Vol 26(1)

THE TROUTS OF CALIFORNIA[1]

By JOHN O. SNYDER

Anglers and naturalists from long before the time of Walton o Artedi have talked and written about the trouts. They have set them apart from among the fishes because of their beauty of form and color their shy and wary disposition, the tremendous energy and fighting spirit, their delicious food qualities and above all their association with the placid pools of the valley streams and the sparkling, turbulent water of the forested hills and snowy peaks. To the more thoughtful comes an appeal to muse on the apparent vagaries of nature which allow these fish to dress in modest browns and olives in boggy waters in silvers and blues in mountain lakes, or in a veritable riot of scarlet and gold in the plunging streams of the mountain slopes. The naturalists in particular have indulged in long and learned dissertations on the speciation of trout, their nomenclature, geographic distribution propagation and what not. The subject of trout and trout fishing is still a live one in many quarters.

FIG. 27. Klamath River near the mouth of Clear Creek. A turbulent mountain stream.

It is the purpose of this paper to present an account of the trouts of California in a somewhat sketchy fashion, avoiding tiresome scientific details, and at the same time keeping as near the prosaic truth as may be expected when the season is open and rods, lines and lures are within easy reach.

DISTRIBUTION AND RELATIONSHIPS

The trouts are all more or less boreal fishes, and where they have succeeded in extending their distribution over any considerable area in the direction of the tropics they have taken advantage of alpine, i.e., high mountain conditions. The most southerly American species

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is the rainbow trout of the San Pedro Martir Mountains of Lower California, where a relatively few individuals representing an isolated species exist in a precarious situation. They are the last survivors of a time, when through more favorable climatic conditions trout were abundant in the southern coastal region where they are now rare or entirely extinct. Their presence calls attention to a period in the remote past when steelheads from the sea entered streams far south of our borders and spawned in the mountain tributaries. The San Pedro Martir trout are now permanently cut off from the ocean, being unable to accomplish a safe passage through the sub-tropical lower course of the stream in which they live. Somewhat similar cases, but with less complete isolation, are furnished by the native trout of the San Bernardino Mountains and the Piute trout of Fish Valley. Trout in situations such as these are isolated much as are humans on oceanic islands. There is no way to escape or spread, neither is there an opportunity under natural conditions for contamination of the breed or strain by

FIG. 28. Butte Creek, a quiet valley stream.

blood from the outside. Under such circumstances, forms whether fish or human beings, tend to differentiate and assume peculiarities which ultimately serve to distinguish them, and they come to be known to us as distinct species or races. For convenience we give them names, scientific or common.

Although boreal in their habitat and fluvial in derivation, trout have come to adapt themselves to life in the ocean, being anadromous where conditions permit. They also have invaded the lakes and accommodated themselves to considerable depths. However, they have not in any case entirely broken away from their ancient fluvial heritage in that cool, rapid, and well aerated water is necessary for their early life.

The trouts belong to a great and ancient family, the Salmonidae, fishes that have not attained a high degree of anatomical specialization. Their general structure and external appearance are simply fish-like. They bear no special armor such as plates or spines, no particular or peculiar fin structures, no dermal tentacles, barbels or fantastic orna-

ments. The Salmonidae occupy a position in the zoological classification of fishes somewhat midway between the sharks with their simple and primitive skeletons of cartilage, and the higher fishes as the basses or cods, which possess a bony framework of great complexity. The trout, none the less, have specialized in one particular, that of bodily color, in which some of them rival the most brilliant productions of the tropical seas.

The Salmonidae are represented in the waters of California as follows:

Native Species

Salmon, *Oncorhynchus;* four species—King, Silver, Humpback and Dog. The king and silver are of commercial and sporting importance. The others are scarcely ever seen.

Trout, *Salmo;* many species.

Charr, *Salvelinus;* one species.

Whitefish, *Prosopium (Coregonus);* Truckee River and Lake Tahoe basins.

Introduced Species

Trout and Atlantic Salmon, *Salmo;* several species.

