when schools of 20, 30, or even 50 or more individuals were observed moving slowly and steadily upstream. It was customary for them to congregate and lie for a while below a rapid place, then suddenly and speedily shoot up, singly or in pairs or in small straggling schools, their brilliant red and brassy sides flashing in the bright sunshine. None of these stopped to

a Proceedings, Academy Natural Sciences, Philadelphia, 1883, p. 149.

Cope spelled the Piute name of the species *Couia*, and it has been thus known to recent authors. The white residents pronounce it kwee-wee. Both the latter and Cope's name are corruptions of the Indian name "pui-ui" (pronounced Kouie-wee).

Fowler holds that *Liponyxon*, Cope, 1879 (*brevirostris*) should be used instead of *Chasmistes* (Jordan, 1879) (Proceedings, Academy Natural Science, Philadelphia, 1914. p. 53). It will be found, however, that Dr. Jordan (Bulletin, Geological Survey, Hayden, vol. IV, 1878. p.417) fully, or at least sufficiently diagnosed the genus *Chasmistes* as follows: "This genus is distinguished from Catostomus by the very large terminal mouth, the lower jaw being very strong, oblique, its length about one-third that of head. The lips in *Chasmistes* are little developed and are very nearly smooth."

Dr. Jordan wrongly supposed that the specimens from which he described *Chasmistes* were representatives of *Catostomus* fecundus Cope and Yarrow, the type of which he had not then seen, and which, as he later determined, is a true *Catostomus*. Under the circumstances it seems to be of secondary importance that C. *fecundus*, the name wrongly applied, was first designated as the type. (Bulletin, United States National Museum, no. 12, 1878, p. 229.)

spawn. Some which were dissected did not appear to be ripe. They were very shy and fled at once on the approach of a shadow, the jar of crunching gravel, or a heavy footfall; but the observer could come close if the move was steadily made. The passage of large numbers continued intermittently, until about May 16, when it became evident that the migration was waning rapidly. After May 11 none was seen moving upstream.

In the meantime spawning had begun and was progressing with great activity. On April 24 the first females were seen depositing eggs. However, several ripe males and females were secured a little earlier. By May 5 every suitable bar or gravel bed was occupied by spawning fishes, whose activities entirely ceased before the 16th.

The spawning is entirely [illegible]; it occurs in relatively shallow water where the flow is rapid, often at the head of a bar which turns or parts the current. At times the dorsal fins project above the surface, and in very shallow places where there is much crowding the whole back is exposed. Two, three, or even five or more males attend a single female during the spawning act. They wriggle over, alongside of, and around her, thrashing the water with such violence that close observation is impossible. Spawning fishes are easily alarmed, but if the observer approaches in the water he may occasionally get close enough to pick up specimens without difficulty. Eggs may be stripped and fertilized with ease.

The ovaries are large, the eggs small and very abundant. No enemy appeared on the spawning beds, but the habit of depositing the eggs in shallow water often exacts an enormous toll from the young of the species, for a sudden fall in the volume of the river may leave many nests high and dry in a single day.

No doubt the migration and spawning activities here described are fairly typical. Usually the water is so high, swift, and roily that very little of what is going on beneath its surface can be seen. Of late years irrigation projects and power plants have at times seriously interfered with the flow of the river and consequently disturbed the normal life of some of its native species. During the winter of 1911–12 the snow was very light in the mountains and there were no heavy rains. The dam at Tahoe was closed early, and a large amount of water was at the same time diverted from the channel of the Truckee above Derby. The lower part of the river then became so reduced that water began to flow back from Pyramid Lake (where it was higher than usual), up the river, down the slough, and into Winnemucca Lake, the surface of which is lower than that of Pyramid Lake. This flow continued until the water of the channel between the lakes was practically as brackish as that of the lakes themselves. No "[illegible]" appeared in the river until a full month after the usual time, and then not until high water suddenly forced back the brackish flow and sent a fresh stream out into the lake. On the advent of this directing current the usual rush of "[illegible]" from the lakes began; large schools passed up the river (May 17) and spawned at once. During the earlier back flow sufficient depth was maintained for the easy passage of the fish, but it seems probable that there being no inflow of fresh water the waiting migrants were unable to find the mouth of the river.

The time of departure of the fish from the river could not be determined because of high water, as no "[illegible]" were seen at any time going down stream. A few individuals were seen in the river June 14, when the water suddenly cleared. On June 5, and for many days thereafter, large numbers of dying, dead, and decaying specimens were found at the mouth of Winnemucca Slough. This mortality among the "[illegible]" is said to be a regular feature of the season at this place. If a similar death rate prevails in the lower Truckee, it was not evident at the time. However, the river was deep, the current strong, and the lake was stormy when the examination was made. A few dead individuals are always found along the river after the breeding season. It is possible and quite probable that the death rate is high just after the breeding season, but there is nothing to indicate that all the fish die after spawning. The dead and dying examples bore no evident scars.

Diligent inquiry brought forth no account of the species spawning in the lakes. No one was found who had even seen one there. Hours of observation from [illegible] domes failed to detect any among the myriads of fishes which could be easily identified. Yet on May 11, 1913, large numbers of "[illegible]" were found depositing eggs along the shallows near some springs on the southwest shore. Both ripe males and females were examined. The Indians were after them almost immediately, and they declared that these were the first that they had seen in the lake. None was observed here May 16 or later. A few individuals were found spawning in Winnemucca Slough.

During the breeding season the males differ from the females in color and there is some variation in both sexes. The males have a dense black stripe 5 to 6 scales wide extending 10 scales below the

dorsal fin from the opercle to the base of the caudal. The borders are interrupted here and there by brassy or silvery scales. Above the black stripe are numerous reddish-bronze scales with dark spots. The middle of the back is dusky, and this dark surface, together with the black stripe below, causes the red area to stand out boldly, especially when the fish turning in the water flashes the metallic red in the sunshine. Below the black stripe the body is silvery, many scales having a brassy sheen. The ventral surface is clean, dead white. The upper part of the head is blackish, the lower part whitish. The fins are slate blue, the paired ones lighter than the others. The tubercles are yellowish white. When the fishes are observed in the water from directly overhead, the stripes are very prominent, converging posteriorly and meeting over the caudal peduncle. The head appears lighter than the body, and the fins are very distinct. Some individuals are much duller, but in every specimen there is at least a strong trace of the red and dark stripes.

In the female the whole upper surface is dark brownish-black, not the olive color usually seen in suckers. The sides are brassy, often more or less dull, and frequently the darker color is broken up into clouds on the sides. Occasionally the entire dorsal region of a female is tinged with a reddish coppery hue, the edges of the scales having a decided metallic luster. Sometimes the females are called black suckers. At times whole schools of both sexes were seen, apparently ready to spawn, but without a single individual with fully developed colors.

Some Indians assert that they can distinguish between "cui-ui" from the different lakes. Those from Winnemucca, said to be lighter in color and inclined to be spotted, are known as Izhi-"cui-ui." The writer after examining many specimens from both lakes was unable to detect any difference.

Observers differ somewhat as to the most distant point reached by *C. cujus* during the nuptial migration. It appears in large numbers at the great bend of the Truckee, and it certainly ascends the river somewhat beyond the confines of the ancient Lake Lahontan. It never quite approaches the swift water above Reno. It would no doubt be a physical impossibility for the species to stem the turbulent water of the river canyon. The great blunt head and huge body, loaded down with eggs and fat, and the relatively small and weak caudal fin are not calculated to lend speed or endurance to a fish entering the current of a river for perhaps the first time. If Pyramid and Winnemucca Lakes contract and become too salty for fresh-water species, as may possibly transpire if much water is withdrawn from the Truckee River for irrigation purposes, this species no doubt will disappear.

Spawning appears to be more active at night than in the daytime, and so, also, is migration. This became evident from direct observation and from the fact that early morning usually revealed greatly changed conditions in the river population.

At times "cui-ui " appeared in such large and densely packed schools that considerable numbers were crowded out of the water in shallow places, especially on the gently sloping river bars. Once several hundred were observed stranded near the mouth of the river. In some places they were jammed together in masses two or three deep. Some were crowded entirely out and dead, while others were in water a foot deep, yet pushing close to the main group in a perfectly demoralized condition. When one such conditionally free individual was carried some distance away and headed upstream, it passed on its way with great speed, but if removed a short distance only it returned to the mass like an iron to the magnet. It was impossible to separate any number and get them started away from the stranded school. Cormorants, gulls, and pelicans in great numbers were attacking them, and many of the still wriggling fishes had lost their eyes and strips of flesh had been torn from their sides.

The stomachs of all specimens examined were devoid of food.

The largest specimen seen measured 670 millimeters, the smallest 410.

Males.		Females.	
Length.	Weight.	Length.	Weight.
Inches.	*Pounds.*	*Inches.*	*Pounds.*
20.5	3	24.75	6
17.25	2	23.5	5.5
19.75	3	20.5	3.5
19.25	3	21.35	4
21.25	3.5	21.75	4.75
20	3.25	22.5	5
		20.75	3.75

The flesh of this species is highly prized by the Indians. In former times the coming of the "cui-ui" was a great event, not only for the Pyramid Lake tribe but also for other Piutes from far to the south, who sometimes reached the fishing grounds in such a starved condition that many were unable to survive the first feast. At present numerous little camps may be seen along the river during the spawning period. The fishes are caught in large numbers and tons of them are dried for later use. They are taken most easily when the river is roily, the fishermen hooking them with an improvised gaff which is drawn quickly through the muddy water. Knowing the "cui-ui" habit of resting in schools in quiet water, the Indian establishes his camp accordingly, and the willows, wire fence, or hastily constructed rack are soon covered with unsalted drying fish, which attract numbers of flies and send characteristic odors a long distance down the wind.

When properly cooked, the flesh is sweet and palatable, equal to that of some fishes which bring a fair price in the city markets. The uncleanly methods of preservation employed by the Indians have caused the "cui-ui" to be regarded with prejudice, and white people of the region will not eat them.

A male specimen measuring 600 millimeters in length is here described, and measurements of others follow:

Head, 3.7 in length to base of caudal; depth, 4.3; depth caudal peduncle, 3.5 in head; snout, 2.2; eye, 10.5; width mouth, 3; interorbital space, 2.3; height dorsal, 2.3; anal, 1.4; length pectoral, 1.5; ventral, 2; caudal, 1.4.

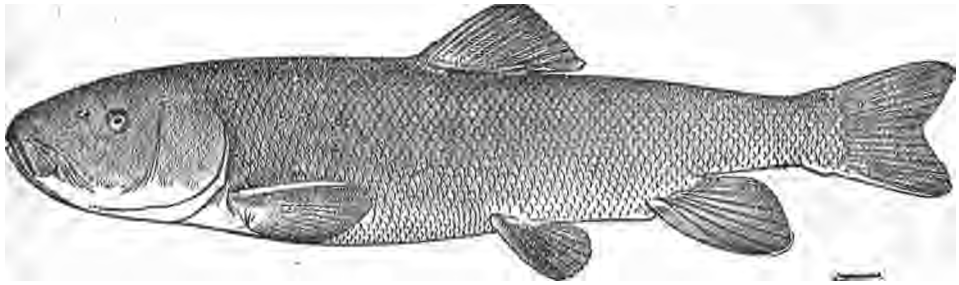

FIG. 2.—*Chasmistes cujus*.

Head and body extremely robust, broad, and round; top of head broad and slightly convex; cheeks puffed out; eye small when compared with the great size of head; snout projecting beyond mouth, evenly rounded in life, the premaxillary process presenting no "hump," the latter being characteristic of poorly preserved or dried specimens; lips smooth, the lower broad and pendulous; both lips plainly show traces of papillæ, which appear as if once developed but since united and grown over. Posterior margin of opercle broadly and evenly rounded, the free fleshy edge about equal in width to half the diameter of eye. There are 43 gillrakers on the first arch. All have wide, papillose edges, the lower ones being especially broad and brushlike, the upper ones falcate and comparatively narrow. The digestive tract is long and coiled many times. The testes are of huge dimensions and lobular. The air bladder extends to a point above posterior edge of base of ventrals. Peritoneum dusky, almost black. The skin of the head is smooth, the dorsal surface with many minute tubercles. Body completely scaled, the scales large and even, nowhere densely crowded. Each scale, excepting those on the ventral surface and immediately above and behind the pectorals, with a tubercle at its tip. Rays of fins with tubercles; those on pectorals, ventrals, and dorsal small; on anal large and sharply pointed.

Base of second dorsal ray inserted half way between tip of snout and posterior edge of last caudal vertebra. Ventrals below posterior half of dorsal; pectorals broadly rounded; anal obtusely pointed; caudal concave.

The females are more stocky than the males, and with their huge heads, large rounded bodies, and relatively short fins are very ungainly looking fish. The scales and fins are without tubercles.

Species related to *Chasmistes* cujus are found in the Bonneville and Klamath Lake Basins.

MEASUREMENTS OF CHASMISTES CUJUS, TRUCKEE RIVER, NEAR MOUTH.

Length of body ..... mm.	444	410	416	420	410	412	418	493	437
	e	e	♂	♂	♂	♂	♂	♂	♂
Length head	0.28	0.27	0.285	0.275	0.30	0.29	0.28	0.275	0.275
Depth body	.22	.22	.21	.225	.231	.22	.22	.185	.19
Depth caudal peduncle	.09	.09	.09	.085	.083	.09	.085	.075	.08
Length caudal peduncle	.15	.145	.15	.25	.16	.18	.162	.16	.15
Length snout	.13	.13	.13	.13	.242	.135	.125	.225	.22
Diameter eye	.03	.027	.03	.035	.03	.035	.03	.03	.03
Interorbital width	.13	.12	.13	.12	.13	.13	.125	.115	.12
Depth head	.185	.18	.29	.185	.19	.191	.20	.176	.185
Snout to occiput	.23	.23	.23	.22	.23	.23	.23	.21	.215
Snout to dorsal	.52	.50	.525	.50	.52	.545	.52	.495	.51
Snout to ventral	.57	.57	.57	.58	.61	.595	.59	.57	.57
Length base of dorsal	.155	.135	.13	.15	.165	.165	.14	.155	.15
Length base of anal	.085	.09	.10	.095	.10	.10	.09	.09	.10
Height dorsal	.24	.24	.23	.225	.24	.214	.22	.22	.125
Height anal	.20	.20	.59	.18	.20	.225	.205	.195	.195
Length pectoral	.205	.19	.185	.185	.20	.20	.18	.275	.185
Length ventral	.155	.135	.13	.211	.25	.245	.125	.135	.24
Length caudal	.21	.21	.22	.20	.205	.205	.215	.185	.195
Dorsal rays	II	10	II	II	12	11	II	12	11
Anal rays	7	7	7	7	8	7	7	7	8
Scales lateral line	60	60	64	62	66	64	62	61	6x
Scales above lateral line	13	13	14	13	14	14	13	13	14
Scales below lateral line	10	10	11	10	12	10	20	10	10
Scales before dorsal	29	30	32	32	31	33	33	35	33

Length of body ..... mm.	422	417	538	525	485	515	45	445	45
	♂	♂	9	9	9	2	9	9	9
Length head	0.27	0.275	0.275	0.27	0.285	0.275	0.285	0.275	0.28
Depth body	.215	.20	.225	.22	.24	.215	.22	.22	.225
Depth caudal peduncle	.055	.08	.08	.08	.089	.08	.085	.085	.085
Length caudal peduncle	.165	.165	.262	.155	.14	.14	.155	.155	.155
Length snout	.12	.13	.125	.13	.14	.14	.13	.13	.132
Diameter eye	.03		.034	.025	.029	.028	.03	.03	.03
Interorbital width	.125	.12	.125	.125	.13	.125	.125	.125	.12
Depth head	.195	.18	.185	.19	.195	.185	.29	.175	.18
Snout to occiput	.225	.215	.21	.225	.225	.225	.22	.215	.22
Snout to dorsal	.51	.505	.51	.505	.50	.515	.505	.493	.51
Snout to ventral	.57	.57	.58	.60	.575	.57	.595	.50	.5
Length base of dorsal	.14	.14	.125	.233	.145	.15	.235	.14	.13
Length base of anal	.09	.09	.09	.071	.075	.08		.09	.08
Height dorsal	.12	.12	.11	.12	.13	.13	.125	.125	.125
Height anal	.19	.21	.145	.15	.15	.16	.16	.174	.155
Length pectoral	.29	.18	.275	.18	.165	.18	.18	.18	.165
Length ventral	.13	.14	.11	.12	.115	.12	.115	.225	.11
Length caudal	.21	.20	.18	.18	.27	.175	.19	.20	.185
Dorsal rays	11	11	10	11	11	10	11	11	11
Anal rays	7	7	7	7	7	7	7	7	7
Scales lateral line	64	59	62	64	59	62	61	62	61
Scales above lateral line	14	14	14	24	14	14	14	13	14
Scales below lateral line	10	12	11	10	10	10	10	10	10
Scales before dorsal	32	30	31	29	31	29	31	31	31

Richardsonius egregius (Girard). Red-striped shiner.

This beautiful little fish is almost universally distributed throughout the brooks, rivers, and lakes of the region.[a] It is found not only in the lower courses of the rivers where the water is deep and quiet, but it also stems the swift currents of the high mountain tributaries, following closely in the

a R. eareoius has been reported from two localities in the Sacramento Valley (Bulletin, United States Bureau Fisheries, vol. XXVII, p. 135). On direct comparison with examples from the Truckee Basin, the specimens upon which this report was based, including the type of *Pheximus clevelandi*, were found to differ in no respect from typical individuals of *R.* eoregius. The writer has at different times attempted to secure specimens of this species from the Putah Basin, including Aetna Springs Creek, the supposed type locality of *P. clevelandi*, but without success, and it seemed safe to conclude that it is not a native of that basin. Now, Stutter's discovery of the species in tributary of Feather River reopens the question. In this connection, however, it will be recalled that *Agosia robusta*, *Pantosteus lahontan*, and *Catostomus* tahoensis were also reported by the same author from a tributary of the Feather River. Since neither of these four forms has been seen elsewhere in the Sacramento River, excepting possibly *R.* epregius as *P. clevelandi*, the suggestion is offered that either these species have been recently introduced along with trout from the Truckee Basin or that Rutter was lead into an erroneous statement from confusion of labels.

wake of the smallest trout. It is best known as a river species—the bait fish of the angler, the "minny" of the small boy, and the food of the kingfisher and tern. It delights in the slow ripples and the quiet, shallow pools, where large numbers may be seen swimming lazily about over the submerged bars, occasionally turning their silvery sides to the bright sun. In the lakes it congregates in large schools, swimming about submerged logs, tops of fallen trees, wharves, and other sheltered places.

The relationships of the species appear to be with R. *balteatus* and R. hydro phlox, in some characters approaching the latter more closely. It may not be out of place to remark, however, that speculation regarding this and other western species of the genus will remain more or less futile until something more definite is known of the fauna of the upper Columbia and the Bonneville Basins.

In describing this species Girard[a] gives the locality as unknown. The register in the National Museum records Humboldt River, the entry having been made in February, 1857. The type is in all respects like specimens of the species from the Humboldt and other rivers of the Lahontan system.

This is one of the most brilliantly colored fishes of the West, not even excepting the trout. The brightest hues appear for a short time only during the breeding season and are seen at their best in the males.

While examining Fallen Leaf Creek, a tributary of Lake Tahoe, on June to, large schools of this species were observed making their way up the smaller tributaries, progressing chiefly at night, when they might be seen or heard struggling over the small rapids and leaping the miniature falls. Both sexes were highly colored, the males especially so, where small whitish epidermal nodules appear on the surface of the head, on the opercles, throat, and body, each scale along the sides having from one to three on its posterior edge. Later observation indicated that these fishes were at that time rapidly attaining the most advanced stages in their brilliant nuptial color.

Specimens were collected from day to day and the changes in color noted. Many ripe males were found at the time, but only an occasional ripe female. One of the latter was a deep olive green above, lighter on the sides, and silvery beneath, brassy and silvery metallic reflections appearing on various parts of the head and body. A distinct brassy stripe extended from the posterior border of the eye, across the upper edge of the opercle, straight along the side of the body and upper third of the caudal peduncle. Below the lateral line was a broad, indistinct area of violet pink over a brassy ground, the latter becoming more intense ventrally. Belly silvery, a narrow, bright-red axillary dash present. Iris tinted with pink. The females mostly were duller at first, many being seen with but a trace of the metallic or red color. A ripe male was deep olive green above, lighter on the sides, and whitish beneath. When viewed from the side or from below, silvery and brassy reflections appeared, these being suffused with a tint of violet pink, an occasional scale or group of scales remaining dark in any light. Two rather distinct brassy stripes extended from snout to caudal, one beginning at upper anterior edge of eye, crossing upper edge of gill opening, and extending posteriorly to upper third of caudal peduncle, the other, less definite in outline, passing from corner of mouth across preopercle, where it broadened and became brilliantly iridescent, along head and body above base of pectoral and straight back to caudal. Posteriorly the lower stripe became somewhat indistinct, but as the fish turned it flashed brighter in the sunlight. Below the lower stripe the sides were strongly suffused with pink, the suffusion growing more intense and darker in tone toward the axil of pectoral where it was light blood red, a dash of brilliantly burnished brass extending forward on base of pectoral to a point below the edge of preopercle. The fins were yellowish orange with metallic reflections, and likewise the body at bases of ventrals and anal.

Other males were much subdued in color, some possessing scarcely a bright tint. As time passed the color of even the brightest rapidly increased in intensity, the brassy reflections becoming more highly burnished, a broad, blood-red band appearing above the base of the pectorals and extending to the origin of the anal , the posterior part being yellowish and broken into spots. The abdomen became dead white. The most brilliantly colored males had a narrow red stripe below the eye, and the lateral dusky stripe that is present in all and which persists in preserved specimens was deep black. When placed in alcohol, the color soon became brighter on all parts of the body, and even appeared in specimens where none was seen in life. In preserved specimens the bright tints soon pass away, leaving the body with a pale, silvery sheen, very dark above, with a broad black lateral stripe, above which is a narrow

[a] Pacific Railroad Survey, X, 1858, p. 291.

yellowish stripe, and below which the sides are covered with spots more or less definitely arranged in stripes.a

During the nuptial migration of *Catostomus*, before noted, large numbers of this species followed the female suckers, feeding on the eggs. Many eggs were found in the stomachs of the minnows. Neither male nor female spawning suckers objected to the presence of the minnows, the latter swarming about and at times darting over and under them.

Many examples were caught with hook and line in Lake Tahoe. None of these exhibited bright colors, although taken at the time when others of the species were spawning in the streams near by. On dissection the ovaries of some of these were found to contain large eggs, although in most cases they were immature. Females here far outnumbered the males.

On May 14 specimens in nuptial colors and nearly ripe eggs were secured in the Truckee River near Pyramid Lake. Examples taken at the same place April 24 load only traces of red color. Specimens from the Humboldt River collected after July 1 had spawned. These were generally lighter in color than those of the Tahoe region, as were also examples from Carson and Walker Rivers.

A few specimens taken August 11 in Walker River near the outlet contained large numbers of almost fully developed eggs. Some rather brightly colored males were found there at the same time.

The teeth of 20 specimens were examined, and in general they numbered 2-4 on the right side, 2-5 on the left. Variations of 1-4 and 1-5 were observed, and in one example an extra row of 2 teeth appeared on one side, making 3 rows in all. The teeth of the outer row are strongly hooked, and when a grinding surface appears it is very narrow and indistinct. The alimentary canal is S-shaped and very

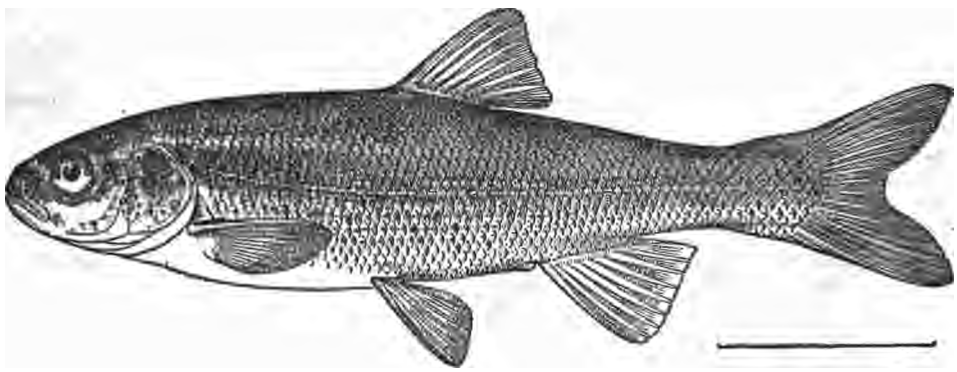

FIG. 3.—*Richardsonius egregius*. Red-striped shiner.

short. The gillrakers number 8 or 9, occasionally 7; of these, 5 or 6 are on the lower arch. They are very short and for the most part sharply pointed. The peritoneum is silvery, immaculate on the belly, generally covered with blackish spots on the sides and above. The spots are more numerous and the effect darker in specimens from the mountain streams, while in examples from the sandy rivers of the desert they are less numerous and the color effect decidedly lighter. Individuals show much variation in the size, shape, and number of pigment spots. The edges of the dorsal and anal are straight or slightly concave. The caudal is large and deeply cleft, especially in male examples.

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a Richardsonius *balteatus* is a species which exhibits a range and variety of coloration similar to that of R. *egregius*, and seemingly a lack of appreciation of this is what led Evermann and Cockerell (Proceedings, Biological Society. Washington, xxn, mo9, p. 185) to the conclusion that examples of R. *balteatus* from Warm Springs, Oreg., represented a new form which they name R. *thermophilus*.

The warm springs from which the locality gets its name flow into a marsh, where water of an even temperature is maintained throughout the year. Silver Creek drains this marsh. The water is full of algæ and at times swarms with minute crustacea and the larvæ of insects. Many large, well-fed, fat fishes collected here belonged to three genera of minnows, and they were much alike in colorand form, differing in the same way from other specimens of like species taken at various places in Silver Creek, just as trout from a deep, shaded pool differ from those living in a shallow, sandy stream. The specimens of R. *balteatus* found here and in other parts of Silver Creek possess certain characteristics of a local nature, as do other examples of the species from particular parts of its very wide range, but although attempts have been made to coordinate these local variations with reasonable geographic distribution no success has been achieved.

The description of R. *thermophilus* mentions no distinctive characters and contains nothing more than had been previously published regarding the specimens upon which the species is based, save a figure of an enlarged scale. This differs in no way from others of L. ballealus from various places in the Columbia Basin.

Females are larger than males, their bodies are more robust, and their fins are lower and shorter. The largest individuals seen measured 5½ inches.

The food seems to consist mostly of aquatic larvæ and winged insects. No algæ or other vegetable matter was found in the stomachs, except such as might have been swallowed by accident.

The scales are very regular in size over the entire body; small, deeply embedded, and scarcely evident on the breast. There are from 52 to 61 in the lateral line, 54 to 59 being the usual number. The following tables give the scale rows and fin rays in a number of examples:

	Scales in lateral line.										Scales above lateral line.		
Number of scales	53	53	54	55	56	57	58	59	60	6x	12	13	14
Number of specimens	2	8	16	20	16	22	20	16	11	3	21	48	20
								Rays in dorsal fin.			Rays in anal fin.		
Number of rays								7	8	9	8	9	10
Number of specimens								5	84	1	34	43	5

Careful measurements and a direct comparison of specimens reveal no characters peculiar to any particular isolated basin.

Measurements of 20 specimens follow.

MEASUREMENTS OF RICHARDSONIUS EGREGIUS.

FALLEN LEAF CREEK, NEAR LAKE TAHOE.

Length of body mm.	77	86	80	75	81	90	90	85	85	81
	♂	♂	♂	♂	♂	♀	♀	♀	♀	♀
Length head	0.25	0.24	0.26	0.25	0.24	0.24	0	0.25	0.24	0.25
Depth body	.23	.24	.25	.22	.23	.25	<1,000	.25	.24	.24
Depth caudal peduncle	.10	.10	.115	.20	.305	.20	2	.10	.10	.10
Length caudal peduncle	.235	.23	.21	.24	.23	.21	2,000	.24	.24	.21
Length snout	.075	.075	.075	.075	.075	.065	7	.06	.065	.075
Diameter eye	.06	.06	.07	.06	.06	.055	5	.055	.06	.06
Interorbital width	.075	.08	.10	.08	.08	.085	9	.08	.08	.09
Depth head	.19	.27	.19	.18	.18	.18	3	.18	.18	.17
Snout to occiput	.21	.19	.21	.20	.20	.185	9	.19	.19	.19
Snout to dorsal	.535	.53	.55	.55	.52	.53	5	.56	.54	.54
Snout to ventral	.48	.48	.52	.48	.47	.50	9	.48	.51	.49
Length base of dorsal	.13	.105	.12	.10	.13	.105	1	.10	.115	.125
Length base of anal	.12	.125	.12	.105	.13	.12		.125	.115	.11
Height dorsal	.21	.19	.21	.19	.195	.195		.19	.20	.18
Height anal	.19	.18	.19	.29	.18	.18		.165	.18	.17
Length pectoral	.23	.21	.34	.23	.21	.18		.19	.18	.19
Length ventral	.285	.255	.29	.27	.16	.15		.16	.14	.15
Length caudal	.27	.25	.29	.25	.255	.24		.25	.245	.24
Dorsal rays	8	8	8	8	8	8		8	8	8
Anal rays	8	9	8	8	9	9		9	8	8
Scales lateral line	54	60	54	55	56	54		59	56	59
Scales above lateral line	12	13	12	13	12	12		12	13	13
Scales below lateral line	6	6	6	6	6	7		7	6	6
Scales before dorsal	27	30	29	31	30	30		31	31	31

MEASUREMENTS OF RICHARDSONIUS EGREGIUS—Continued.

STAR CREEK, NEAR DEETH, NEV.

mm	84	73	76	74	70	100	100	96	91	82
	♂	♂	♂	♂	♂	♀	9	♀	9	9
	0.25	0.25	0.25	0.16	0.25	0.24	0.24	0.24	0.25	0.26
	.24	.25	.26	.265	.25	.26	.26	.24	.28	.27
	.105	.10	.11	.10	.10	.10	.095	.10	.10	.11
	.22	.21	.23	.23	.23	.12	.12	.21	.21	.22
	.07	.07	.07	.075	.07	.07	.07	.065	.07	.075
	.055	.06	.06	.065	.06	.055	.06	.06	.06	.065
	.09	.09	.08	.085	.08	.08	.085	.08	.08	.09
	.19	.19	.18	.18	.18	.28	.18	.17	.29	.18
	.19	.20	.20	.185	.20	.18	.19	.18	.19	.20
	.55	.565	.55	.53	.55	.57	.55	.55	.56	.55
	.5-	.50	.49	.49	.5-	.49	.50	.49	.5-	.5-
	.11	.10	.11	.12	.10	.11	.115	.11	.10	.10
	.12	.11	.11	.12	.11	.11	.11	.225	.11	.135
	.29	.19	.20	.20	.21	.18	.19	.18	.20	.19
	.17	.18	.18	.19	.20	.18	.17	.17	.19	.18
	.21	.22	.22	.23	.21	.18	.19	.17	.18	.20
	.16	.16	.17	.16	.16	.18	.16	.145	.16	.15
	.26	.26	.265	.25	.26	.23	.24	.21	.24	.24
	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂
	9	♂	♂	9	9	9	9	9	♂	♂
	58	55	55	57	57	56	54	53	54	55
	1/4	23	12	13	12	13	12	12	1/4	13
	6	6	6	7	7	7	6	6	7	7
	33	32	30	31	31	31	31	30	32	33

Cockerel and Allison[a] employ structural scale characters to distinguish between this and other species of the genus. Their conclusions, apparently based on few specimens, will not stand the test of this species, for the scale radii are found to number from 6 to 21 and the number of circuli depends upon the age of the individual from which the scale was taken. The variable character of the peritoneum pigment has been described. The annexed table will exhibit the number of radii possessed by a few scales taken from between the lateral line and dorsal fin of specimens of R. egregius selected at random from several localities.

	6	7	8	9	10	11	12	13	14	15	16	17	18	19	21
Number of radii on scales between lateral line and dorsal fin -															
Walker River															
Truckee River															
Summit Creek															
Star Creek															
Quinn River															
Fish Lake Lake			1		2	3	9	4	6	11	3	2	3	1	1
Carson River	1	9	10	13	4	1	10	9	3	4	2	1	1	.....	.....

Richardsonius microdon, new species. Tahoe shiner.

This species will not be confused with Richardsonius egregius, another member of the genus found in the basin, for it has a much more robust form, a heavier caudal peduncle, a longer snout, and a larger mouth. In general appearance it more closely resembles Siphateles *obesus* and Leucidius pectinifer, having the same general color and shape, except that the body is a little more slender, the head somewhat longer, the snout more pointed, the mouth larger, and the posterior border of the opercle more angular. From these it may be told at a glance by the posterior position of its dorsal fin. The species is not distinguished from either S. obesus or L. *pectinifer* by the local fishermen, but it is not mistaken for R. egregius.

Description of type, No. 75652 United States National Museum, a female measuring 140 mm., from Lake Tahoe, near Tahoe City, Cal., June 27, 1911.

a P. B. S., W., . XXII, . 180.

R. (8 9); 39; , , *neogaeus*, , , . W. C., H. L. B., C. . L. *egregius* (G.).

R. (13); , . E. Lakes, M. . L. *neogaeus* (C.).

R. (20); 10; 20 side; , . Cemetery. C., W., N. Y. L. *margarita* (C.).

Head 3.75 in length to base of caudal; depth 3.75; depth caudal peduncle 10; snout 3.5 in head; eye 4.5; interorbital space 3; height dorsal 1.4; anal 1.7; length pectoral 1.3; ventral 1.7; caudal 1; scales lateral series 53; dorsal rays 8; anal 8.

The general shape is much like that of the young of S. obesus, the head being longer and more pointed, the mouth a little less oblique, the eye slightly larger, the opercle more angular, and the caudal peduncle more slender. Width of body somewhat less than half the depth. Diameter of eye less than length of snout; interorbital space convex; cleft of mouth not quite reaching a vertical through anterior edge of orbit. Gillrakers 13, slender, sharply pointed and curved downward; the largest about equal in length to vertical width of posterior nostril; space between gillrakers about equal to width of base of gillraker. Teeth x, 5-5, 1; hooked, with a narrow grinding surface; the teeth of inner row very frail. Lateral line complete, strongly decurved on anterior third of body. Body completely covered with large scales, which are nowhere much reduced in size nor crowded. Dorsal inserted well behind a vertical through origin of ventrals; edge of anal straight; caudal deeply cleft, the lobes pointed; edges of ventrals rounded, the depressed fin just reaching the anal opening; pectorals obtusely pointed.

Color in spirits dark above and light below, as usual in minnows, the dusky pigment spots clustering along the edges of the scales. A rather indefinite lateral stripe extends along the side, becoming more definite posteriorly, where it is about 3 scales wide, and ending just anterior to base of caudal fin in an enlarged, rounded spot. In life the upper parts were olive, the sides somewhat silvery. The peritoneum is silvery but thickly dusted with black pigment. The alimentary canal is not quite equal in length to the total length of the specimen.

The teeth of the inner row are very frail and seem to be on the veree of disappearing entirely. Three specimens, in addition to the type, have them as follows: 1, 5–5, 1; 1,4-5, o; 0, 5-5, I.

Only four examples of this species have been seen. They were taken with baited hook from below the wharf at Tahoe City. All were females, the eggs being well developed and relatively few in number. Measurements of these specimens follow:

MEASUREMENTS OF RICHARDSONIUS MICRODON.

Length of body ..... mm.	123	110	102	90	Length of body ..... mm	123	110	102	90
Length head	0.26	0.27	0.28	0.29	Height dorsal	0.27	0.20		0.19
Depth body	.25	.26	.25	.255	Height anal	.15	.16		.17
Depth caudal peduncle	.10	.10	.11	.115	Length pectoral	.19	.21		.20
Length caudal peduncle	.22	.21	.20	.22	Length ventral	.13	.16		.15
Length snout	.075	.575	.075	.08	Length caudal	.25	.27		.26
Diameter eye	.05	.06	.06	.06					
Interorbital width	.09	.085	.09	.09	Dorsal rays	8	8	8	8
Depth head	.17	.18	.185	.19	Anal rays	8	9		8
Snout to occiput	.29	.19	.20	.22	Scales lateral line	53	55		56
Snout to dorsal	.53	.53	.54	.55	Scales above lateral line	12	11		12
Snout to ventral	.50	.52	.52	.53	Scales below lateral line	6	6		6
Length base of dorsal	.12	.13	.12	.13	Scales before dorsal	27	28		28
Length base of anal	.11	.12	.11	.12					

The writer is inclined to regard this species as a possible representative of R. caurinusa of the Columbia. They are not very unlike in general appearance, although the Columbia species is more slender, suggesting Ptychocheilus in shape. The dorsal fin in each is inserted posterior to a vertical through bases of ventrals. Its relationships may be with R. bicolor of the Klamath. It is probably not closely related to R. *atrarius*[b] of the Bonneville Basin.

a A specimen of *Richardsonius caurinus* was lately found by the writer in the National Museum collection. It is the second recorded since the species was described by Richardson. It was collected by Livingston Stone, but nothing further is known of it. It measures 9⅝ inches in length. There are 79 scales in the lateral line, about 20 between lateral line and back. Dorsal 10; anal 9. The pectorals are rather sharply pointed. The edge of the anal is slightly concave.

It is believed that the name Richardsonius atrarius (Girard) should stand for the species recognized by recent authors as *Leuciscus* linestus (Girard). (Bull., No. 47, United States National Museum, 1896, p. 232.) The type of *Tigoma lineata* Girard is lost, and the locality from which it was obtained is unknown. Furthermore, it was described (Proceedings, Academy Natural Sciences, Philadelphia, 1856, p. 206.) as being "elongated, the body subfusiform, the head small and conical," a form apparently like that of *R. bolteatus*, *R. hydrophlox*, or *R. egregius*. Also, the describer remarks of his *Tigoma egregia*, "By its general aspect this species resembles *T.* lineata." Siboma *atraria* Girard (Proceedings, Academy Natural Sciences, Philadelphia, p. 208) on the other hand is a deep-bodied, thick-tailed form with a comparatively large head, not to be compared with R. *egregius* (*Tigoma egregia*), which is elongated, subfusiform, trim, and graceful.

The type of *S. atraria*, United States National Museum, no. 236, is a specimen somewhat over 6 inches long. There are 9 rays in the dorsal fin, 8 in the anal; 56 scales in the lateral series; 11 between lateral line and back; 30 between occiput and

Siphateles obesus (Girard). Lake chub. (Species illustrated on p. 64.)

This is the *Rutilus* or Myloleucus a olivaceus of recent authors, which, at times confused with Leucidius *pectinifer*, has been reported from various parts of the Lahontan system. It was first described from the Humboldt River as Alga nrea obesa.b The type of this species, no. 193, United States National Museum, is a specimen measuring 171 millimeters, and although the pharyngeal bones have been removed there seems to be no reason to doubt that it belongs to the same species which Cope later called Leucus olivaceus, and which is abundantly represented in the Humboldt River, its tributaries, and other streams and lakes of this system.