Great Lakes Trout, *Cristivomer.*

Brook Trout, *Salvelinus.*

Montana Grayling, *Thymallus.*

NATIVE TROUTS

The difficulty of separating and defining the various species or races of western trout has long been recognized. The problem does not essentially differ, however, from that presented by the chipmunks or song sparrows, or even the native aborigines. In their entirety they seem to form a huge mosaic, the elements of which, as diverse as the golden trout of the High Sierra, the coast rainbow and the royal silver trout of Lake Tahoe, are difficult to separate. The picture includes not only the colors of the entire spectrum, but numerous irregularities of form, anatomical structure and habits as well. These trout present a veritable medley of geographic races or forms that make logical treatment very difficult. Attempts at systematic investigation have been made and some generally accepted species have been recognized. These attempts have been sporadic in all cases; they have been founded upon insufficient material, and they have not contributed greatly to a reasonable interpretation of the situation as a whole. The problem may now be impossible of satisfactory treatment because of depletion or near extermination of certain forms of restricted distribution and of the activities of artificial propagation in the distribution of various trouts.

Real contributions to the speciation of trout will not come from cursory inspections of occasional fish from here or there, but rather from careful and coordinated studies of large series of examples from single localities.

California trout, as also the stories relating to them, sometimes grow to enormous size. There are many records of over 20 pounds for both rainbows and cut-throats. Commercial fishermen once took 14,578 steelheads in Klamath River from August 5 to September 6. On some

days these fish, large and small, averaged as little as 3.2 pounds or as large as 6.7 pounds. The average weight of the entire number was 5.7 pounds. In the winter migration the fish are much larger, examples frequently weighing 12 to 28 pounds according to sober and competent observers.

It takes several years for a trout to attain a weight of 5 or 6 pounds, longer than for a deer to reach a legal size for the hunter. Yet the present legal day limit on trout carries less restriction than the year limit on deer and the open season on trout is very much longer. Unless precautions are soon taken it seems evident that some of our native trouts like our wild flowers will disappear, giving place to various exotic weeds and mongrel crosses.

The following species of native trout have been generally recognized:

Rainbow Series, pages 123-130

Coast Rainbow Trout, *Salmo irideus.* All streams entering the ocean.

Shasta Trout, *Salmo stonei.* Upper Sacramento and McCloud rivers. The rainbow trout of fish culture fame.

Kern River Trout, *Salmo gilberti.* Kern River and possibly other streams draining the southern Sierras.

Soda Creek Golden Trout, *Salmo whitei.* Upper Kern tributaries, Soda Creek, Wet Meadow Creek, Coyote Creek and Little Kern River.

South Fork Golden Trout, *Salmo agua-bonita.* South Fork of Kern River, Volcano Creek.

Culver Lake Trout, *Salmo roscl.* Lake Culver and neighboring lakes of the High Sierras.

San Gorgonio Trout, *Salmo evermanni.* San Bernardino Mountains.

Eagle Lake Trout, *Salmo aquilarum.* Eagle Lake.

Royal Silver Trout, *Salmo regalis.* Lake Tahoe.

Cut-throat Series, pages 130-135

Coast Cut-throat Trout, *Salmo clarki.* Coastal streams south to Mad River.

Tahoe Cut-throat Trout, *Salmo henshawi.* Lake Tahoe and Truckee basin, Walker, Carson and Owens rivers.

Piute Trout, *Salmo seleniris,* a geograr hic variant of *S. henshawi.* Fish Valley, Alpine County.

Colorado River Trout, *Salmo pleuriticus.* Salton Sea, New River.

The Charrs, pages 136-137

Dolly Varden Trout, *Salvelinus spectabilis.* Upper tributaries of Sacramento River.

The localities given are original ranges; fish-culturists have extended the ranges of many species to a great extent.

INTRODUCED SPECIES

A considerable number of exotic fishes have been introduced into the State. Some of these appear to occupy niches not so well adapted

to native species where they thrive and furnish sport fishing. Others are of questioned value and some are recognized nuisances.

The distribution of introduced species should be guarded with great care and so controlled as not to displace or endanger the native trout. The introduction of foreign animals is usually attended with danger and sometimes with disastrous results. Its practice usually comes from a too prevalent human desire to tinker and meddle with nature. In many cases it accompanies an inability or an unwillingness to conserve native fishes which in some instances are markedly superior.

Introduced trout and trout-like forms are (see pages 136-138) :

Loch Leven Trout, *Salmo levenensis,* early crossed with importations of Brown Trout, *Salmo fario,* of Europe.

Brook Trout, *Salvelinus fontinalis,* a charr, native of Atlantic coast streams.

Mackinaw Trout, *Cristivomer namaycush,* from the lakes of northeastern United States.