S. obesus is related to similar forms, S. *columbianus*, S. formosus, c S. bicolor, and S. oregonensis, of the Columbia, Sacramento, Klamath, and Oregon Lake systems. Its affinities are most close to the Oregon Lake form, S. oregonensis, and it is very doubtful whether the latter should be recognized at all. The form called S. oregonensis is made up of isolated units which occupy distinct basins and which

dorsal fin. The following measurements are in hundredths of the length to base of caudal fin, which is 130 millimeters. Head 0.28; depth body 0.28; depth caudal peduncle 0.11; snout to occiput 0 22; 'snout to dorsal 0.54; snout to ventral 0.56. The gillrakers are 11 in number, short and pointed.

R. *atrarius* and *Tigoma* obesa Girard (Proceedings, Academy Natural Sciences Philadelphia, 1856, p. 206) are apparently not synonymous. The type of the latter, United States National Museum, no. 215, is a specimen with a very long deep body, small head, and short rounded fins, looking much like a well-fed and fat example of R. *balteatus*, such as one occasionally finds in a slough or pond where food is very abundant. Its describer says that it came from Salt Lake Valley. The Museum register gives no locality. The teeth, 5, 2-2, 4, have a narrow grinding surface. There are 8 rays in the dorsal, 9 in the anal; scales in the lateral series 53; between lateral line and back 13; between occiput and dorsal fin 28 Length from snout to base of caudal 111 millimeters; length head 0.25; depth body 0.34; depth caudal peduncle 0.11; snout to occiput 0.19; snout to dorsal 0.59; snout to ventral 0.55. There are 7 stubby, pointed gillrakers. If this specimen was collected in Salt Lake Basin, it apparently represents a species not since found there.

Richardsonius *humboldti* (Girard) is another nominal form known from the type only (Proceedings, Academy Natural Sciences Philadelphia, 1856, p. 206). It is said to have been collected by Bowman and Beckwith in the Humboldt River. The species has not been seen there since. There is difficulty in distinguishing between the type specimen and examples of R. *hydrophlox*. It has a somewhat larger head, deeper body, and deeper caudal peduncle than any specimen of R. *hydrophlox* with which it has been compared. It differs from examples of R. *evermanni* from the Humboldt in having 11 rays in the anal fin, a deeper body, larger head, and larger eyes. There are 54 scales in the lateral series, 13 between the lateral line and back, 29 between occiput and dorsal fin. The dorsal is inserted considerably behind a vertical through the ventrals. Both this specimen and the type of T. obesa were collected in the course of one of the early surveys. Neither has had an attached label. Both look like over-fed examples of the same species which might have lived in a spring or pond, the bloated body and short, rounded fins being characteristic.

a Fowler (Proceedings, Academy Natural Science, Philadelphia, 1913, p. 71) finds that the cotype of Myloleucus *pulverulentus* Cope which is preserved in the collection of the Philadelphia Academy has 2 rows of pharyngeal teeth. No type or cotype of the species is in the National Museum. The specimen examined by Fowler is apparently a *Richardsonius*. The name *Siphateles* (Cope, Proceedings, Academy Natural Science, Philadelphia, 1883, p. 146) then becomes available for the lake and channel species that have been referred to *Rutilus* and Myloleucus. Through the kindness of Mr. Fowler the writer was enabled to examine the type of Siphateles *vittatus* Cope at the museum of the Philadelphia Academy. It is a specimen belonging to the species that is here called S. obesus.

b Girard, Proceedings, Academy Natural Science, Philadelphia, 1856, p. 183.

c On careful comparison, the type of Alpansea *formosa* Girard from Merced River, Cal., and also a number of specimens from Wolf Creek, north fork of Feather River, collected by Rutter and referred to Rutilus *bicolor*, are found to differ in no way from examples taken in Pit River and Goose Lake, these in turn being like those described by Cope as Myloleucus thalassinus. *Siphateles* (Rutilus or Myloleucus)bicolor is confined to the Klamath Basin and should not be confused with the Sacramento form. The latter will now be referred to as *Siphateles* formosus. A partial synonomy of these forms may serve to eliminate some of the confusion regarding them:

Siphateles formosus (Girard).—Sacramento-San Joaquin system, including Goose Lake and its tributaries. Algansea *formosa* Girard, Proceedings, Academy Natural Sciences, Philadelphia, 1856, p. 183. *Myloleucus thalassinus* Cope, Proceedings, Academy Natural Sciences, Philadelphia, 1883, p. 144. Rutilus *symmetricus* Jordan and Evermann, Bulletin 47, United States National Museum, 1896, p. 245. *Rutilus thalassinus* Snyder, Bulletin, Bureau Fisheries, vol. xxvii, 1007, p. 86. Rutilus bicolor Rutter, Bulletin, Bureau Fisheries, vol. xxvii, 1907, p. 135.

Siphateles bicolor (Girard).—Klamath River, Klamath Lake, and tributaries. Alpansea *bicolor* Girard, Proceedings, Academy Natural Sciences. Philadelphia, 1856, p. 183. *Myloleucus parovanus* Cope, Proceedings, Academy Natural Sciences, Philadelphia, 1883, p. 143. *Rutilus* bicolor Jordan and Evermann, Bulletin 47, United States National Museum, 1896, p. 244. Gilbert, Bulletin, United States Fish Commission, vol. xvn, p. 8, figure.

Siphateles oregonensis (Snyder).—Lake region of southeastern Oregon; generally distributed. (Not in Goose, Klamath, and Malheur Basins.) *Rutilus* oreponensis Snyder, Bulletin, Bureau Fisheries, vol. xxvii, 1907, p. 87, fig. 3. Myloleucus *formosus* Cope, (not of Girard), Proceedings, Academy Natural Sciences, Philadelphia, 1883, p. 143.

Siphateles columbianus (Snyder).—Columbia River, Malheur Lake Basin. (Not known from the Snake River or Bonneville Basins.) Rutilus columbianus Snyder, Bulletin, Bureau Fisheries, vol. xxvii, 1907, p. 92, fig. 4.

Siphateles obesus (Girard).—Lahontan system, including Eagle Lake. Aloanseaobesa Girard, Proceedings, Academy Natural Sciences, Philadelphia, 1856, p. 183. Leucos *oberus* Jordan, Report Chief. Engineers, 1853, pt. 3, Appropriation, N. N., p. 1614, and L. formosus, p. 1615. *Leucus olivaceus* Cope, Proceedings, Academy Natural Sciences, Philadelphia, 1883, p. 145, also L. *dimidiatus* Cope, p. 145, and Siphateles *vittatus* Cope, p. 146.

appear to possess some characters that are in a degree more or less distinctive.a The same is true of S. *obesus*, although apparently to a lesser extent. From S. columbianus, S. bicolor, and S. *formosus* the species in hand differs in having smaller scales, as illustrated by the following tables:

Scales lateral line	41	42	43	44	45	46	47	48	49	50	52	52	53	54	55	56	57	58	59	to
Specimens of—																				
S. formosus																				
S. columbianus																				
S. bicolor					2	5	14	21	34	36 1	46 2	56 2	44 13	51 6	57 16	26 13	21 5	9 7	6 4	1 1
S. oregonensis																				
S. obesus																				

Scales before dorsal	22	23	24	25	26	27	28	29	30	31	32	33
Specimens of—												
S. formosus												
S. columbianus												
S. bicolor			3	8	9	27 4	23 9	34 27	16 16	20 18	10 3	4 2
S. oregonensis												
S. obesus												

The same genus is represented in Owens River and also in the Mohave River. Owens River specimens are very similar to those of S. obesus from the Lahontan system, while those from the Mohave seem to differ from all the others. Sufficient material for careful comparisons is not now available however.

S. obesus is both lacustrine and fluvial, reaching its maximum size and abundance in lakes and deep ponds, thriving in the lower courses of the rivers, but apparently not entering the swifter, clearer, and more shallow upper courses and tributaries. It is distributed almost universally throughout the Lahontan system, being like S. *oregonensis*, a species that maintains itself to the last in a dessicating basin.

S. obesus is a minnow with a large, robust body, large head, and relatively short fins. With advancing age and increasing size the head grows larger and the snout longer in relation to the body. Often a pronounced hump appears on the back behind the head. This hump is decidedly more prominent in alcoholic specimens than in life, however. Some individual difference appears in the depth of body, size of eye, height and length of fins, etc., but this is not found to be coordinate with locality, i. e., distinct basins, except that specimens from the Humboldt River and its tributaries seem to represent the extreme of large bodies and short, rounded fins.

There are from 50 to 60 scales in the lateral line, usually 53 to 0; 27 to 33 before the dorsal, usually 29 to 31; 12 to 16 before the lateral line. There are 8 rays in the dorsal fin and 7 or 8 in the anal. The number of scales and dorsal and anal rays aid in distinguishing between this and allied species:

Scales above lateral line	10	11	12	13	14	15	16
Specimens of—							
S. formosus							
S. columbianus		13	21	1			
S. bicolor							
S. oregonensis							
S. obesus			8	30	25	5	1

Number of gillrakers	8	9	10	11	12	13	14	15	16	17	18	19	20
Specimens from—													
Abert Lake													
Silver Lake													
Warner Lake								3	3	3	6	2	1
Alkali Lake													
Summer Lake													

An inspection of this table might lead to the supposition that well-defined local races, perhaps subspecies in the commonly accepted meaning of the term, might here be recognized. But investigation along that line shows that these races, if they may be so termed, are not of apparent geographical or distributional significance.

a Bulletin, Bureau Fisheries, vol. xxvn, 2907, p. 87-92. The characters referred to are seen in body proportions, length of 6E4 etc. One illustration will suffice.

D	7	8	9	Anal rays	7	8	9	10	11
S of—				S—					
S. formosus			159	S. formosus					
S. columbianus		9	35	S. columbianus					
S. bicolor		14	6	S. bicolor					
S. oregonensis	1	130	61	S. oregonensis	54	135	3	1	-
S. obesus		86	3	S. obesus	21				

There are 4 pharyngeal teeth on the right side; 5 on the left. Occasionally there are only 4 on the left, and sometimes there are 5 on both sides, in which case the supernumerary is slender and frail. The teeth are large, slightly hooked; a narrow grinding surface present. The posterior limb of the arch is equal to the anterior, or even larger, thus contrasting with that of L. *pectinifer*, which is much shorter than the anterior.

Number of teeth	4–4	4–5	5 5
N	2	33	12

The peritoneum is dusky in color, but not black. The alimentary canal is about equal in length to the entire length of the specimen. The air bladder extends the length of the abdominal cavity.

In life the color is deep olive above, lighter on the sides, white below; upper parts and sides with a very pronounced brassy reflection. Some of the scales are darker than the others; some are pinkish. Fins olive, with a little red. In some examples the belly is suffused with yellow and the fins are strongly tinged with red. Others are more green than olive, and some have the dark lateral color extending almost to the ventral surface. The pink and yellow tints are more prominent during the breeding season. The green is more pronounced in lake specimens. In an occasional individual a faint pinkish stripe may be detected along the side, its outline and extent being very indefinite. In the rivers the general color is sometimes lighter. Young specimens have a narrow dark stripe along the lateral line.

On May 24 this species had begun to spawn in Pyramid Lake, at least the eggs were then ripe, and the milt flowed from the males when they were touched. Small and medium sized examples caught in Lake Tahoe June 15 were not yet ready to spawn.

Large individuals (12 to 14 inches) do not appear to come near shore, at least during the daytime. During the summer they may be secured with a small spinner trolled at a depth of 20 feet or more. They bite readily when the hook is baited with angleworms. When still fishing, specimens were caught only at a long distance from the boat and at a depth of about 20 feet. A line so rigged that the bait would settle 20 feet below the surface, and cast out from shore where the bottom shelved off very rapidly, would generally secure specimens. Many smaller ones were taken in the seine and gill nets near shore along with L. pectinifer. Nets set at night were sure to be full of fishes in the morning.

Large schools of lake chubs gather about the wharves, fallen trees, and other sheltered places. At the mouth of Fallen Leaf Creek, Lake Tahoe, at times the rising water slowly spreads out over the meadows, and when covering the ground but a few inches is invaded by great schools of this species. After sundown they appear in countless numbers, thrashing about in the grass and rushes. When approached they either scurry off in great haste, sometimes diving into a bunch of grass, or settle down perfectly still. On the approach of daylight they return to deeper water. Dissection showed that they were probably feeding, certainly not spawning. Algæ, bits of plants, and fragments of insects were found in their stomachs.

Lake chubs when prepared for the table were found to be sweet and very palatable. They have at times been salted and sold in the markets as "whitefish." They contribute to the food of the larger trout and also to that of the water birds.

MEASUREMENTS OF SIPHATELES OBESUS.

	Pyramid Lake.					Walker Lake.									
Length of body... mm..	195	191	187	189	186	240	262	255	236	240	357	232	232	267	268
Length head	0.27	0.27	0. 255	0.26	0.26	0. 295	0.29	0.32	0.28	0.315		0.315	0. 28	0.28	0.29
Depth body	.271	.27	.25	.28	.25	.295	.295	.31	.25	.315		.28	.285	.28	.275
Depth caudal peduncle	.11	.11	.11	.11	.115	.115	.12	.13	.11	.115		.12	.115	.113	.12
Length caudal peduncle	22	.23	.22	.23	.22	.795	.20	.18	.20	.181		.19	.11	.105	.20
Length snout	075	.08	.07	.07	.076	.09	.085	.10	.095	.09		.09	.08	.09	.08
Diameter	05	.05	.05	.05	.04	.045	.045	.045	.045	.05		.042	.045	.04	.045
width	.08	.08	.08	.08	.08	.10	.10	.17	.095	.10		.105	.09	.09	.09
Depth head	.175	.775	.17	.18	.17	.20	.21	.21	.795	.22		.21	.20	.19	.20
Snout to	19	.195	.28	.18	.18	.21	.81	.225	.31	.22		.22	.21	.205	.20
Snout to dorsal	52	.53	.50	.525	.52	.545	.56	.58	.555	.595		.58	.57	.57	.56
Snout to ventral	54	.525	.52	.54	.51	.59	.57	.60	.58	.585		.59	.56	.59	.52
Length base of dorsal	115	.105	.115	.115	.115	.12	.125	.125	.11	.11		.12	.11	.125	.12
Length base of anal	10	.705	.095	.10	.105	.10	.10	.10	.09	.095		.09	.09	.10	.09
Height dorsal	17	.175	.17	.17	.17	.165	.17	.17	.165	.17		.18	.17	.17	.765
Height anal	.74	.14	.135	.14	.74	.13	.125	.135	.24	.235		.14	.135	.73	.13
Length pectoral	18	.19	.185	.19	.70	.77	.165	.17	.77	.175		.28	.575	.165	.77
Length ventral	.25	.16	.15	.15	.13	.13	.15	.155	.155	.15		.15	.155	.745	.14
Length caudal	25	.25	.24	.25	.25	.235	.25	.25	.25	.37		.25	.15	.26	.235
Scales lateral line	55	57	58	58	58	59	55	53	57	53		56	54	56	53
Scales above lateral line	13	13	24	24	14	16	14	15	14	13		15	14	14	15
Scales below lateral line	7	7	7	8	7	7	8	8	8	7		8	7	7	7
Scales before dorsal	30	32	31	30	31	31	33	31	33	29		30	31	31	30

	Little Humboldt River.									
Length of body	116	131	121	706	143	89	95	92	90	89
Length head	0. 265	0.27	0		0.275	0. 27	0.28	0.27	0. 28	0.26
Depth body	.275	.265			.27	.27	.27	.28	.28	.30
Depth caudal uncle	.135	.122			.19	.11	.12	.12	.13	.12
Length caudal peduncle	.20	.21			.21	.22	.21	.21	.21	.22
Length snout	.075	.075			.08	.08	.08	.075	.07	.07
Diameter eye	.053	.05		66	.045	.06	.055	.06	.06	.055
width	.095	.09		92	.09	.08	.09	.08	.095	.09
Depth head	.20	.195		21	.19	.19	.19	.195	.20	.19
Snout to	.21	.20			.21	.20	.21	.21	.19	.79
Snout to dorsal	.55	.53			.55	.54	.53	.545	.54	.53
Snout to ventral	.555	.54			.56	.53	.54	.55	.55	.54
Length base of dorsal	.12	.12			.115	.11	.12	.13	.11	.12
Length base of anal	.10	.105		75	.09	.10	.095	.10	.09	.09
Height dorsal	.18	.175		5	.27	.20	.20	.18	.21	.19
Height anal	.14	.135		5	.74	.25	.16	.15	.17	.55
Length pectoral	.17	.16		7	.16	.20	.19	.20	.18	.17
Length ventral	.15	.14			.15	.17	.17	.16	.17	.16
Length caudal	.225	.22	5		.335	.24	.23	.24	.24	.24
Scales lateral line	50	59			57	57	59	56	55	58
Scales above lateral line	53	14			24	14	74	23	14	13
Scales below lateral line	8	8			8	8	8	8	8	8
Scales before dorsal	29	29	0		29	31	31	31	29	30

	Susan Creek.									
Length of body	100	89	85	89	75	81	81	79	76	70
Length head	0.29	0. 265	0. 27	0.27	0.26	0. 27	0. 28	0.29	0. 30	0.28
Depth body	.26	.25	.26	.26	.28	.17	.26	.25	.28	.27
Depth caudal peduncle	.11	.105	.12	.12	.13	.13	.12	.12	.125	.12
Length caudal peduncle	.185	.20	.20	.22	.19	.21	.21	.21	.20	.30
Length snout	.09	.08	.075	.075	.075	.08	.08		.08	.08
Diameter eye	06	.06	.06	.06	.065	.07	.065	.06	.07	.065
width	.09	.085	.09		.085	.09	.09	.09	.085	.095
Depth head	.20	.19	.20	.20	.20	.20	.21	.19	.20	.20
Snout to	.22	.21	.20	.23	.22	.21	.23	.21	.22	.21
Snout to dorsal	.56	.56	.55	.56	.54	.54	.54	.55	.57	.58
Snout to ventral	.56	.55	.54	.55	.55	.56	.55	.53	.56	.55
Length base of dorsal	.13	.12	.11	.11	.12	.11	.125	.12	.12	.13
Length base of anal	.09	.10	.10	.09	.10	.09	.10	.10	.085	.20
Height dorsal	.17	.185	.18	.19	.18	.79	.20	.21	.20	.20
Height anal	.73	.13	.75	.16	.16	.15	.16	.16	.155	.17
Length pectoral	.17	.265	.165	.17	.20	.19	.21	.18	.27	.18
Length ventral	.15	.25	.15	.16	.16	.17	.16	.16	.25	.15
Length caudal	.23	.24	.24	.26	.25	.25	.25	.27	.27	.26
Scales lateral line	54	56	58	55	55	54	55	55	56	54
Scales above lateral line	14	12	14	14	53	13	13	13	14	13
Scales below lateral line	8	7	8	8	7	8	7	8	8	7
Scales before dorsal	29	30	30	30	30	31	31	30	30	29

Leucidius, new genus of *Cyprinidæ*. Type *Leucidius pectinifer*, new species.

Teeth 5-5; slightly hooked, high and slender, the grinding surface rather narrow; base of arch long and slender, the limbs somewhat cylindrical. Gillrakers 29 to 36, the usual number being 32 to 34; closely apposed, long, slender, sharply pointed, almost straight; the inner edge with short, blunt papillæ; those at both ends of arch relatively long and well developed, the whole suggesting a fine-toothed comb. Pseudobranchiæ present; no barbels; premaxillary protractile; lateral line complete; peritoneum dusky; alimentary canal short; air bladder extending the entire length of the visceral cavity. Dorsals inserted almost directly above ventrals; dorsal and anal short. Scales large and regular; lateral line complete.

Leucidius is a lake minnow. It takes its place at once among an array of peculiar western genera, *Pogonichthys*, Mylopharodon, *Orthodon*, Lavinia, Mylocheilus, *Gila*, Meda, *Tiaroga*, and others.

Leucidius pectinifer, new species. Lake minnow.

This species has long escaped notice by reason of its close resemblance to *Siphateles* obesus. Preserved specimens of both species look remarkably alike until those of greater length than 8 or 10 inches are compared, when S. obesus begins to appear deeper and shows a more or less definite nuchal hump. In life L. pectinifer is lighter in color, whitish and silvery, while S. obesus is bronzy or brassy. Cope[a] apparently recognized both species in Pyramid Lake, for he says, when speaking of S. obesus (L. olivaceus), "This and the smaller L. dimidiatus swim in schools in the lake, as may be seen from the elevated

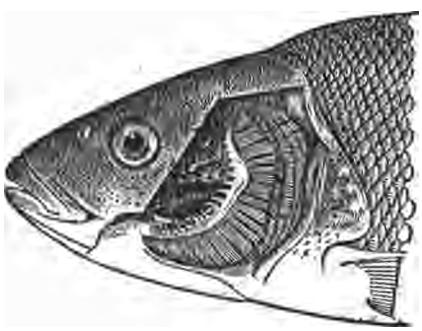

FIG. 4.—*Siphateles* obesus. Winnemucca Lake, Nev.[b]

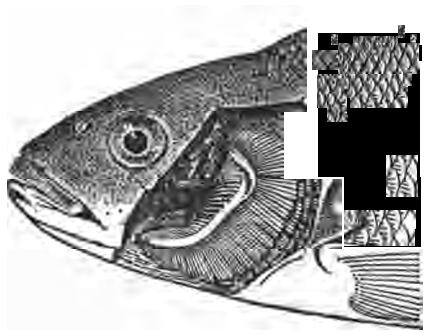

FIG. 5.—*Leucidius pectinifer*. Pyramid Lake, Nev.

road along the rocky shores, rippling the surface like a gust of wind." However, Cope's descriptions of both L. *dimidiatus* and L. *olivaceus* are based on specimens of S. obesus, as the types showS Examples of Leucidius *pectinifer* were long ago collected with those of S. obesus in Washoe Lake and recorded as the latter species. The same oversight was later made in a collection from Eagle Lake. Cleaned pharyngeals of this species from the latter place, labeled L. olivaceus, led to the erroneous statement that the teeth of L. olivaceus numbered 5-5.d *Leucidius* pectinifer might on superficial examination be confused with Richardsonius microdon, but a glance at the gillrakers will serve to identify it among other western minnows. (See fig. 5.)

Description of type no. 76304, United States National Museum, a female specimen measuring 237 millimeters, from The Willows, Pyramid Lake, Nev., June 2, 1913. (See fig. 6.)

Head 3.7 in length to base of caudal; depth 3.6; depth caudal peduncle 9.3; eye 5.3 in head; snout 3.5; maxillary 3.7; height dorsal 6 in length; anal 7.3; length pectoral 6.7; ventral 6.7; caudal 4; dorsal rays 8; anal 8; scales lateral series 57; between lateral line and back 13; between lateral line and ventral fin 8; between occiput and dorsal 30.

Depth of body somewhat less than twice its width, the deepest part being below origin of dorsal fin. Dorsal contour rather angular, sloping forward from origin of dorsal to tip of snout, this part of the outline somewhat convex, and backward to caudal peduncle, the outline slightly concave. Ventral contour

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a Proceedings. Academy Natural Sciences, Philadelphia, 1883, p. 145.

b See p. 62 for description of species.

c When at the Academy of Natural Sciences in Philadelphia, Mr. Henry W. Fowler kindly allowed the writer to examine the types of both species.

a Bulletin, Bureau Fisheries, vol. XXVII, p. 87.

rather evenly convex. Head pointed; mouth oblique, but not enough so to interfere with the curved ventral contour of head; lower jaw slightly projecting; premaxillary protractile. Eye large, its diameter less than length of snout and greater than half the width of interorbital space. Posterior nostril elongate, the anterior semicircular. Teeth (paratype) in a single row, 5 on each side, slightly hooked at tip; a narrow grinding surface present. They are higher, lighter, and the arch is more slender than in *S. obesus*.. Gillrakers long and slender, so closely apposed that the space between two of them is narrower than the base of either. Pseudobranchiæ restricted to a small area. Scales large, very regular, somewhat crowded on the throat. Lateral line decurved anteriorly and then extending straight along side of body and middle of tail. Origin of dorsal midway between tip of snout and last scale on base of caudal. Edge of anal straight. Ventrals inserted directly beneath origin of dorsal; their edges rounded. Upper edges of pectoral longest. Caudal deeply forked.

The preserved specimen is dusky above, light yellowish beneath; the scales on sides broadly edged with dusky color; caudal with a distinct dusky edge. In life, olive above, lighter on the sides, white

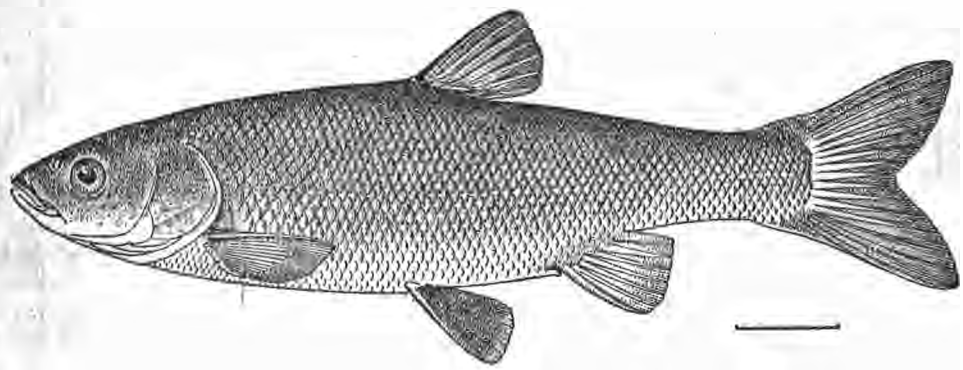


FIG. 6.—*Lavinia pectinifer*. Type. Lake minnow.

below; scales with a bright silvery sheen. Dorsal olive; caudal olive, but lighter than the dorsal; other fins strongly tinted with red.

There are from 29 to 36 gillrakers in this species; usually 31 to 33:

Number of gillrakers	29	30	31	32	33	34	35	36
Number of specimens	1	4	7	5	9	4	1	2

The teeth are invariably 5–5. The scales in the lateral series number from 53 to 63; between lateral line and back 13 to 15; between occiput and dorsal fin 29 to 35; between ventrals and lateral line 7 or 8.

Scales in lateral series	53	54	55	56	57	58	59	60	61	62	63
Specimens	2	1	8	2	28	22	4	3	9	7	5

Scales before dorsal	29	30	31	32	33	34	35
Specimens	2	18	17	20	29	2	3

Scales above lateral line	13	14	15
Specimens	29	51	11

Other measurements follow:

MEASUREMENTS OF LEUCIDIUS PECTINIFER.

PYRAMID LAKE, THE WILLOWS.

Length of body mm	196	201	186	177	272	182	184	187	184	166
Length head	0.27	0.27	0.27	0.265	0.265	0.26	0.27	0.265	0.26	0.26
Depth body	.255	.26	.26	.27	.25	.265	.27	.26	.25	.265
Depth caudal peduncle	.105	.115	.115	.135	.11	.12	.115	.112	.113	.115
Length caudal peduncle	.225	.195	.22	.21	.235	.215	.22	.23	.215	.21
Length snout	.08	.08	.079	.07	.07	.073	.07	.07	.075	.07
Diameter eye	.05	.048	.05	.05	.05	.05	.05	.05	.05	.05
Interorbital width	.08	.08	.078	.08	.085	.08	.085	.08	.08	.08
Depth head	.17	.175	.173	.175	.18	.18	.18	.175	.17	.18
Snout to occiput	.19	.20	.195	.19	.19	.29	.20	.185	.195	.19
Snout to dorsal	.53	.525	.53	.53	.52	.52	.52	.525	.525	.52
Snout to ventral	.325	.53	.545	.54	.53	.53	.54	.53	.53	.525
Length base of dorsal	.11	.11	.115	.11	.11	.12	.11	.105	.10	.115
Length base of anal	.095	.095	.1	.09	.095	.10	.095	.09	.09	.10
Height dorsal	.165	.16	.57	.165	.175	.175	.165	.15	.16	.175
Height anal	.235	.13	.13	.13	.15	.14	.135	.12	.13	.13
Length pectoral	.17	.165	.17	.185	.195	.19	.19	.155	.18	.17
Length ventral	.145	.14	.14	.145	.16	.155	.155	.13	.15	.15
Length caudal	.265	.26	.27	.23	.265	.2	.24	.23	.255	.255
Dorsal rays	8	8	8	8	8	8	8	8	8	8
Anal rays	8	8	8	8	8	8	8	8	8	8
Scales lateral line	57	63	62	57	57	62	62	59	57	57
Scales above lateral line	14	15	15	14	15	13	14	14	14	14
Scales below lateral line	7	8	7	8	7	7	8	8	8	8
Scales before dorsal	29	38	31	33	35	33	33	33	31	29

LAKE TAHOE, TAHOE CITY.

Length of body mm.	141	124	203	119	121	123	148	140
Length head	0.24	0.25	0.26	0.25	0.255	0.255	0.25	0.245
Depth body	.29	.27	.29	.26	.26	.26	.25	.24
Depth caudal peduncle	.113	.12	.13	.12	.115	.11	.12	.11
Length caudal peduncle	.22	.21	.23	.22	.22	.22	.215	.23
Length snout	.072	.068	.07	.07	.01	.07	.07	.065
Diameter eye	.052	.052	.06	.055	.055	.05	.05	.05
Interorbital width	.08	.085	.09	.08	.08	.08	.08	.08
Depth head	.18	.182	.18	.17	.18	.175	.18	.17
Snout to occiput	.19	.185	.2	.38	.19	.18	.19	.2
Snout to dorsal	.525	.52	.53	.52	.53	.54	.53	.52
Snout to ventral	.55	.55	.53	.52	.51	.53	.53	.53
Length base of dorsal	.11	.115	.11	.115	.11	.12	.11	.11
Length base of anal	.09	.10	.10	.09	.09	.10	.20	.10
Height dorsal	.19	.19	.20	.195	.19	.18	.18	.17
Height anal	.13	.145	.14	.15	.14	.14	.15	.15
Length pectoral	.17	.19	.18	.185	.18	.18	.19	.17
Length ventral	.142	.155	.17	.155	.16	.16	.161	.155
Length caudal	.25	.265	.26	.265	.26	.255	.26	.25
Dorsal rays	8	8	8	8	8	8	8	9
Anal rays	8	8	8	8	7	8	8	8
Scales lateral line	56	57	60	59	55	55	56	55
Scales above lateral line	13	13	14	13	13	13	13	14
Scales below lateral line	8	7	8	8	7	7	8	7
Scales before dorsal	29	30	32	32	33	30	28	30

This seems to be the most abundantly represented species in Pyramid Lake, approaching the shore at times in enormous schools. Perched on a high tufa crag near the shore one may observe countless numbers of these fish slowly passing through the clear water. From the cliffs above they resemble large purple clouds reflected from the green surface of the lake. They bite eagerly at a baited hook, a small spoon, or an artificial fly. It is said that during the winter very few are seen.

On May 16 the writer began observations on the western side of Pyramid Lake at The Willows. The weather was then cold and squally, the lake rough and forbidding. Relatively few fishes were seen, although large schools of suckers were spawning and a few minnows might be observed here and there among the suckers and in the algæ, while an occasional trout was caught by the Indians. On May 20 the weather suddenly settled and became warm. As the sun went down, its last rays from over the mountains fell on the surface of the lake, which was as calm and placid as a great mirror. About o'clock on the following morning there was heard a vigorous lapping of the water, which in the quiet air appeared entirely without cause until it was found to accompany the leaping of vast numbers of fishes. Far out and up and down the shores the surface of the water fairly boiled. Spring had come,

and with it, in the dim light of the early morning, myriads of fishes from the depths of the lake. Daylight revealed them everywhere, along the shore, among the bowlders, and in the algæ, hovering in enormous schools over the bars and moving about in the clear water of the sheltered bays. From this time the suckers rapidly disappeared, while the large trout approached the shore in their eagerness to feed on the luckless minnows.

Most of the fishes engaged in this particular migration were L. pectinifer, although many examples of S. obesus were seen among them. At this time the latter were often taken in deep water with a troll at some distance from shore. Most of these fish (L. *pectinifer*) were not ready to spawn, and no ripe individuals were seen until May 24, after which date spawning soon began.

Residents report that during the summer large numbers of minnows frequent the inshore waters, but that in September they disappear and are seen no more until the following spring. Late in the summer great numbers of small minnows swarm in the shallows near shore. Young specimens of this species were taken from several schools in protected, shallow bays in Winnemucca Lake, June 17, 1913. They were of two distinct sizes, measuring, respectively, 42 to 58 and 65 to 80 millimeters. There was a black lateral stripe extending along the side, broader, darker, and more definite in outline posteriorly and enlarging greatly near base of caudal fin, where there is a more or less distinct dark spot. The scales of the lateral line are very thin, the tube is large, and when the scales are rubbed off the line appears broken or incomplete.

Large numbers of the species fall a prey to gulls, cormorants, and pelicans, the latter scooping them up in great numbers to feed their young. They contribute largely to the food of the trout. They make excellent pan fishes, although very bony.

The species appears to be entirely lacustrine.

Agosia robusta Rutter. Black minnow.

The name *robusta* was first applied by the describer of this species [a] to examples of Agosia found in tributaries of the Truckee and Susan Rivers. It was later [b] used to include fishes of the genus found in streams of the western slopes of the Sierras which flow into the Sacramento and San Joaquin Rivers. It was at first thought to be characterized by the blunt, rounded snout, the heavy body, incomplete lateral line, absence of scattered brown scales, shorter pectorals, greater development of rudimentary caudal rays, scales in lateral series 56 to 57, and in the presence of a silvery stripe across the cheek. Later it was seen to be "quite variable," and, in the hands of its describer, it was assuming the same complex medley of variations which are found in A. *carringtoni* or A. nubila *carringtoni* of later writers. It now appears that the name must be restricted to the Agosia of the Lahontan system or else abandoned entirely, for if its range is extended to include even a part of the Sacramento system its variation becomes so great that it can not now be differentiated from the form or forms occupying the Oregon Lake region or the upper Columbia. As yet the present writer is unable to find any character or set of characters which will distinguish Agosia *robusta*, and the name is therefore only provisionally retained.

A large series of specimens from the Lahontan system are at hand, and from these the following observations are made:

The snout is short and evenly rounded from its tip to the interorbital space. It is not blunt, nor does it project much beyond the mouth in any case. The under jaw is included. The maxillary is protractile, no frenum appearing. Barbels are present on both sides, on one side only, or absent altogether. When present, they are occasionally long and prominent, but at times they are so short as to almost escape notice. When one only is present, it is indifferently on the right or left side.

Barbels	Present.	On side.	Absent.
Specimens from—			
Susan Creek	13	4	10
Carson River	10		
Fallen Leaf Creek		8	ix
Humboldt River Palisade	8	a	10
Star Creek	14	5	I
Marys Creek	9	5	4
Quinn River	5		15

a Bulletin, United States Fish Commission, vol. xxii, 1902, p. 148.
b Bulletin, United States Bureau Fisheries, vol. xxviii, 1907, p. 139.

The gillrakers are short and stubby; 6 or 7 small protuberances. The body is deep and robust; no more so, however, than many examples from the Columbia or Bonneville systems. The lateral line sometimes extends to the last scale, although in most cases it is less complete. It often differs on opposite sides of the body, and sometimes it extends the entire length, but interrupted at irregular intervals. It is found to end anterior to the dorsal or at any point between the dorsal and caudal fins.

Lateral line	Almost complete.	Ends before anal fin.	Ends near middle of anal.	Ends anterior to dorsal.
Specimens from-				
Susan Creek	11	5	1	8
Carson River	1		7	2
Fallen Leaf Creek	1		18	
Humboldt River Palisade	5		12	3
Star Creek	7		9	14
Marys Creek	12	5	1	
Quinn River	6	3	3	8

No scattered brown scales occur, their absence, however, not being characteristic of Lahontan specimens alone. The dorsal is almost always inserted well behind the ventrals, nevertheless the distance is found to vary from a point near a vertical through the insertion of ventrals to almost halfway between their bases and the anal opening. The pectorals are usually short, not reaching the ventrals. Specimens with longer fins are easily found, the pectorals at times extending well beyond the bases of ventrals. Usually there are not less than eight fully developed rays in the ventral fin. When depressed their tips fall short of the anal opening or extend even to the origin of the anal fin. The edges of the fins are truncate or rounded, never falcate. Membranous stays do not appear behind the bases of the ventrals. Rudimentary caudal rays number from three to six. A more or less definite, broad, dark, lateral stripe is present, although in some cases it is poorly defined and seen only on the caudal peduncle. Usually a distinct narrow stripe appears along the side of the abdomen. Dark blotches of variable size are often present, but the dark pigment is not confined to particular scales. Examples from the desert are lighter than those from wooded areas, the stripe being present on individuals from both regions. This stripe is not black and sharply defined as in specimens of A. nubila from the coast region of Oregon and Washington. The bright silvery area observed by Rutter soon disappears under the action of preservatives.

In life the color is yellowish olive above, growing brassy on the sides and yellowish beneath. The spots and stripe are olive black. End of maxillary and small space behind it, a spot posterior to edge of opercle, median area of throat and breast, a broad axillary area of both pectorals and ventrals, and a narrow space along base of anal, bright crimson with a slight brassy reflection. Fins tipped with yellowish red.

The teeth in 10 examples were 4, 4, strongly hooked. and without grinding surface.

The alimentary canal is not longer than the entire length of the individual. The peritoneum is jet black, occasionally lighter. The bladder extends over about four-fifths of the visceral cavity. A female caught at Tahoe City June 27 was full of nearly ripe eggs.

The scales are very small, convex, rounded in outline, and possess both basal and apical radii. They are almost if not altogether indistinguishable from those of Hesperoleucus mitrulus, thus rendering their minute structure useless as a generic character.

This species inhabits both streams and lakes. In the rivers it is most often taken on the ripples. In lakes it frequents the shallow water, swimming near the bottom, or in crevices between rocks. From above, when seen in the water, the color is decidedly black. In the lakes it was taken with hook and line, a method which will often secure very small fishes where the net fails on account of deep, clear water or rough bottom.

Agosia nevadensis and A. velifer are very distinct from this form and are easily recognized.

MEASUREMENTS OF AGOSIA ROBUSTA.