Montana Grayling, *Thymallus montanus,* which now appears to be established in the Yosemite region. When compared with trout the grayling is immediately distinguished by its large and highly colored dorsal fin. The mouth is smaller and the body more slender. The eggs are more delicate than those of trout. The grayling is a gamy fish and not so wary as the trout. It is sub-arctic in distribution, adapted only to our high mountain waters.

Atlantic Salmon, *Salmo sebago.* Attempts have been made from time to time to introduce this fish but without apparent success. Lately large introductions were made in Smith River. This species will not, as popularly supposed, replace western salmon, *Oncorhynchus,* where they have become depleted but will, if established, be a competitor of our native steelhead.

THE CUT-THROATS AND THE RAINBOWS

In the opinion of the writer, all of the native trouts of California (excepting the charrs) belong to two groups or great races, namely the cut-throats and the rainbows. The cut-throats are the more boreal or alpine, while the rainbows are the more austral, and more generally distributed. The cut-throats are characterized by having smaller scales, a somewhat more complete dentition, more numerous black spots, and usually a red streak beneath the mandible, from the presence of which their name is derived.

The cut-throat is found in the coastal streams from the Oregon border southward to Redwood Creek, or possibly Mad River. It has been reported from Eel River, but no examples have come to hand in support of the record. It occurs in the eastern drainage of the Sierras (Truckee, Carson, and Walker basins, and in Owens River), and in the Colorado River from which it gained a temporary access to Salton Sea.

The rainbows are pretty generally distributed in the trout waters of the State, in some places living as natives with the cut-throats. Rainbows inhabiting the upper courses of the mountain streams have finer scales than those of the coastal region, thus exhibiting a well known boreal characteristic.

By adherence to the assumption that all California trouts may be assembled in two natural groups, cut-throats and rainbows, one is enabled to account for their derivation and relationships as well as their present geographic distribution in a fairly logical way.

THE STEELHEADS

Some observers hold to the belief that the steelhead is a distinct species of trout somewhat intermediate between the cut-throat and the rainbow. Such is not the case, and this statement is supported by a mass of observational and experimental evidence. A steelhead is a sea migrant of the particular species inhabiting the stream, and in our waters it may be either a cut-throat steelhead or a rainbow steelhead, and there is no occasion to apply a Linnean binomial name to a steelhead as such.

The steelhead is a fish that has come from the sea and entered a river to spawn. The resulting young live in the stream for from one to three years as rainbow or cut-throat trout and then migrate to the

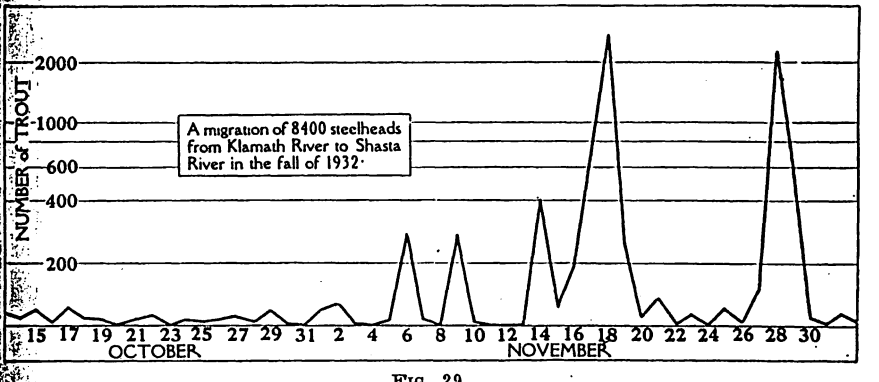

FIG. 29.

ocean. Some individuals appear to remain in fresh water during life. Steelheads come in from the sea in regular migrations which occur at more or less definite times. The migration is so timed as to provide for the arrival of the fish on the spawning beds when conditions are best fitted for propagation. For example, a migration of such fish appears in the estuary of Klamath River during the fall and early winter. The fish of this migration have in general a long distance to travel. Their entry into the river and their progress up stream are apparently coordinated with conditions in the tributaries. They enter Shasta River where their migration is in full swing, long before they appear in Beaver Creek, the mouth of which these advance migrants have already passed. The smaller coastal streams are not visited so early, some of them being temporarily closed by bars, while others although open do not have a sufficient flow of water. A migration is not a steady movement of fish. It has a general rise and decline, but it has periodic irregularities as well, waves of varying intensity so as speak, the cause of which is problematical.