	Fallen Leaf Creek, near Tallac, Lake Tahoe.					Susan Creek, 10 miles below Susanville.				
Length of body mm.	60	58	58	56	79	52	60	55	57	60
Length head	0.24	0.26	0.24		0.26	0.26	0.26	0.25	0.25	0.25
Depth body	.25	.20	.25		.26	.25	.22	.23	.24	.225
Depth caudal peduncle	.225	.115	.105		.10	.12	.11	.11	.13	.12
Length caudal peduncle	.26	.26	.24		.26	.21	.23	.23	.25	.24
Length snout	.08	.10	.08		.08	.085	.10	.07	.08	.08
Diameter eye	.06	.095	.06		.045	.06	.05	.05	.05	.055
Interorbital width	.07	.07	.075		.06	.07	.08	.08	.08	.07
Depth head	.17	.17	.17		.16	.18	.16	.16	.18	.17
Snout to occiput	.21	.21	.21		.20	.22	.20	.20	.20	.20
Snout to dorsal	.56	.53	.55		.54	.58	.55	.55	.55	.56
Snout to ventral	.50	.47	.50		.51	.52	.54	.51	.48	.51
Length base of dorsal	.11	.115	.12		.11	.11	.10	.20	.30	.12
Length base of anal	.10	.10	.095		.10	.09	.10	.085	.09	.08
Height dorsal	.19	.20	.19		.18	.17	.165	.18	.16	.16
Height anal	.16	.18	.16		.16	.37	.16	.16	.16	.16
Length pectoral	.20	.23	.19		.37	.18	.17	.17	.17	.17
Length ventral	.15	.17	.15		.13	.15	.14	.15	.13	.14
Length caudal	.26	.25	.24		.235	.4	.23	.22	.23	.23
Dorsal rays	8	8	9		7	8	8	7	7	8
Anal rays	7	7	7	7	8	7	7	7	7	7
Scales lateral line	75	76	73	8	70	67	67	73	68	65
Scales above lateral line	13	13	13	3	13	12	14	23	12	14
Scales below lateral line	9	9	9	10	10	9	9	10	9	11
Barbels	1	0	0	0	0	2	2	2	0	0

Coregonus williamsoni Girard. Mountain whitefish.

Sufficient material for a careful comparison of whitefish from the Lahontan and Columbia systems is not at hand. They seem to be alike, but the appearance of differences when series of each are compared would not be regarded with surprise.

The species is found in the Truckee, Walker, and Carson Basins, it was reported from the Humboldt, but no evidence of its occurrence elsewhere in the system was found. It spawns in October, large numbers then moving up the tributaries of Lake Tahoe. The migration is said to last about two weeks, being at its height near the middle of the month. Males collected at that time had tubercles on the posterior part of the body and tail, both above and below the lateral line.

An example from Carson River, near Genoa, was silvery in life, tinted with pale olive above, white beneath. This specimen measured 395 millimeters. A smaller one, 185 millimeters long, was silvery, somewhat darker above than below. When the body was turned, indistinct parr marks appeared in some lights on the sides, which became more evident after preservation. Examples from 150 to 230 millimeters long, taken at Lake Tahoe, show no parr marks, while others measuring 95 to 545 millimeters, collected in Fallen Leaf Creek, are broadly marked along the sides. These usually have nine almost square, round, or somewhat oval dark spots on the sides, each of which is about four scales wide, their edges extending just below the lateral line. The first is immediately behind the gill opening; the last at the base of the caudal fin. Those near the middle of the body are largest. Occasionally a spot is very small or absent, or a supernumerary may appear anywhere along the median line. Above this row are many smaller spots, close together and without any definite arrangement. With growth the smaller spots are first to disappear.

The mountain whitefish seems to be particularly fond of the eggs of spawning fishes, and sometimes their stomachs will be found filled with the eggs of their own species. It rises to the fly at times, is as game as a trout, and by sonic is preferred as a food fish.

A further comparison of specimens of this species with those of C. [illegible] Jordan and Snyder, from the Willamette River, fully warrants the recognition of the latter.

MEASUREMENTS OF COREGONUS WILLIAMSONI.

	Lake Tahoe.						Vallen Leaf Creek.					
Length of body mm.	238	228	207	200	187	185	114	121	115	107	101	101
	♀	♀	♀	♀	♀	♂						
Length head	0.195	0.205	0.215	0.21	0.22	0.215	0.23	0.21	0.21	0.23	0.23	0.24
Depth body	.18	.20	.21	.195	.20	.195	.20	.18	.19	.17	.19	.17
Depth caudal peduncle	.06	.065	.06	.06	.06	.065	.065	.06	.065	.06	.06	.06
Length caudal peduncle	.14	.135	.135	.14	.145	.14	.14	.15	.16	.19	.15	.24
Length snout	.06	.061	.065	.065	.065	.06	.065	.07	.07	.065	.06	.07
Length maxillary	.055	.055	.06	.06	.06	.055	.065	.065	.065	.065	.065	.07
Diameter eye	.05	.05	.05	.05	.05	.055	.06	.06	.065	.06	.065	.07
Interorbital width	.065	.065	.06	.06	.06	.06	.065	.06	.06	.07	.065	.06
Depth head	.135	.15	.145	.14	.15	.145	.15	.14	.14	.145	.15	.15
Snout to occiput	.16	.27	.17	.17	.18	.18	.18	.17	.17	.18	.185	.19
Snout to dorsal	.335	.455	.45	.46	.46	.46	.45	.445	.43	.44	.445	.44
Snout to ventral	.53	.535	.535	.55	.55	.555	.51	.5	.50	.51	.51	.53
Length base of dorsal	.125	.12	.115	.11	.105	.11	.12	.12	.12	.12	.13	.12
Length base of anal	.105	.10	.095	.095	.10	.10	.10	.105	.11	.115	.51	.15
Height dorsal	.35	.135	.3	.12	.14	.13	.14	.13	.35	.35	.13	.12
Height anal	.11	.11	.11	.10	.105	.11	.12	.11	.105	.12	.11	.12
Length pectoral	.15	.155	.165	.165	.175	.16	.17	.16	.15	.17	.175	.17
Length ventral	.135	.13	.12	.13	.13	.135	.13	.13	.11	.14	.12	.12
Length caudal	.165	.17	.17	.17	.18	.18	.22	.205	.20	.215	.20	.20
Dorsal rays	12	12	11	11	12	12		11	11	11	12	1
Anal rays	12	11	12	.....	11		1	11	12	.....	11	1
Scales lateral series	82	89	85	85	87	85	82	89	86	86	80	
Scales above lateral line	8	9	9	9	9	9	10	10	10	10	9	1
Scales below lateral line	7	8	8	8	8	7	7	8	8	8	8	1
Scales before dorsal	30	32	30	31	33	31	33	34	34	32	31	

Salmo henshawi Gill and Jordan. Tahoe trout.

This trout is best known to ichthyologists and anglers from fish caught in Lake Tahoe, in its numerous tributary streams and small lakes, and in the upper portions of the Truckee River. Here its most striking characteristic is the dark-olive body with an array of large black spots scattered almost uniformly over the entire surface. The species is distributed throughout the entire Lahontan system, however, and living under greatly diversified conditions it seemingly reacts to its surroundings, appearing in a medley of variations of color, such as are not often observed among individuals of a single species.

Examples in bright nuptial dress may be seen in Lake Tahoe in May and early June. The males are then of a dark yellowish-olive color, with faint metallic reflections, the dark color being uniform from the back to the ventral surface. On the side is &broad, pinkish stripe, indefinite in outline, but about so scales wide and located mostly below the lateral line, originating at the opercle and extending to below the adipose fin, beyond which it gradually fades out and disappears. Each scale included in this stripe and also in a broad area above and below is narrowly edged with pale yellow. The opercle, preopercle, subopercle, and a triangular spot above the axil of pectoral are scarlet or yellowish scarlet. The under surface of the lower jaw has two parallel stripes of bright red, the color not extending on the mandibular side of the membranes. There is a patch of bright red on the tongue beneath the tip. The inner edge of the shoulder girdle is bright red. One or more small orange spots may often be found on the head, especially on the cheeks and jaws. The entire head and body, together with the unpaired fins, are marked with dense, brownish-black spots, usually larger than the pupil, and rounded oval in outline, widely spaced and fairly regular in distribution. On the dorsal fin the spots are arranged in five pretty well defined rows, parallel with the outline of the back. The adipose fin bears two or three spots; they are numerous on the caudal, but not more than six or seven occur on the anal, usually at the base. Females ate similarly colored, though much lighter and with more metallic luster.

Males often vary toward lighter tints, while some females are occasionally darker than the others, sometimes rendering the determination of sex on color alone very difficult. Frequently a very light-colored, silvery specimen of either sex appears. Such fishes are distinguished by the bright metallic luster of the sides and also by having smaller and more elongate spots. These are known as silver trout,

and are said to frequent the greater depths. They represent *Salmo clarkii tahoensis* Jordan and Evermann.[a] A specimen of this sort measuring about 14 inches was caught near the mouth of Cascade Creek. It was very silvery in color, lacking the red and rich olive shades of the more usual type. The spots were small and elongate, contracted laterally instead of from all sides. A silver trout, caught by Mr. Ralph Lowe, near Brockway, measuring 23 inches and weighing 5 pounds, *was* dull silvery over nearly the entire surface, the upper parts tinted with brownish and having purplish reflections. A broad, indistinct lateral stripe of light pink extended posteriorly to near the anal fin. The head was dusky above, the cheeks silvery, with a pinkish tint, the skin beneath the maxillaries bright red. This specimen was apparently 6 years old, as indicated by an examination of the scales. These so-called silver trout sometimes attain a great size, one having been caught which weighed 29 pounds.[b]

The trout seen in the smaller lakes and streams of the Tahoe Basin were like those of the lake itself. Those seen in the Truckee River near Lake Tahoe, at Truckee, and farther down the river were much like those of the lake, the spots being usually smaller and possibly more numerous.

Trout are at times rather common throughout the entire course of the Truckee River. Before the introduction of irrigation dams, power plants, factories, and sewers they were abundant, but now the partly diverted, interrupted, and contaminated river is a very precarious summer home for the larger fishes at least.

On the appearance of rain in the mountains, and the following rise of the river, trout begin to migrate from Pyramid and Winnemucca Lakes, passing up the stream in a leisurely way, briskly running the rapids, or loitering about in the deep pools. They often pass the great bend in December or even as early as October and continue upstream, migrating in waves or schools and series of schools. With the advancing season the fish grow more numerous, appearing in incredible numbers as the run reaches its maximum. The trout of this migration are locally known as redfish.

After becoming acquainted with the dark and comparatively small Tahoe trout, one regards the huge redfish with amazement, its long and powerful body gleaming with flashes of gold and silver, and the great red cheek spot glowing like a coal of fire. By some observers it is regarded as entirely distinct from the Tahoe trout and also from the smaller fishes of a later run. The Mutes call it "Tomooagaih," or winter trout.

A large male redfish dipped from the pool below the dam at Thisbe (March 26) was colored as follows: Whole body suffused with pink and yellow, the color approaching vermilion in some lights or darker red in othets, the yellow with metallic reflections. The yellow color is more intense above and below, the pink brightest in the region of the lateral line, but not distinctly outlined as a stripe. Opercle bright, livid red; subopercle like body; preopercle reddish yellow, much brighter than body, but duller than opercle. An indefinite, small pinkish spot midway between eye and opercle. A few deep-orange, coin-shaped spots somewhat smaller than eye, scattered here and there on the body near bases of pectorals and on the breast. The caudal fin is yellow, the dorsal suffused with yellow, the paired fins with purplish red. The area beneath the mandible is strongly marked with bright red, the color confined to the side next to the branchiostegals. More brilliantly colored examples are often seen where the red of the opercle is more livid and spreads to the shoulder girdle, the lateral stripe better defined and more intense in color, and the entire head and body of a brighter hue. The females are similar though paler in color. The small orange spots referred to are remarkable in that they appear, without regularity, on any part of the body except in the region of the lateral line. One was seen on the lower jaw, another on the base of the caudal, and one on the adipose fin. In addition to the bright colors noted above, the head and body are sprinkled with black spots which are smaller than in the Tahoe trout. The red color beneath the jaw is apparently always present in the redfish.

The migration of the redfish ceases in March. The running fishes do not appear to go upstream farther than the approach of the swift water of thecanyon above Verdi.

As the redfish migration slowly wanes, large numbers of smaller trout enter the Truckee River and pass up with considerable rapidity. Smaller, generally darker in color, and more heavily spotted than those of the preceding run, and arriving with the spring, they are called by the Piutes "Tamagaih," meaning spring trout. The native name is passed on by the anglers as plain tommy. Like

a Bulletin 47, United States National Museum, p. 2870.

b Jordan and Evermann, Bulletin 47, United States National Museum. p. 493 (*Salmo* mykiss *henshawi*) and p. 2870 (*Salmo clarkii tahoensis*).

the redfish, the movements of the tommies are apt to be somewhat irregular, depending on the state of the river, appearing and passing in large numbers while the water is rising and being less numerous when it is low. Advance scouts of the tommies come in with the last of the redfish, while an occasional lingering individual of the latter is overtaken by the advancing hordes of tommies. But on the whole the two migrations are distinct, and fishes belonging to each may be distinguished with some degree of certainty. The second migration usually occurs in April, being well over by May r. Individuals which have not yet spawned may be found in the river during May and even later. By the latter part of June, certainly by the middle of July, the lower part of the river is practically clear of large trout.

At times many very silvery tommies appear in the lower Truckee, and again only an occasional one will be seen. Silvery redfish also occur. These are not to be confused with the emerald trout, which have not been reported from the river.

In Pyramid and Winnemucca Lakes trout abound, and they grow to a large size. Specimens of 9 or so pounds are common, while sometimes examples weighing over 20 pounds are caught. Considerable variation in color is found here, especially early in the season, when breeding fishes are returning from the river. An example 2 feet long, taken in Pyramid Lake May 20, in life was clear greenish olive on the upper surface, this color becoming diffuse on the sides, where it gave place to silvery, strongly tinged with pink, the ventral surface of the body, throat, and chin being white. The whole dorsal surface when seen from the side appeared silvery with a suffusion of pink, instead of greenish olive, as when viewed from above. Cheeks pinkish, the upper edge of opercle brassy. Paired fins and anal tinted with orange red. Dorsal and adipose fins like the back. A red gash present on the under mandible. Small black spots scattered rather evenly over head and body, varying in size from about a third the diameter of pupil to mere specks. They were largest on the upper surface and on the caudal fin. Many examples similar in color were seen. The red was never entirely absent from the throat, and small, round, brassy spots were frequently found on the head and body. Large, fat examples are sometimes taken, the general color of which is very pale and silvery, the spots being few and small, exact counterparts of the silver trout of Lake Tahoe. Several specimens taken on the western side of Pyramid Lake late in May were brilliantly colored and dark like the migrating trout. Their fins were frayed, they had spawned, and it was quite apparent that they had but recently returned from the river. Rarely an individual is caught which has no spots below the lateral line except on the caudal fin and only a few above. Trout from Winnemucca Lake are like those from Pyramid Lake. An examination of many from both localities gave the impression that those from the former were somewhat lighter in color.

Anglers usually distinguish trouts by color and form, and in the Truckee Basin they generally recognize 6 varieties: In Lake Tahoe, the Tahoe trout, dark in color, with large spots; the silver trout, silvery in color, with small, elongate spots, body deep and heavy; the royal silver trout, deep blue above and silvery on the sides, with few or no spots. In the lower Truckee River and the lakes, the redfish, migrating from Pyramid and Winnemucca Lakes, brilliant in color, the red cheek especially prominent; the tommy, a smaller and relatively large spotted fish, which appears in a separate run following thatof the redfish; and, finally, the greenback (emerald trout) of the lakes, green above, silvery on the sides, and with very few spots. Except the royal silver and the emerald trouts, these appear to be representatives of the same species, no character or set of characters having been found which will serve to distinguish between any of them. The introduction of marked fingerlings of the redfish into Lake Tahoe and of small Tahoe trout into Pyramid Lake might lead to interesting results.

Questions at once arise regarding the two migrations of trout in the lower Truckee River, and it may be briefly stated that nothing has been accomplished by way of explanation except negatively. The redfish and tommies are found in both lakes, and the migrations appear to proceed from both at about the same time.

The following table is presented to aid in expressing the numerical variation seen in the spotting of trout from different localities. Typical specimens were selected, and a line drawn along the side of the body from the gill opening'to the middle of the base of the caudal. This was crossed by another passing vertically through the anal opening, thus separating body and tail and dividing each into an upper and lower half.

NUMBER OF SPOTS ON TROUTS PROM DIPPERENT LOCALITIES

Locality		Lake Tahoe.		Truckee River. Redfish.		Truckee River. Tommy.		Pyramid Lake.		
Length of specimen	mm.	370	390	675	720	500	555	529	584	400
Spots on head		55	60	16	12	44	68	65	20	13
Body above line		95	103	100	44	115	92	102	5-	43
Body below line		113	53	45	49	175	259	111	x6	0
Tail above line		43	45	48	39	63	59	52	42	40
Tail below line		59	44	25	31	57	82	56	28	7
Dorsal fin		36	42	86	103	55	45	66	52	41
Adipose fin		3	5	4	5	2	4	8	6	4
Caudal		66	93	234	284	145	162	184	65	95
Anal		28	20	27	26	23	16	12	6	17

The native trout seen elsewhere in the Lahontan system belong to this species. Those of the Humboldt, Carson, and Walker Rivers are lighter in color than fishes from Lake Tahoe. Like other trout they are darker in deep, shaded water and lighter and more silvery in the open rivers. Large trout of this species are found in the upper part of Walker Lake, where the water is comparatively fresh.

S. *henshawi* is a more slender trout than the rainbow. The head is longer and more pointed, and in some cases the body is very elongate.

MEASUREMENTS OP FRESHLY KILLED SPECIMEN.

Total length	inches..	22½	23½	294	254	21¾	2534	24	274	264	24	23	26½	21¾	20¾
Depth	do....	4⅞	5¾	6%	4%	3%	5⅝	4	5¼	5⅛	4⅜	4⅛	4 ⅝	3⅝	3%
Depth caudal peduncle	do	2%	1 ⅝	2¾	1⅞	1¾	2	1⅛	2	1⅞	1¾	1¾	1⅞	1⅛	1¾
Length head	do..	5¼		6¾	5⅜	4½	534	5¾	5%	5%	5%	4%	5%	4⅛	4
Weight	pounds..	334	3	8%	4¾	2¼	5¾	3%	7	5¼	3%	3%	334	2¼	2⅜

In addition to the above, the following measurements and weights may be of interest. The fishes were taken in Pyramid and Winnemucca Lakes.

Length.	Weight.	Length.	Weight.	Length.	Weight.	Length.	Weight.	Length.	Weight.
Inches.	Pounds.	Inches.	Pounds.	Inches.	Pounds.	Inches.	Pounds.	Inches.	Pounds.
15½	1¾	21¾	2¾	24	334	2634	5¼	18	1¾
214	334	224	34	24	334	26½	354	20¾	2¾
21¾	2¾	23	334	25½	44	27¼	7	21	234
20¾	24	234	3	254	5¼	294	8%	23¼	3%

In this species the basibranchials bear teeth which are generally numerous and large. Occasionally specimens will be found in which the teeth are few and frail or entirely absent. Many examples observed at the Truckee Dam at Thisbe were without exception supplied with basibranchial teeth. At another time 20 individuals examined at the same place produced 6 examples without such teeth. An occasional specimen taken in Pyramid and Winnemucca Lakes had none, the number running about x to 10. It here appeared probable that teeth are more often absent in larger individuals, those over 500 millimeters in length, than in the smaller ones. The gillrakers usually number from 23 to 25. The branchiostegals number so or 11, often 12, rarely 9.

Number of gillrakers	22	23	24	25	26	27
Number of specimens	9	13	17	3	1	2

Number of branchiostegals	.....	9	10	11	12
Number of specimens		1	30	49	9

There are from 70 to 85 cæca present. There are usually from 553 to 563 scales in the lateral series sometimes as few as 150 or as many as x 70; 29 to 39 above the lateral line.

Measurements of a series of specimens are here presented:

LAKE TAHOE NEAR TALLAC, CAL., JUNE 20, 1911.