In the larger streams which are permanently open to the sea the migrations occur at about the same time each year. In Klamath River,

for example, steelheads appear in the estuary in numbers about July 15. From then on they progress up the stream, appearing at various points about as follows: Klamath Glen, August 1; Weitchpec, August 8; Bluff Creek, August 12; Orleans, August 20; Somes Bar, August 24; Clear Creek, September 3; Happy Camp, September 7; Seiad Valley, September 16; Scott River, September 20; Oak Bar, September 25; Brown's, September 29; Shasta River, October 3; Klamathon, October 8; Fall Creek, October 20. (See Fig. 31.)

As the steelheads appear fresh from the ocean they are a beautiful steel blue above with bright, silvery sides. They usually have very definite black spots on the head and body (those of the head round, of the body linear), and on the unpaired fins. Sometimes the head is without apparent spots and the body has relatively few. The ova found in the early migrants are very small, their relatively undeveloped condition giving rise to the conjecture that these fish have entered upon a

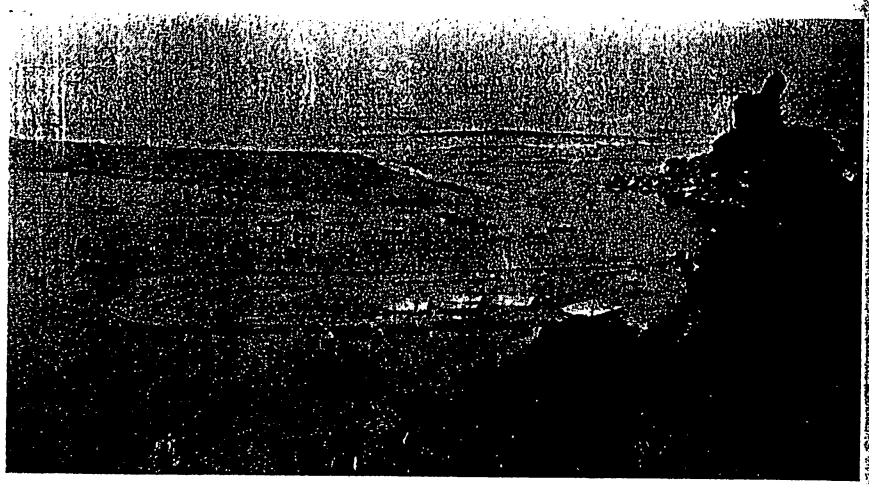

FIG. 30. The mouth of Klamath River where the steelheads come in from the sea. This photograph was taken before the construction of the jetty.

very long migration, or at least a considerable sojourn in fresh water, and this has been found to be true. Later migrants usually have more mature ova, as their spawning time is less remote.

On entering the streams their stomachs are usually empty, and they seem to remain so while they are in the estuaries. A little farther up stream their appetites appear to return, and their behavior is governed accordingly. They snap a fly or a spoon with avidity, and in rapid water they severely test the angler's skill. It appears, however, that the activities of stream life are largely supported by stored energy which has been accumulated in the sea. They enter the stream robust and corpulent, overloaded with vigor, and they leave relatively wan and emaciated.

Steelheads enter all the coastal streams which are large enough, sometimes appearing where the volume of water is scarcely sufficient to carry them. When fresh from the sea, resplendent in their blues and bright silver, the steelheads may often be seen in numbers leaping

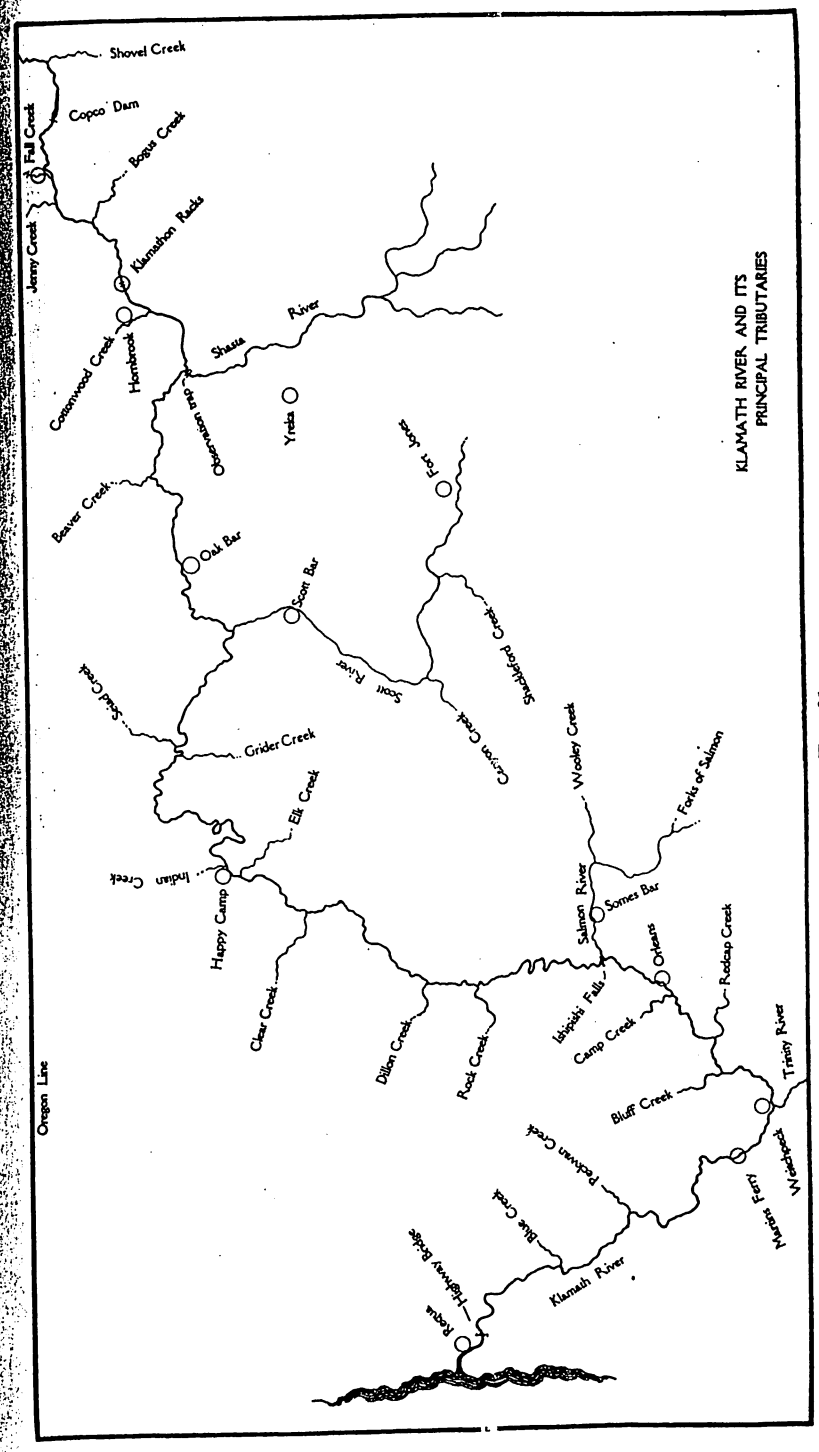

FIG. 31.

high from the surface of the water and falling with a great splash. They seem fairly intoxicated from their new experience in the stream. Soon their colors begin to change. Their linear spots grow larger and more nearly round while others appear in regions where they seemed absent. As time passes and they progress up stream they assume the bright hues of stream trout, and all degrees of coloration may be found among them from the typical steelhead to that of a brilliant rainbow. Sometimes belated steelheads progress so rapidly as to be found near the headwaters still bearing much of their marine color and mingling with more brightly tinted trout already arrayed in their nuptial hues. Steelheads all come to the fresh water to spawn, and unless prevented most of them will accomplish their purpose and eventually return to the sea. Some die, perhaps from injury, old age, or from the unusual exertion incident to migration. A few remain for an indefinite time in fresh water. In many of the larger streams with constantly open communication with the sea, are trout of considerable size and scarcely if at all distinguishable from the spawning steelheads. These fish appear to be residents of the river.

Lake rainbows behave as do ocean steelheads, migrating from the deep water to spawn in the streams. The cut-throat of Pyramid Lake, Nevada, furnishes an exact parallel with the ocean steelhead in that its lake colors are largely silvery and pale olive, while in the river on its spawning migration it assumes a wonderful dress of red and gold.

The cut-throat steelheads of the coastal streams of the State perform only short migrations up stream, leaving the real mountain climbing to the rainbows.

Steelheads are sometimes caught by fishermen at sea, far from the mouths of any rivers. When so taken they look exactly like fish which have just entered the river.