Length of body ..... mm	325	300	274	318	280	324	305	295	344	330
	♂	a		♂	♂	♂	♀	9	9	9
Length head	0.26	0.25	0.255	0.27	0.255	0.255	0.255	0.25	0.24	0.24
Depth body	.215	.23	.24	.24	.21	.215	.235	.23	.20	.215
Depth caudal peduncle	.095	.to	.95	.105	.10	.10	.105	.10	.095	.10
Length caudal peduncle	.255	.175	.55	.5	.18	.16	.145	.165	.16	.165
Length snout	.07	.07	.07	.075	.07	.075	.065	.06	.06	.06
Length maxillary	.16	.25	.145	.16	.15	.145	.145	.135	.125	.13
Diameter eye a	.045	.04	.045	.04	.04	.038	.04	.04	.037	.04
Interorbital width	.075	.08	.075	.085	.075	.075	.075	.079	.075	.075
Depth head	.16	.17	.16	.18	.16	.16	.16	.155	.5	.16
Snout to occiput	.18	.17	.17	.18	.17	.163	.x6	.16	.15	.16
Snout to dorsal	.495	.485	.51	.53	.50	.49	.49	.495	.485	.48
Snout to ventral	.53	.53	.54	.54	.53	.53	.53	.53	.53	.525
Length base of dorsal	.11	.12	.10	.11	.105	.105	.115	.10	.115	.11
Length base of anal	.105	.11	.10	.115	.11	.11	.125	.115	.105	.12
Height dorsal	.13	.145	.125	.13	.14	.13	.135	.135	.125	.135
Height anal	.13	.135	.12	.14	.135	.13	.135	.14	.13	.135
Length pectoral	.17	.19	.18	.17	.265	.16	.17	.565	.x6	.17
Length ventral	.14	.14	.13	.135	.14	.225	.125	.13	.125	.53
Length caudal	.21	.22	.215	.21	.225	.20		.20	.20	.20
Dorsal rays	11	11	10	10	10	11	11	10	11	11
Anal rays	11	10	11	12	12	11	12	11	11	12
Pectoral rays	13	14	13	14	14	14	14	14	14	13
Scales lateral series	156	160	170	263	266	162	166	159	169	160
Scales above lateral line	33	33	35	35	32	31	34	32	34	31

PYRAMID LAKE, EAST SIDE, MAY 29, 1911.

Length of body ..... mm	500	462	460	385	460	462	465	443	385	422
	♂	9	♂	9	9	♂	♂	♀	9	♂
Length head	0.24	0.235	0.26	0.25	0.24	0.242	0.255	0.245	0.245	0.245
Depth body	.205	.205	.20	.215	.20	.178	.20	.195	.25	.22
Depth caudal peduncle	.08	.085	.085	.083	.078	.08	.085	.08	.085	.5
Length caudal peduncle	.165	.165	.155	.175	.155	.155	.165	.16	.165	.17
Length snout	.065	.063	.075	.06	.06	.065	.075	.068	.06	.063
Length maxillary	.136	.13	.25	.135	.135	.135	.135	.155	.14	.14
Diameter eye	.035	.035	.034	.036	.035	.035	.035	.035	.035	.034
Interorbital width	.075	.075	.08	.075	.071	.075	.075	.075	.075	.071
Depth head	.155	.16	.155	.15	.145	.145	.16	.155	.145	.145
Snout to occiput	.16	.15	.17	.163	.145	.18	.165	.155	.16	.55
Snout to dorsal	.51	.49	.505	.51	.505	.50	.495	.505	.50	.50
Snout to ventral	.535	.54	.54	.545	.53	.55	.55	.535	.545	.545
Length base of dorsal	.095	.09	.115	.095	.11	.115	.11	.095	.105	.095
Length base of anal	.115	.104	.12	.10	.12	.105	.10	.11	.105	.095
Height dorsal	.115	.105	.11	.115	.115	.11	.11	.115	.125	.113
Height anal	.115	.12	.11	.115	.12	.12	.11	.125	.125	.11
Length pectoral	.14	.135	.145	.145	.15	.135	.15	.145	.155	.55
Length ventral	.105	.105	.12	.115	.115	.105	.115	.13	.13	.115
Length caudal	.18	.17	.95	.19	.175	.17	.185	.195	.205	.185
Dorsal rays	10	9	10	10	10	10	10	10	10	10
Anal rays	11	10	12	11	11	11	10	11	11	11
Pectoral rays	13	14	14	12	14	14	13	14	14	13
Scales lateral senes	156	161	153	150	161	153	154	160	150	161
Scales above lateral line	34	33	35	31	30	29	30	35	31	31

a The eye is measured vertically.

TRUCKEE RIVER AT GOVERNMENT DAM, NEAR THISBE, NEV., MAR. 26, 1911.

Length of body..... mm	610	595	640	460	425	585	500	483	447	415
	♂	♀	♀	♂	♀	♀	♂	♀	♂	♀
Length head	0. 265	0. 245	0. 24	0. 27	0. 245	0. 245	0. 27	0. 245	0. 26	0. 235
Depth body	.215	.20	.21	.225	.195	.20	.225	.20	.20	.295
Depth caudal peduncle	.110	.083	.09	.20	.085	.077	.95	.085	.09	.09
Length caudal peduncle	.155	.160	.155	.160	.17	.255	.160	.262	.135	.160
Length snout	.075	.063	.68	.075	.07	.065	.077	.065	.07	.065
Length maxillary	.160	.13	.14	.15	.14	.24	.165	.138	.255	.23
Diameter eye	.032	.032	.03	.035	.37	.03	.03	.045	.032	.035
Interorbital width	.092	.078	.082	.08	.08	.075	.085	.075	.082	.075
Depth head	.175	.160	.160	.175	.255	.255	.160	.15	.16	.145
Snout to occiput	.27	.x6	.15	.27	.160	.160	.178	.152	.160	.155
Snout to dorsal	.54	.52	.54	.51	.49	.49	.532	.515	.49	.52
Snout to ventral	.59	.59	.555	.55	.535	.545	.57	.53	.54	.54
Length base of dorsal	.111	.112	.205	.20	.105	.105	.111	.095	.105	.105
Length base of anal	.21	.125	.113	.205	.11	.105	.115	.21	.105	.111
Height dorsal	.12	.11	.112	.12	.12	.105	.115	.205	.105	.115
Height anal	.13	.13	.115	.13	.118	.107	.13	.12	.12	.13
Length pectoral	.14	.132	.13	.155	.142	.225	.24	.133	.14	.15
Length ventral	.115	.105	.105	.12	.115	.095	.105	.11	.11	.15
Length caudal	.275	.19	.18	.185	.19	.16	.18	.185	.17	.19
Dorsal rays	10	11	12	10	10	11	11	10	11	11
Anal rays	11	12	13	10	10	12	11	11	12	11
Pectoral rays	13	14	15	13	23	14	14	14	15	13
Scales lateral line	162	165	160	158	x58	165	261	237	162	158
Scales above lateral series	33	30	32	30	32	.....	32	.....	32	31

TRUCKEE RIVER AT GOVERNMENT DAM, NEAR THISBE, NEV., APR. 22, 1912.

Length of body..... mm	465	450	487	418	424	414	493	445	500	467
	♂	♀	♂	♀	♀	♀	♂	♀	e	♀
Length head	0.265	0. 255	0. 25	0. 24	0. 235	0. 25	0. 26	0.24	0. 27	0. 24
Depth body	.235	.22	.21	.22	.22	.215	.235	.23	.23	.225
Depth caudal peduncle	.105	.09	.095	.095	.093	.10	.095	.095	.10	.095
Length caudal pedunde	.16	.145	.16	.16	.16	.155	.x6	.25	.17	.175
Length snout	.075	.06	.0	.062	.062	.06	.075	.06	.08	.06
Length maxillary	.255	.115	.13	.235	.225	.145	.16	.135	.15	.125
Diameter eye	.035	.035	.034	.035	.033	.035	.03	.035	.032	.033
Interorbital width	.085	.075	.08	.074	.075	.08	.085	.073	.92	.08
Depth head	.175	.15	.16	.155	.15	.155	.17	.16	.17	.15
Snout to occiput	.175	.145	.155	.145	.15	.255	.17	.15	.17	.15
Snout to dorsal	.485	.495	.49	.485	.48	.51	.505	.51	.53	.51
Snout to ventral	.55	.53	.55	.344	.32	.535	.56	.545	.55	.545
Length base of dorsal	.11	.115	.10	.111	.115	.205	.105	.115	.22	.11
Length base of anal	.105	.125	.105	.12	.115	.11	.105	.11	.115	.11
Height dorsal	.10	.103	.11	.125	.115	.113	.111	.113	.111	.112
Height anal	.12	.11	.124	.13	.125	.13	.125	.13	.10	.119
Length pectoral	.155	.12	.14	.242	.14	.155	.142	.145	.142	.15
Length ventral	.12	.105	.115	.12	.11	.135	.12	.215	.118	.115
Length caudal	.19	.175	.18	.21	.185	.195	.18	.18	.18	.185
Dorsal rays	11	10	10	20	10	10	10	10	10	10
Anal rays	10	12	11	11	11	11	11	11	11	11
Pectoral rays	14	14	14	15	14	14	13	14	14	14
Scales lateral lme	153	158	157	149	155	137	169	156	156	158
Scales above lateral series	32	31	.....	32	34	32	32	32	33	34

In the lakes adults of this species appear to feed largely on minnows, yet many individuals examined at Lake Tahoe had the stomachs fairly stuffed with large black ants. However, these fishes were taught with a spinner, showing that they would even then be attracted by a minnow. In the rivers and creeks insects are eaten whenever they are found. The difficulty of determining the normal food is appreciated when it is seen that the hungry trout is the one most often caught. Of approximately a hundred large trout taken in Pyramid and Winnemucca Lakes only one had the stomach well filled. It contained two large minnows and the partly digested remains of another.

There was not time enough allotted to the present investigation to make any progress in a study of the movements of the lake trout. During a portion of the year these live in deep water and can be caught, if at all, only on long lines. Early in the spring and summer they approach the shore and are taken in relatively shallow water. Juday [a] discusses the movement of this species from shallow to deep

a Bulletin, Bureau Fisheries, vol. XXVI, 2906, p. 237.

water as the season advances. He found no facts in support of theories which had already been offered to account for the migration, but expressed the opinion that several factors were involved.

Brief observations at Pyramid Lake seem to indicate that the trout start from deep water (which may possibly be regarded as their normal habitat) on the nuptial migration. Returning later in the season, thin and exhausted, they begin ravenously feeding on the minnows which have then come inshore for spawning purposes. As the emaciated condition of the trout approaches the normal, they gradually retire to the deeper water from which they came earlier in the year. When their hunger becomes satisfied, and fatty tissue has accumulated in the body, it is evidently more difficult to take them with hook and line.

Trolling is the method usually employed by fishermen and anglers in catching trout in the larger lakes. The usual outfit consists of 100 feet of 6-strand No. 27 copper wire; closely twisted. To this is attached sufficient length of heavy hand line so that some may be available in case of fouling. A swivel on the distal end of the line connects an attraction spoon of bright metal measuring about 4 inches. This is followed by a fine wire or gut leader from 1 to 2 feet long, carrying a small spinner with single, double, or triple hook or merely a baited hook of liberal size. The line is trolled deep, jerked at regular intervals, or held in the hand with the moving oar. The captured fish is brought over the side without ceremony or landed with a large scoop net. Often a linen line with large sinker is used. Anglers usually employ more refined methods, light trolling rods being often seen.

Trolling with and without the large attraction spoon, from the same boat and at the same depth, resulted in many more strikes on the line bearing the large spoon. With the spinner, baited hooks seemed to bring better results than the naked ones.

Along the lower courses of the rivers and on the lakes, especially off rocky points where the rapidly shelving bottom brings the deep water near shore, a crude method of bait casting is successfully employed in taking large trout. A bamboo pole from 12 to 20 feet long and very stiff is supplied at regular intervals with large steel guide rings, a tip ring of the same sort is also lashed on, a clear space of about 4 feet is left at the butt, and a long, heavy line is passed outward through the rings and a lead weighing from 2 to 8 ounces is attached. From the lead a 2-foot leader of wire or gut extends to a spinner with single, double, or triple hooks. The latter are used naked or baited. The excess line is either coiled on the ground preparatory to a long cast or wound about the hand for a short one. A rapid side cast sends the lead and its dangling tackle far out over the water. As the lead plunges, the pole is brought to a nearly vertical position, the butt resting against the belt of the fisherman, and the line slowly and steadily brought in, the lure being thus trolled toward the shore. A steady troll is maintained by swinging the pole forward and backward, the forward movement coinciding with the pull on the line. The line is hauled with the left hand and checked by passing it between the fingers of the right. A slight variation from this rig is used by different fishermen, but on the whole it is a heavy, awkward, and unsportsmanlike assemblage of tackle.

On observing this method of fishing it occurred to the writer that light bait-casting equipment might be profitably substituted, and when an opportune time came the experiment was tried and some tackle tested out. Split-bamboo bait-casting rods 534 feet in length and weighing 4¾ and 5½ ounces, respectively, were provided with an easy-running quadruple reel and light (4 or G) soft braided line of about 200 yards length. Various lures, spinners with naked and baited hooks, and minnows were used. It appeared that a fresh minnow following a small spinner or impaled on an "Archer" was the most successful of all. A trout thus landed weighed 8¾ pounds, and judging from the ease with which it was killed it seemed probable that the very largest might be successfully brought to gaff. This for the clear open water of the lake. In the river where the current is swift, and when a fish is large, a stronger line and possibly a more sturdy rod may be necessary.

Observations from rocky points, where one may see far out and deep in the clear water, showed that the trout often followed the lure for a time before taking it. Sometimes the spoon was closely inspected or nosed and then abandoned. Experiments appeared to demonstrate that when the hooks were baited with worms or pieces of minnows these slow-biting and cautious trout, which are presumably the better-fed and fatter examples, were much more often taken. Occasionally a sharp jerk on the line seemed to end the fishes' indecision.

The light bait-casting equipment is not often seen in the West. However, it would seem from the observations here recorded that it might profitably be employed in many situations and among the mountain lakes at least become a companion if not a rival of the rod and fly. Bait casting for trout

seems to be more successful when the water is ruffled by the wind. It should be attempted only when the trout are feeding near shore. Large minnows and an occasional Sacramento sunfish were caught in this way in Pyramid and Winnemucca Lakes.

The large trout seldom rise to the artificial fly except at times in the high Sierras. The same species when living in the rivers and in their rapid and cool tributaries furnish excellent sport for the angler. All recommend small flies, 12 to 16, and not in great variety.° Many of the smaller desert streams are so closely lined with dense brush as to make fly fishing quite out of the question. Here the angler should provide himself with a short bait rod, use worms and grasshoppers, and be prepared for a trout weighing 2 or 3 pounds.

Salmo aquilarum, new species. Eagle Lake trout.

The trout of Eagle Lake is allied to the trouts of the western slopes of the Sierras, but is not closely related to the cutthroat of the Lahontan system. It is distinguished by the robust body with a deep

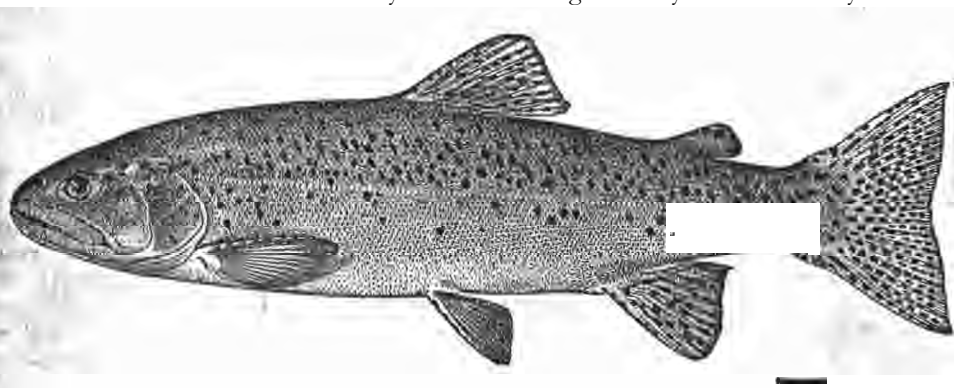


FIG. 7.—*Salmo aquilarum*, Type. Eagle Lake trout.

caudal peduncle and large and strong fins, the very large and conspicuous adipose fin, the large scales, and the color.

The following description is of the type 75653, United States National Museum, a male specimen 480 mm. long, taken at Eagle Lake near the mouth of Pine Creek, Cal., May 27, 1913. (See fig. 7.)

Head 4.2 in length to base of caudal; depth 4.2; depth of caudal peduncle 9.8; eye 7.5 in head; interorbital space 3; snout 3.5; maxillary x.9; height dorsal 6.5 in length; adipose fm 12.5; length caudal 4.8; pectoral 5.6; ventral 7.5; height anal 6.9; scales in lateral series 136.

Body deep, caudal peduncle robust; head rather pointed; maxillary broad and long, extending far beyond posterior border of eye; edge of opercle gradually sloping from above downward and backward to the bluntly rounded point; distance from edge of preopercle to edge of opercle 3.8 in head. Branchiostegals 11. Gillrakers x8, rather thick at the base, pointed at tips, and decidedly sickle-shaped. Vomerine teeth in three series in front, the middle ones extending backward. Teeth of palatines, maxillaries, and mandibles in a single series; glossohyal with teeth; basibranchials without teeth.

° The expressed opinions of some successful anglers may serve as a guide to one who has not fished in the region.

Fred A. Gladding: "From Truckee to near Reno, royal coachman, professor, ginger quill, march brown; from near Reno downstream to near Glendale, gray drake, stone fly, hare's ear, and wren tail; June and July."

George T. Mills: "For eastern slope of the Sierras, alder, pale evening dun, imbrie, bee, fern fly, and blue bottle."

Prof. R. L. Green: "Sierras above Lake Tahoe, Governor Alvord; sometimes change to a fly not often used in the region."

George I. James: "For the Truckee, royal coachman, professor, march brown, white miller, cow dung, ginger quill, blue quill."

Prof. S. B. Doten: "Ginger quill, blue quill, royal coachman, professor, may fly, and red spinner. The may fly is a rubber body, gauze wing."

Dr. W. K. Fisher: "Region above Fallen Leaf Lake, cahil, brown hackle, black gnat, royal coachman, cow dung, march brown."

George G. Schweis: "Truckee, blue quill, pheasant, royal coachman, professor (assorted). Quills most satisfactory, especially during low, clear water when the fish are shy."

Morton's gun store, Reno: "We sell most of royal coachman, ginger quill, blue quill, red spinner, golden spinner, professor, and red ant. Dry flies not generally useful because of turbulent water."

Scales large and deeply embedded; pores in lateral line 120; series of scales above lateral line, counting upward and forward to a point just before dorsal, 29. Scales of nape minute and closely crowded as are those of throat and abdomen. Axillary scales of ventral small, equal in length to vertical diameter of eye; sharply pointed. Dorsal rays, ; edge of fin concave. Adipose dorsal very large, broad, and thick. Caudal broad and strong, the posterior edge slightly concave, the lower lobe a little longer than the upper. Anal rays 11, edge of fin somewhat concave. Pectorals strong and rather pointed. Ventrals obtusely pointed.

In alcohol the body is dark brownish or olive, somewhat lighter below. There are very few spots on upper part of head; middle of back from occiput to dorsal without spots; upper half of body with large, elongate, sometimes nearly rectilinear spots of somewhat irregular outline, which grow larger posteriorly; dorsal with about 10 rows of oval spots; caudal covered with elongate spots some of which are connected; anal spotted; pectorals with a row of spots along first ray; ventrals immaculate; adipose dorsal with six round spots.