Steelheads bear a superficial resemblance to salmon, four species of which migrate into our streams to spawn. Salmon all die after spawning and in this they differ greatly from steelheads. There is no occasion to confuse steelheads and salmon if one observes closely. While they differ in many anatomical particulars, the trout, large or small, may be known by the shorter anal fin base (rays usually 12 or fewer, compared with 13 to 16 or more in the salmon), the deeper caudal peduncle (see Fig 32), the narrower anal fin, and the white lining of the mouth. A salmon's mouth has much black inside. The color of the flesh is not of interest in this connection, as an occasional steelhead or trout has very red flesh, while some salmon may be pink or almost white.

The determination of the specific status of the steelhead is an important step in the direction of conservation, for it now becomes evident that protection for the steelhead involves both the rainbow and cut-throat trouts. Overfishing of stream trout depletes the steelhead and destruction of the steelhead removes the breeding stock of the stream trout.

During the summer and fall the steelhead streams which are not greatly depleted are amply stocked with robust and vigorous little fish, the result of natural propagation. These are nicely and equally distributed throughout the well-aerated, food producing tributaries. If these were well protected and allowed to migrate to the sea, a supply

of returning steelheads would be assured. It is the writer's opinion that the introduction of artificially propagated fish in such situations upsets the balance and serves no good purpose. He further believes that ample protection of nursery tributaries, or what amounts to the same, an enforced size limit of eight inches or so, would insure steelhead fishing in the northern coastal streams for many years to come. An enforced size limit would of itself tend to keep anglers away from small tributary streams, in which, as a rule, only young fish occur.

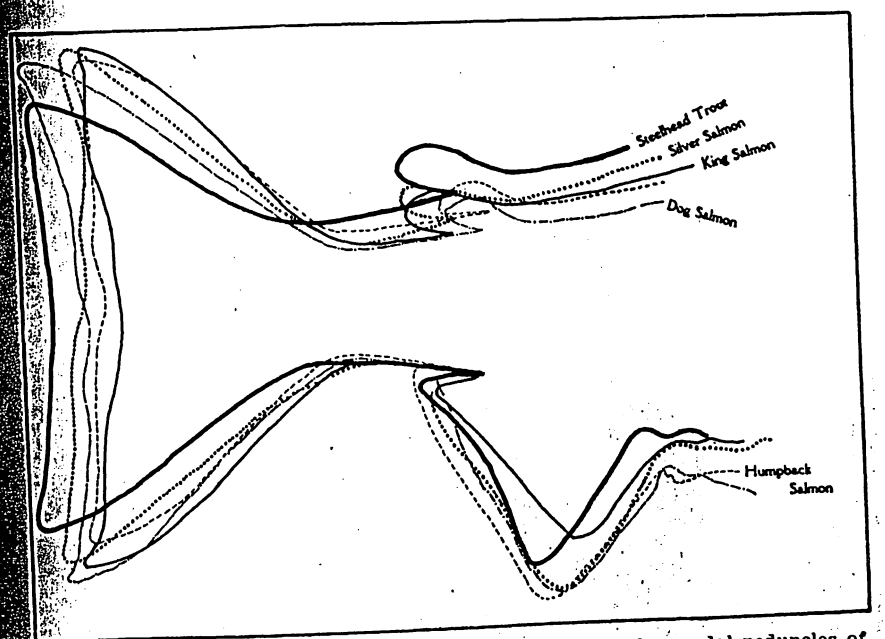

FIG. 32. Tracings of the outlines of the posterior fins and the caudal peduncles of salmon and the steelhead, each of which was of the same length.

THE SCALES OF TROUT

Contrary to the expressed belief of some anglers, all trout have scales. They first appear as little rings or plates when the fish measures an inch or so in length (see Fig. 34) and their size increases nearly in proportion to that of the fish. In some cases, particularly when the trout approaches the spawning period, the skin thickens and the minute pouches which hold the scales tend completely to enclose them, and they seem to disappear.

The scales are very thin, flexible, and are almost perfectly transparent. They grow by the addition of circular plates, and when examined under a lens appear much like the cut end of a small tree limb, in that they present growth rings. They also exhibit annular regions which correspond to the periods of inactive growth. Growth rings are illustrated by figure 33, which was made from a scale of a Waddell Creek trout.[2] It is enlarged 34 diameters. An area of

[2] Snyder, Cedric O. A study of the trout (*Salmo irideus* Gibbons) from Waddell Creek, California. CALIFORNIA FISH AND GAME, vol. 24, pp. 354-375, 1938.

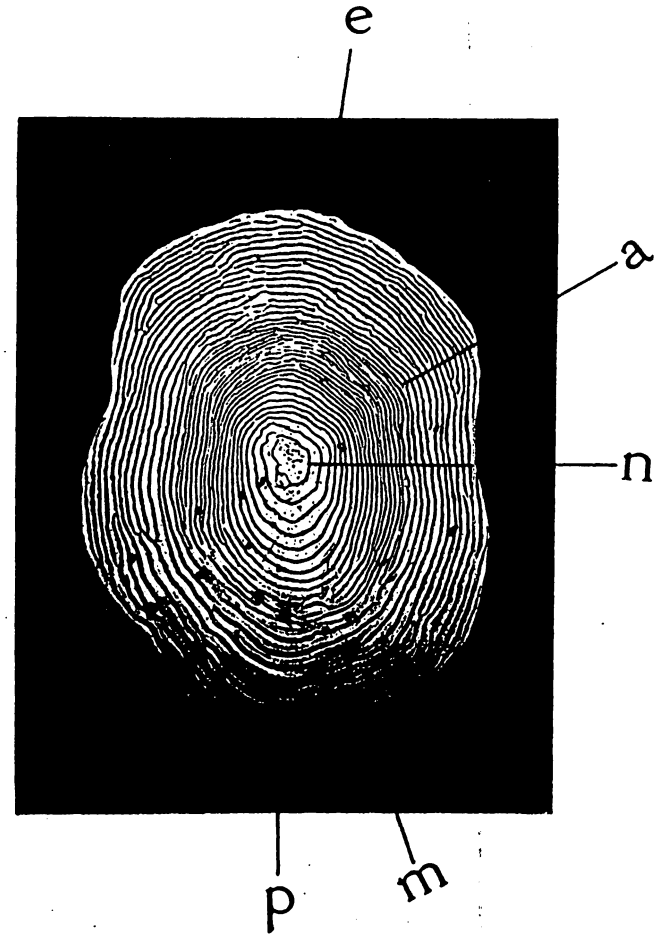

FIG. 33. Trout scale, from fish in its second year, 185 mm., July 7, Waddell Creek, California; *e* is anterior end; *p*, posterior end; *n*, nucleus; *a*, annulus; and *m*, melanophore.

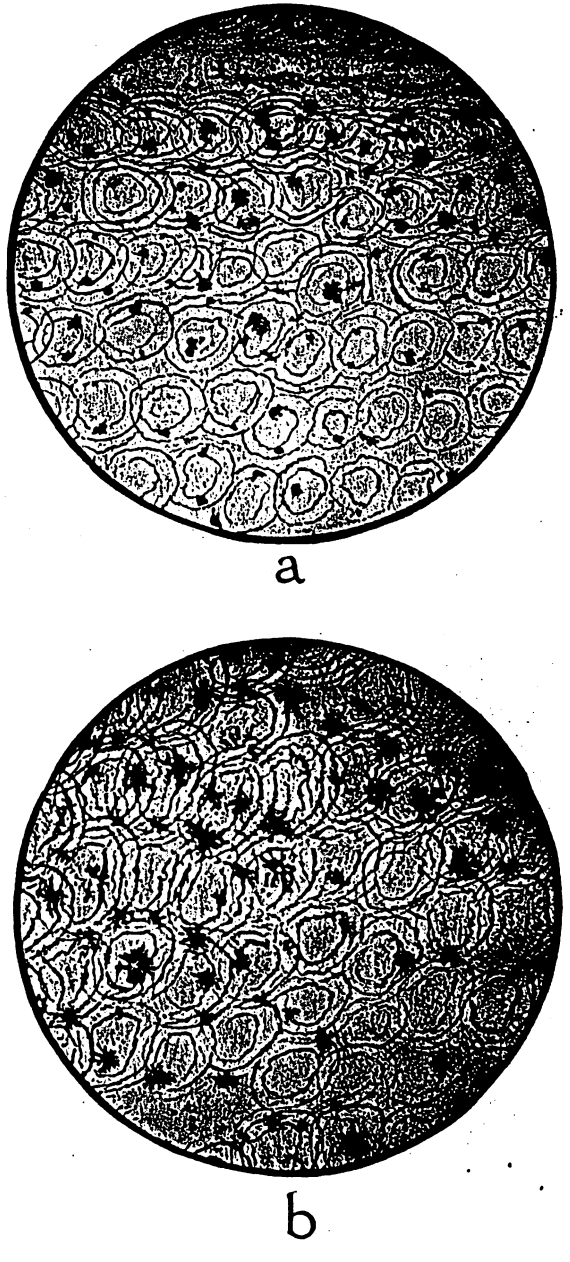

FIG. 34. Sections of skin with scales adhering, from young trout: *a*, 52 mm., May 28; *b*, 48 mm., June 26. From Waddell Creek, California.