In life the body above and down the sides nearly to the lateral line was a rich dark olive, each scale brassy and showing very conspicuously. Sides from just above the lateral line downward and including the ventral surface deep coppery red with bright metallic reflections. Upper part of head like the body; sides of head cherry red, very rich in color; throat and chin dusky, but with a trace of red beneath the mandibles. Iris brassy. Pectorals dusky, broadly and very conspicuously edged above with olive. In life the spots were similar to those of the preserved specimen, dense black.

A female of exactly the same length is somewhat deeper, and has a smaller head and shorter maxillary. The color is very different. The spots are somewhat larger and more numerous, and they extend downward on the sides far below the lateral line. In life the female was light olive above, each scale being silvery with greenish reflections; sides lighter, the scales reflecting a more intense green, the ventral surface silvery with a pinkish tint. A very indistinct pale reddish lateral stripe extends along the side of body, mostly below the lateral line. A narrow, deep green stripe, two scales wide along the lateral line. Dorsal surface of head like the back. Cheeks and opercles reddish. Iris orange. Dorsals and caudal olive. Pectorals dusky, distinctly edged with olive on the first ray. Ventrals and anal suffused with red and very distinctly edged with the same.

A large school of this species consisting of about 40 individuals of both sexes was observed loitering in the deep channel leading to the mouth of Pine Creek, which was then almost dry (May 27, 1913). Through the clear water they were seen to be remarkably uniform in size and color, the males being easily distinguished by their deep, coppery sides and rich red cheeks. Several dead specimens along the shore were of the same size as those secured

The flesh of this trout is deep red, very firm and fatty, far superior to that of the Tahoe trout.

It is said that anglers do not succeed in catching trout in Eagle Lake, their failure being attributed to either a scarcity of fish or an abundance of food.

Numbers are killed each year by certain settlers in the neighborhood, who take advantage of the annual spawning migration which occurs early in May, when apparently the entire trout population of the lake attempts to move up Pine Creek, the only tributary. This annual carnage, which of recent years has taken nearly every fish that entered the creek, was indulged in by the Indians long before the whites appeared. If continued by deadly methods recently adopted here, it will surely result in the complete extermination of the species unless perchance a few small individuals succeed in breeding in Pine Creek. In extenuation of this unsportsmanlike and destructive practice the plea is offered that many of these fishes are often stranded and perish on the meadows after a sudden fall in the water of the creek, and that at times large numbers never reach the spawning grounds, and also that numbers fail to return to the lake.

MEASUREMENTS OF SALMO AQUILARUM, EAGLE LAKE, CAL.

Length of body ..... mm.	417	443	478	466	Length of body ..... mm.	437	443	478	466
	♂	♀	♀	♀		♂	♀	♀	♀
Length head	0.24	0.225	0.22	0.225	Length base of anal	0.115	0.11	0.10	0
Depth body	.24	.245	.225	.235	Height dorsal	.14	.13	.14	4
Depth caudal peduncle	.105	.10	.095	.095	Height anal	.145	.4	.145	45
Length caudal peduncle	.175	.185	.18	.165	Length pectoral	.18	.17	.16	75
Length snout	.073	.055	.055	.055	Length ventral	.135	.35	.175	3
Length maxillary	.135	.105	.105	.111	Length caudal	.19	.195	.17	8
Diameter eye	.035	.032	.032	.035					
Interorbital width	.085	.07	.07	.07	Dorsal rays	ix	xo	11	0
Depth head	.16	.15	.145	.15	Anal rays	ix	10	10	0
Snout to occiput	.15	.14	.13	.13	Gillrakers	18	16	18	10
Snout to dorsal	.49	.485	.475	.485	Scales lateral series	136	140	139	137
Snout to ventral	.53	.52	.53	.53	Scales above lateral line	29	31	32	32
Length base of dorsal	.11	.115	.11	.315	Branchiostegals	11	11	10	1

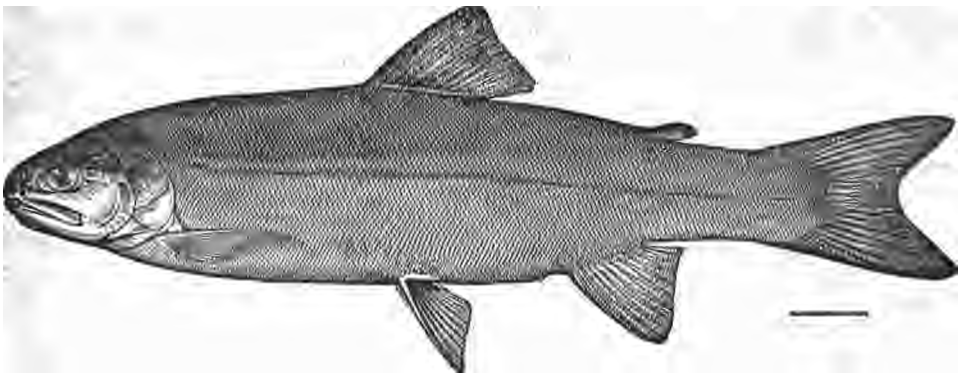
Salmo **regalis** Snyder. Royal silver trout.

Anglers' reports of the presence of a peculiar trout in Tahoe and Pyramid Lakes, with more or less accurate descriptions of one which seemed to differ from the more common Tahoe trout, led to the discovery of this species. By the local fishermen this trout is known as the greenback or grayback. It is distinguished by the absence of spots, by the blue or green dorsal surface, the silvery sides and white belly, and the loose scales which, when the fish is caught, adhere to the fingers like bits of foil.

A careful examination of many trout from Lake Tahoe and the questioning of anglers and market fishermen brought no more important results than the finding (June 20, 1911) by Mr. G. E. West of a 10-inch king salmon, 0. tschawytscha, apparently the first to be observed of some that had been introduced.

Later, specimens were secured by Messrs. Ralph Lowe and W. P. Lyon, of San Jose, and F. K. Pomeroy, of Palo Alto. These were caught in deep water near Brockway, on the east side of Lake Tahoe, and served as a basis for the description a of the species.

S. regalis is distinguished from S. *henshawi* by color and in having a shorter head, a shorter and more rounded snout, a smaller maxillary, larger scales, narrower and more pointed fins, perfectly smooth basibranchials which are without teeth, and fewer gillrakers. A fresh specimen is of a beautiful deep steel blue on the dorsal surface, which in some lights is seen to be shaded with olive, the blue extending downward on the sides to about the sixth row of scales above the lateral line, where it abruptly gives place to the most brilliant and highly burnished silver. The silver dulls ventrally, the chin, throat, and abdomen being dead white. No dark spots appear except on the dorsal and caudal fins, where they are inconspicuous. No red or yellow color is found anywhere except on the cheek, where it glows faintly through the silver. After a specimen has been preserved in alcohol, small spots appear on the dorsal and caudal fins and a few poorly defined ones on the dorsal part of the body.



8.—*Salmo regalis.* Type. Royal silver trout.

From the specimens examined (four in all) there seems to be from 144 to 150 lateral series of scales, 29 to 32 above the lateral line, 11 to 13 branchiostegals, and 19 to 21 gillrakers. No external sex differences were observed.

The market fishermen and most of the anglers who visit Lake Tahoe confuse examples of this species with silvery individuals of S. *henshawi*, and as it is next to impossible to get taintless information regarding S. regalis, almost nothing definitely is known of its habits. It seems to be very rare, or at least specimens are seldom caught. It does not appear to enter the creeks which are tributary to the lake, and its time of spawning is unknown.

An examination of the stomach contents revealed the remains of many small insects—ants, bugs, beetles, etc.—which usually may be seen floating on the surface of tributary streams and are carried out into the lake. This would indicate surface feeding, which may possibly occur at night. As this trout may be taken with a spinner, it may be inferred that it also feeds upon minnows.

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a Bulletin, Bureau Fisheries, vol. xxxu, 1912, p. 15.

It seems probable that the relationships of S. regalis and also of S. *smaragdus*, a representative species found in Pyramid Lake, are with S. *irideus* of the western slopes of the Sierras, S. smaragdus having apparently departed farther from the parent form than has S. regalis.

Salmo smaragdus, new species. Emerald trout.

The trout here described for the first time is a native of Pyramid and Winnemucca Lakes and does not seem to occur elsewhere. It is apparently a representative of S. regalis of Lake Tahoe, and in common with that form it is characterized by its peculiar color, remarkably different from that of other species of the region. The upper parts of the head and body are deep emerald green, with a few small, evanescent, dark spots scattered here and there, the sides of polished silver, and the ventral surface dead white. The body is long and slender, the head rather short and rounded, eyes large, maxillary weak, basibranchials without teeth, gillrakers few, slender and sharp, the scales large and very loosely attached, and the fins thin and pointed, the entire appearance of the fish suggesting the depths of the lake as its habitat rather than the river or the mountain torrent. From S. regalis this species differs in being green above instead of blue, in having larger scales (there being 124 lateral series—144 to 153 in S. regalis), a more slender body, longer and more pointed snout, and a gill cover distinctly different in shape, the upper or opercular part presenting a rounded, broad shoulder, while the posterior margin is relatively truncate.

The species is recognized by the older Piute Indians. To them it is the trout, "A-gaih," in contradistinction to " Tomoo-agaih" or the winter trout, the large migrants of S. henshawi which appear in the lower Truckee River early in winter, and the " Tama-agaih" or spring trout ("tommy" of the anglers), a smaller fish, also S. henshawi, though of a later run. It is also familiar to the more experienced fishermen of Pyramid and Winnemucca Lakes, who call it the ' green-back."a By them it is distinguished by its more slender form, the brilliant silver of the sides, the unparalleled green of the dorsal surface, the frail, broad, thin scales which adhere to the fingers like bits of foil, the firm, deep-red flesh, and also by the unusually strong and characteristic fight which ensues after the fish has been hooked. Their description of this trout led indirectly to the discovery of S. regalis in Lake Tahoe. It is said by all to be extremely rare, so that the most persistent fisherman sees but one or two during a season. It may possibly escape notice in the hands of some anglers where it is confused with small, silvery examples of the more common cutthroat trout, although even the less observant will immediately recognize the difference when attention is called to the specific characters. But whether or not the species is rare, the fact remains that while in the past countless numbers of large trout have been shipped from the lakes, many even reaching the markets of San Francisco, this form with its strongly marked external characters, and very desirable food qualities, has escaped the notice of naturalists and the serious attention of anglers and others interested in fishes.

Description of type no. 75596, United States National Museum, a specimen measuring 480 mm. in length, from Pyramid Lake, Nev., May 22, 1913, Sex, male. (See fig. 9.)

Head 4.5 in length to base of caudal; depth 5; depth caudal peduncle 10.5; snout 3.8 in head; vertical diameter of eye 5.6; length maxillary 2.9; dorsal rays Ii; anal 11; scales in lateral series 124; above lateral line 26; between lateral line and base of ventral 23; between occiput and dorsal about 70.

Body slender, the head and snout elongate when compared with S. regalis. Maxillary comparatively broad, rather thin and weak, not extending far beyond orbit. Gill cover obtusely rounded behind; the opercle wide and with the upper edge broadly rounded, imparting to the gill cover a pronounced and characteristic shoulder. Branchiostegals 11. Gillrakers 9–11, long and acutely pointed. Vomerine teeth in 2 distinct rows, the toothed area somewhat longer than in S. henshawi. Strong teeth on anterior part of tongue; none on basibranchials; edge of maxillary except extreme posterior part with teeth.

Scales notably large and loosely embedded; those immediately behind occiput and on ventral surface minute. Fills naked. Lateral line with 123 pores, slightly decurved beyond its origin, and then straight to middle of caudal.

Longest (first) dorsal rays contained 1.8 times in head; pectoral 1.6; pectorals and ventrals acutely pointed; ventral inserted on a vertical through base of third dorsal ray. Caudal deeply forked, the lobes pointed. Adipose fin small and rather narrow.

a The name "green-back" is not available, as it has been applied elsewhere as a common name for a particular trout, therefore "emerald trout" is suggested as an appropriate substitute.

In the preserved specimen the dorsal surface including the upper third of body is jet black, no spots being visible; sides silvery, with greenish and yellowish reflections; ventral surface white; dorsal fin with about 12 rows of very small, elongate, black spots. Adipose fin with 4 round spots. Caudal with small, elliptical spots arranged along the rays. In life the upper surface including the head and snout was deep emerald green, yellowish reflections appearing in some lights, and scattered dark spots occurring here and there from the occiput to the tail; sides silvery, the metallic color extending almost to the tip of caudal fin; lower surface dead white. There is no red or pink on any part of the body or fins.

The following proportional measurements are recorded in hundredths of the length to base of caudal: Length head 0.225; depth body 0.2; depth caudal peduncle 0.095; length caudal peduncle 0.18; length snout 0.065; length maxillary 0.115; diameter eye 0.04; interorbital width 0.075; depth head 0.15; snout to occiput 0.14; snout to dorsal 0.475; to ventral 0.505; length base of dorsal 0.12; of anal 0.1; height dorsal 0.125; height anal 0.12; length pectoral 0.15; length ventral 0.125; length caudal 0.21.

The specimen here described was caught by the writer shortly after sundown, while trolling with rather heavy tackle at a depth of about 40 feet below the surface. On being brought near the boat the fish left the water twice in spite of its heavy impediments, in strong contrast to the behavior of the more sluggish cutthroat, which even with light tackle may sometimes be brought to gaff without breaking the surface. The immediate region of its capture and the water near by were carefully worked over for a considerable time without success. That, it was taken with a spinner demonstrates that it feeds, at least at times, on minnows. The stomach contained parts of a small minnow together with the remains

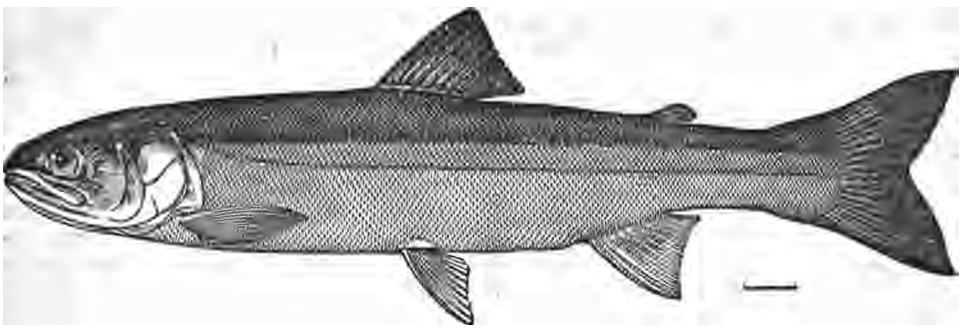

FIG. 9.—Salmo *smaragdus*. Type. Emerald trout.

of insects (beetles and bugs); but whether the latter had been taken directly or as part of the captured fish could not be determined.

Little is known of the habits of this species. It is said to be more frequently taken in the northern parts of the lakes, far from the inlets. It is not known to enter the river, and consequently it is supposed to spawn in the lake.

It will be noted that both this and the preceding species are indigenous to the same basin. None the less they may be regarded as particularly good examples of species which differentiated through the agencies accompanying isolation. For although Lake Tahoe, the habitat of S. regalis , and Pyramid Lake are connected by the Truckee River, which has its origin in the former and flows into the latter, they are in effect separated by what to some species is an impassable barrier rather than an open channel, the turbulent waters of the river plunging down 2,300 feet over a bowlder-strewn bed but little more than a hundred miles in length. Along with isolation the species are subjected to very different environmental conditions. The water of Lake Tahoe comes almost immediately from melting snow and is unusually pure and fresh, while that of the lower lake into which it finally flows is so charged with various salts that no arborescent vegetation grows on the shores.

Cottus beldingi Eigenmann. Desert rifflefish.

Cottus beldingi is closely related to C. *gulosus*, C. punctulatus, and the doubtful form C. *klamathensis*, differing from the first and last in having fewer rays in the anal fin and from C. *punctulatus* in the weaker armature of the preopercle. Like the latter, C. beldingi has a smooth skin and usually a narrow band of palatine teeth. The four forms here enumerated resemble each other very closely and their

separation is at times a matter of some difficulty. Distributed through the Sacramento, Klamath, Columbia, Oregon Lake, and Lahontan systems, they may be regarded as representatives of a single ancestral form. Rutter has recorded C. beldingi from Cole Creek near Sierraville, "a Truckee Basin species with entirely smooth skin, no palatine teeth, and short fins." The difficulty of distinguishing between C. beldingi and C. *gulosus* compels one to accept this identification with reserve. Examples of C. *gulosus* often appear with perfectly smooth skin, no palatine teeth, and comparatively short fins. The writer has not observed C. beldingi with prickles, but palatine teeth are frequently present, and the fins are usually longer than those of C. *gulosus*.[a]

Like C. gulosus, C. beldingi has a large and well-rounded head and a deep robust body with a large caudal peduncle. The skin appears to always be free from prickles. The lateral line is imperfect, usually reaching a point below posterior third of the soft dorsal, scattered pores sometimes appearing on the caudal peduncle. Palatine teeth are absent, or in some cases present when there is a narrow band equal in length to about half the longitudinal diameter of eye. The maxillary reaches posteriorly to below edge of pupil or even to center of eye. The nostrils have distinct and well-elevated rims, that of the anterior being the higher. There is always one prominent, sharp, flat, upturned, preopercular spine and usually a second small one below it which projects downward. The spinous dorsal is broadly rounded in outline, the edge scarcely scalloped, entirely separated from the soft dorsal in some examples, meeting it in others, or even joining it, the membrane then extending a short distance upward on the base of the first ray. The edge of the soft dorsal is but little scalloped. The last ray is connected with the caudal peduncle with a narrow membrane. Edge of anal deeply scalloped, the last ray without a posterior membrane. Pectoral rays usually 14 or 15, their tips often extending to a point above second or third anal ray, sometimes barely reaching origin of anal, but averaging longer than those of C. gulosus. Ventrals 1, 4, sometimes 1, 3. Caudal bluntly rounded. The dorsal spines number from 6 to 8; rays 15 to 18; anal rays is to 13.

The sides and upper part of the body are irregularly banded or clouded with dusky, coarsely and profusely spotted, or in some cases reticulated. When more or less definite bands appear, there are usually two beneath the spinous dorsal and three beneath the soft dorsal. There is almost invariably a narrow and sharply defined band at the base of caudal. The spinous dorsal is more or less clouded with dusky pigment. The soft dorsal, anal, and caudal rays bear at intervals elongate black spots, which arrange themselves in lines, the fins thus presenting a barred effect. Often the anal is immaculate, and in some cases the dorsal is nearly so. The pectoral is frequently barred. The head is dark, with closely apposed dusky clouds, reticulations, and spots. In life the color is light or dark olive, some examples being rather grayish.

On account of the roily condition of the streams when most of the observations in the Lahontan system were made, specimens of this species were seldom seen until they became entangled in the net. Several were secured with hook and line. None was caught in the lower course of the Truckee River. Examples were most often taken while dragging the net over rough bottom in the more rapid parts of the stream. In the Truckee River near Ploriston an individual was occasionally seen either under a bowlder or close by its sheltering edge. The partly digested body of a young sucker was found in the stomach of one specimen.

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a Rutter also described two new Cottoids from the Sacramento, C. macrops and C. asPerrima (Bulletin) Bureau Fisheries. vol. XXVII, 1907, p. 544 and 146). The writer has made a careful examination of the types of both of these which are preserved in the National Museum. The type of C. *macrops* on direct comparison with examples of C. *gulosus* seems to differ in no way from a typical example of that species, except that the eye is somewhat larger. In the figure the eye is represented as directed laterally, while in specimens it is directed obliquely upward. The type of C. *asperrima* appears also to be a specimen of C, *gulosus*, having the same general characteristics of that species, except that the prickly investment of the skin is much more marked than usual, but not more extensive than has been observed in other specimens. There are seven dorsal spines in the type. The eyes are directed more laterally, the back is somewhat more elevated, the caudal peduncle is snore slender. and the dorsal fins are more broadly united than the figure would lead one to suppose. Coitus *gulosus* is a species of wide range and variable characteristics, able to enter the brackish water in the mouths of the rivers and also make its way high up in the smaller mountain tributaries. It has been described under several names ,and at times has been confused with C. *asper* and C. aleuticus.

MEASUREMENTS OF COTTUS BELDINGI

	Humboldt River, Carlin.					Humboldt River, Palisade.					Carson River, Gardnerville.						
Length of body ..... mm.	63	62	55	55	56	62	65	58	75	55	80	81	69	76	68	64	52
Length head	034	0.34	0.35	0.35	0.34	0.32	0.34	0.36	0.37	0.35	0.30	0.33	0.31	0.31	0.30	0.31	0.31
Depth body	28	.24	.26	.25	.25	.24	.22	.26	.26	.24	.21	.23	.21	.21	.25	.21	.23
Depth caudal peduncle	08	09	.095	.09	.09	.095	.08	.095	.095	.09	.08	.so	.08	.08	.09	.09	.09
Length caudal peduncle	15	.15	.16	.18	.18	.15	.15	.15	.15	.16	.18	.16	.13	.17	.18	.16	.19
Length snout	11	.12	.12	.12	.11	.10	.11	.12	.12	.11	.12	.12	.10	.10	.10	.10	.095
Length maxillary	16	.16	.15	.15	.16	.15	.16	.16	.18	.it	.17	.19	.15	.15	.145	.14	.13
Diameter eye	08	09	.07	.07	.08	.075	.07	.06	.08	.075	.10	.07	.08	.07	.065	.08	.07
Interorbital width	.05	.05	.05	.045	.04	.05	.05	.045	.05	.05	.05	.04	.04	.04	.04	.04	.05
Depth head	21	.20	.20	.21	.20	.19	.20	.20	.21	.19	.19	.23	.19	.20	.21	.20	.18
Snout to dorsal	41	.39	.37	.38	.37	.37	.36	.39	.40	.41	.35	.38	.35	.35	.34	.35	.34
Length base of spinous dorsal	23	.22	.22	.20	.21	.22	.23	.21	.24	.21	.23	.21	.22	.22	.22	.22	.21
Length base of soft dorsal	39	.42	.39	.39	.38	.40	.36	.37	.38	.40	.37	.35	.38	.39	.36	.38	.38
Length base of anal	29	.34	.28	.27	.28	.29	.29	.30	.27	.31	.25	.28	.29	.27	.28	.28	.29
Height spinous dorsal	.11	.10	.to	.11	.20	.10	.II	.11	.09	.sos	.10	.10	.10	.10	.10	.09	.09
Height soft dorsal	.16	.16	.15	.14	.25	.15	.17	.15	.16	.17	.22	.13	.15	.23	.03	.14	.14
Height anal	.20	.18	.17	.16	.17	.21	.20	.18	.19	.20	.14	.19	.15	.11	.15	.13	.15
Length pectoral	.31	.32	.33	.34	.34	.33	.29	.35	.31	.32	.29	.29	.31	.29	.28	.30	.31
Length ventral	22	.23	.23	.21	.24	.22	.22	.205	.21	.22	.19	.19	.20	.18	.19	.20	.21
Length caudal	25	.26	.26	.26	.25	.25	.25	.26	.25	.27	.22	.23	.24	.22	.23	$.^{2}4$	$.^{2}5$
Dorsal spines	7	7	8	7	7	7	8	7	7	7	8	7	7	7	7	7	7
Dorsal rays	17	57	16	16	16	17	17	16	15	16	16	57	17	16	17	17	17
Anal rays	13	13	II	II	12	12	11	11	11	13	11	12	12	12	12	12	12
Pectoral rays	15	15	14	$^{-}4$	14	15	15	14	14	13	14	$^{1}5$	$^{-}4$	$^{1}4$	$^{-}5$	$^{1}4$	$^{-}4$

	Dorsal fin.							Anal fin.	
	Spines.			Rays.				Rays.	
Number	6	7	8	15	16	17	18	11□12	13
Specimens from-									
Carson River		22	18	....	8	19	3	6 20	4
Lake Tahoe	1	8	4	....	4	6	3	1 9	3
Star Creek									
Humboldt River		5	4	....	4	4	1	2□6	1

LOCALITIES WHERE SPECIMENS OF NATIVE SPECIES WERE COLLECTED.

Locality	Catostomus tahoensis Gill and Jordan.	Catostomus arenarius new species.	Pantosteus lahontan Rutter.	Chasmistes cujus Cope.	Richardsonius egregius (Girard).	Richardsonius microdon new species.		Leucidius pectiniformis new species.	Agosia robusta Rutter.		Salmo henshawi Gill and Jordan.	Salmo aquilarum new species.	Salmo regalis Snyder.	Salmo smaragdus new species.	Cottus beldingi Eigenmann.
Truckee Basin:															
Fallen Leaf Lake									X		X				
Fallen Leaf Creek															
Lake Tahoe near Tallac	X								X		X				
Cascade Creek															
Lake Tahoe near Brockway	X										X				
Lake Tahoe near Tahoe City						X									
Lake Tahoe															
Truckee River near Tahoe City										X					
Truckee River near Truckee															
Donner Lake															
Little Truckee River									X		X				
Truckee River near Floriston															
Truckee River near Reno	X		X								X				
Truckee River near Derby															
Truckee River near Wadsworth	X														
Truckee River near Nixon	X	X	X												
Truckee River near mouth											X				
Winnemucca Slough	X														
Pyramid Lake	X	X													
Winnemucca Lake	X														
Washoe Lake	X														
Susan River Basin:															
Long Valley Creek	X		X												
Susan River near Susanville			X												
Susan River near Snyder's mill	X		X												
Susan River near mouth	X														
Gold Run	X								X						
Quinn River Basin:															
Quinn River, Port McDermitt	X		X						X						
Willow Creek															
Humboldt River Basin:															
Star Creek near Deeth															
Marys Creek near Deeth	X								X						
Pine Creek near Palisade															
Humboldt River near Palisade	X								X						
Humboldt River, Carlin															
Humboldt River, Winnemucca	X														
Little Humboldt River, Winnemucca	X		X												
Carson River Basin:															
Markleeville Creek, Markleevilie															
West Carson, Woodford's															
East Carson, Gardnerville	X		X						X						
Carson River, Genoa	X		X												
Carson River near Carson City															
Walker River Basin:															
West Walker River near Topaz															
West Walker River, Hudson															
East Walker River, Bridgeport									X						
Walker River, Yerrington	X														
Walker River, Schurz	X		X												
Walker River near mouth	X														
Walker Lake															
Eagle Lake Basin:															
Eagle Lake	X														
Pine Creek near Eagle Lake															

INTRODUCED SPECIES.

From time to time fishes from other regions have been introduced into the rivers and lakes of the L[illegible] system. This has usually been done without any serious study of local conditions which might affect the introduced form or of any consideration of the relations which might arise between introduced and native species. Among the introduced species most of the following seem to have established themselves, some, especially the carp and possibly the Mackinaw trout, to the detriment of more valuable fishes. Black bass are said to reach a large size in Eagle Lake and in Humboldt River. None was seen by the writer. "Black bass" from Walker Lake proved to be Sacramento perch.

Ameiurus nebulosus (Le Sueur). Catfish.

Catfish of this and possibly other species thrive in the broad, quiet waters of the lower valleys. Examples of moderate size may be caught with hook and line in the Truckee, Humboldt, Carson, and Susan Rivers.

Cyprinus carpio Linnæus. Carp.

Carp are widely distributed, and in suitable places they reach a large size. At present they are of no economic importance and are generally regarded as a nuisance.

Oncorhynchus kisutch (Walbaum). Silver salmon.

Mr Mills, of the Nevada Fish Commission, placed a large number of small silver salmon in the lower Truckee River June 27, 1913.

Oncorhynchus tschawytscha (Walbaum). King salmon.

An example of this species [illegible] inches long was caught by an angler while trolling in Lake Tallac June 20, 1911.

Salmo **irideus** shasta (Jordan). McCloud River trout.

This species, known locally as rainbow trout or Shasta trout, seems to be increasing in numbers. Other forms of the rainbow trout may have been introduced at various times, but records are not available. It thrives in the rivers and lakes, where the native cutthroat appears to give way before it. Large specimens were seen in the lower Truckee River and in the Humboldt and Carson Rivers. Examples were collected in Honey Lake Basin and also in Walker River. Specimens found in the desert streams are very light in color. One from Carson River at Genoa was pale olive on the upper surface down to where a pink lateral stripe occurred on the side, which extended from the upper edge of the opercle to base of caudal. Below the stripe the body was silvery, suffused with pale pink. Pectorals, ventrals, and anal bright salmon pink. Dorsal and adipose fins like the back. Some individuals were lighter and more silvery. Black spots were numerous above the lateral line in all the above, An example measuring 18 inches was caught in the Truckee River near the Indian Agency. Above the lateral line the body was profusely spotted, and the general color was darker than that just described. The scales numbered about 140.

In the Nevada hatchery this and the native species have been crossed, and the hybrids have been turned into various streams, but the writer is not aware that any further attention has been paid to the experiment.

Salmo fario Linnæus. European trout; German trout; Loch Leven trout; brown trout.

Specimens of European trout were seen at Tallac. They were caught in Lake Tahoe, Fallen Leaf, and other lakes, and in the Truckee River.

Cristivomer namaycush (Walbaum). Mackinaw trout.

Specimens of this long-headed, ravenous-looking trout were frequently seen at Tallac. It is found in Fallen Leaf, Cascade, and other smaller lakes as well as Lake Tahoe, and it is generally regarded as inferior to both the rainbow and the cutthroat trout. It is difficult to say anything in defense of the introduction of the species. Mr. Mills reports one weighing 26 pounds.

Salvelinus **fontinalis** (Mitchill). Brook trout.

The eastern brook trout has been introduced, and found a place in the small brush linedtributaries of the larger streams and lakes where examples of considerable size are frequently caught. Judging from descriptions in eastern publications, it appears to retain its brilliant color and characteristic habits here.

Archoplites interruptus (Girard). Sacramento perch.

The Sacramento perch is locally known as perch, sunfish, and bass. It is found in the lower courses of the larger desert streams and in Walker, Pyramid, and Winnemucca Lakes. It reaches a large size, an angler reported one which weighed 5 pounds. It may be taken in numbers after the weather grows warm, in the latter part of May or early in June, by trolling or with a light bait-casting outfit. Specimens are attracted by small minnows or spinners with naked or baited hooks. The following measurements and weights are from specimens caught in Winnemucca Lake:

Length.	Depth.	Head.	Weight.	Sex.
Inches.	*Inches.*	*Inches.*	*Pounds.*	
13¾	5¾	4½	2	
14¾	5¾	4½	2½	
13½	5¼	4¾	2¼	
13	4¾	4	2¼	
11	4¼	3¾	1½	♂

Large eggs were found in specimens taken from Pyramid and Winnemucca Lakes May 11, May 22, June 4, and June 7.

Lepomis pallidus (Machin). Bluegill.

Specimens measuring 4¾ to 6 inches were caught in Susan Creek, July 13, 1911. The species is said to have been introduced in October, 1908.

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Pyramid and Winnemucca Lakes May ix, May 22.

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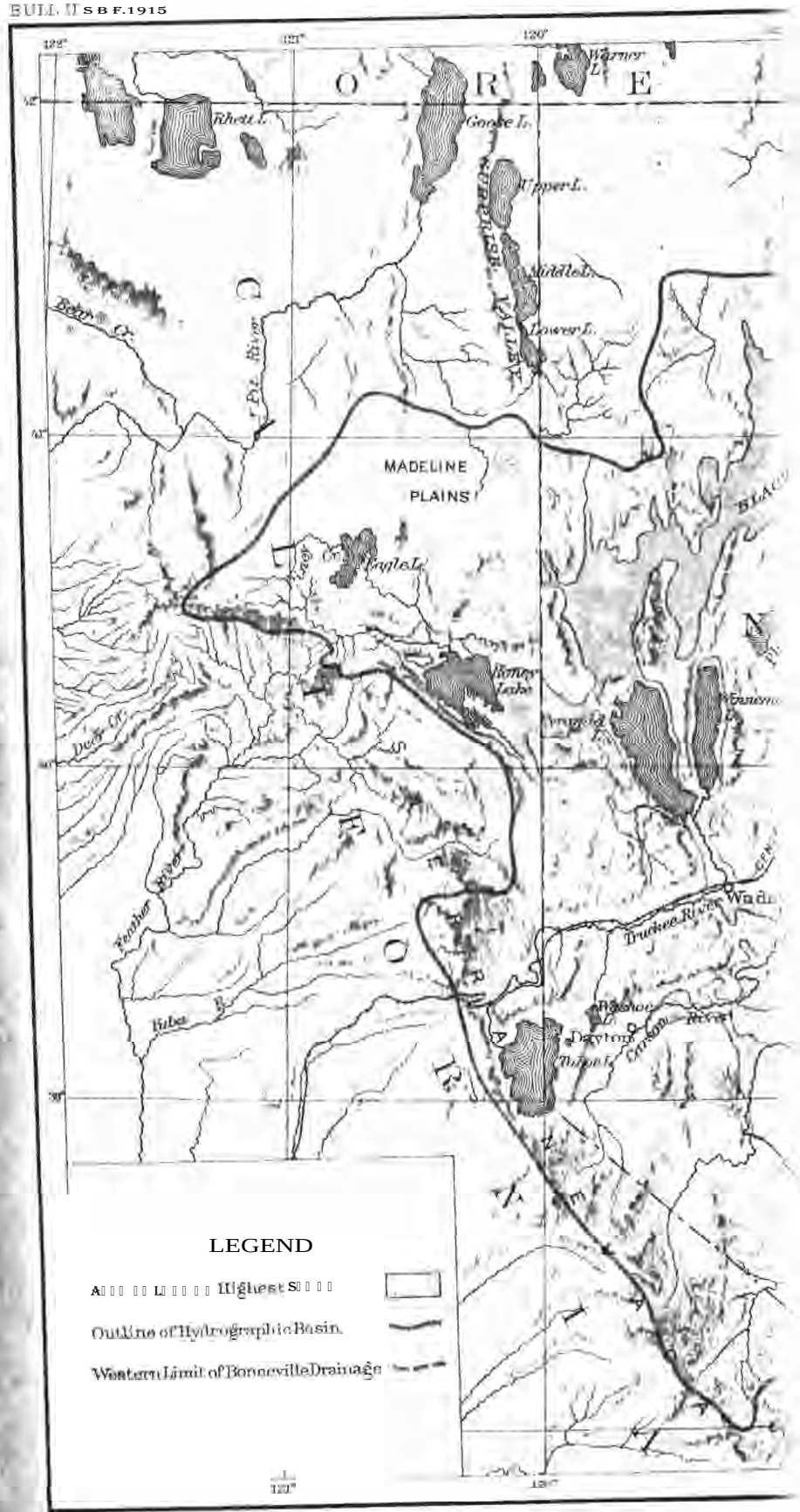

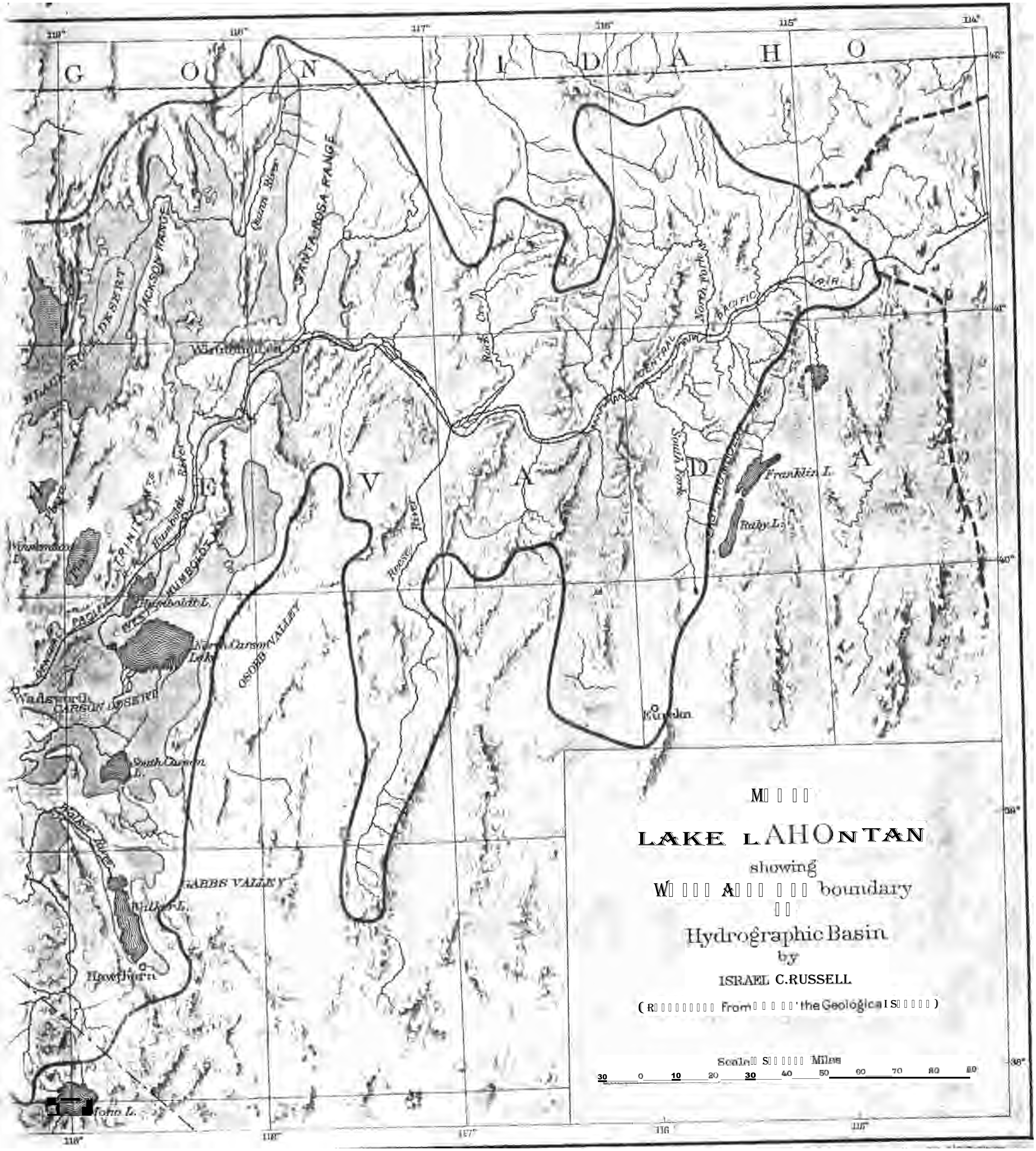
LAKE LAHONTAN
showing
boundary
Hydrographic Basin
by
ISRAEL C.RUSSELL
Miles
SANTA ROSA RANGE
JACKSON RANGE
Winnemucca
Franklin L.
Ruby L.
Humboldt L.
North Carson Lake
OSOBB VALLEY
Wadsworth
CARSON DESERT
South Carson L.
GABBS VALLEY
Walker L.
Hawthorn
Mono L.
Eureka
Reese River