arrested growth is seen at the point *a*. The anterior or forward part of the scale is marked *e*. This part is embedded in the skin. The posterior, exposed part is marked *p*. The central part, *n*, sometimes termed the nucleus, represents the primitive plate, similar to the little scales represented in figure 34, whereas the surrounding dark rings

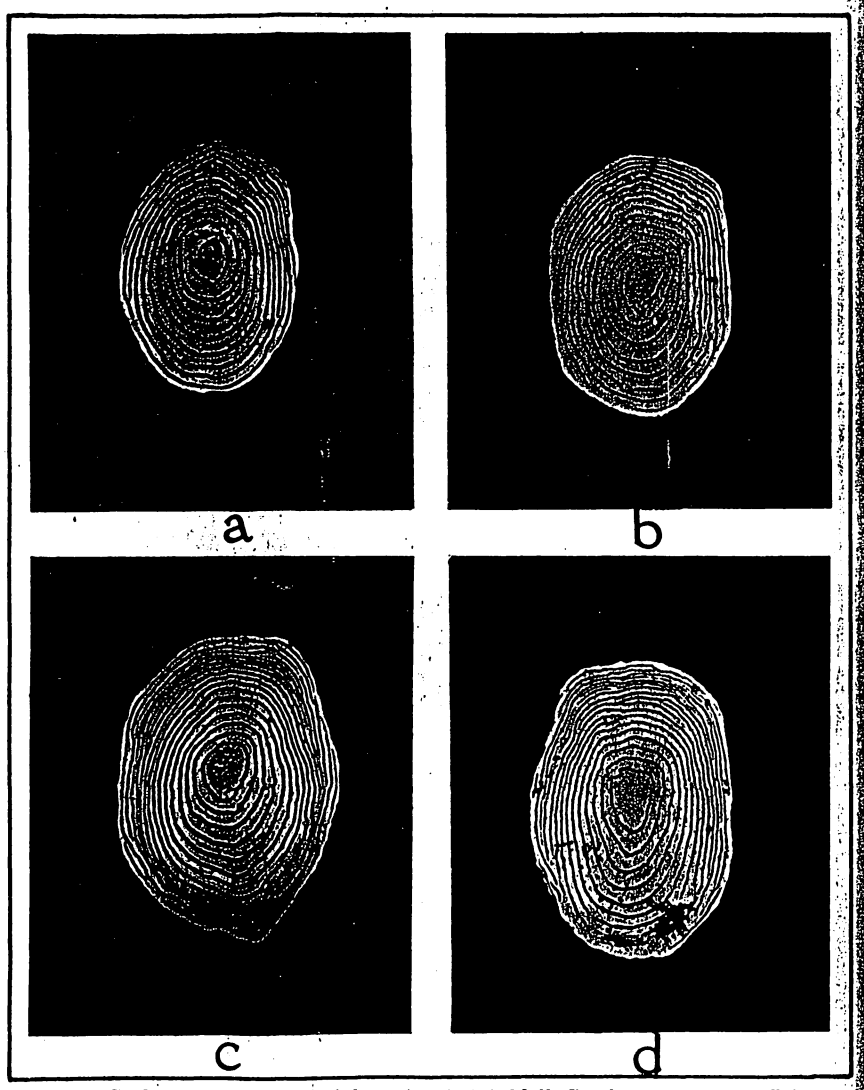

FIG. 35. Scales from young rainbow trout, Waddell Creek: *a*, 87 mm., July 7; *b*, 97 mm., August 15; *c*, 107 mm., January 21; *d*, 115 mm., February 5.

represent the edges of the plates formed through added growth. It will be noted that the rings follow each other outwardly from the nucleus in fairly regular fashion until the point *a* is reached, where they are somewhat less distinct and more closely crowded. This narrow region is called the annulus, and represents the end of a season's

growth. Beyond this point the rings are wider apart, representing more rapid growth.

If in spring or early summer one examines the scales of the little trout, two inches or so in length, the scales will appear much like those represented in figure 34. Young trout taken later in the

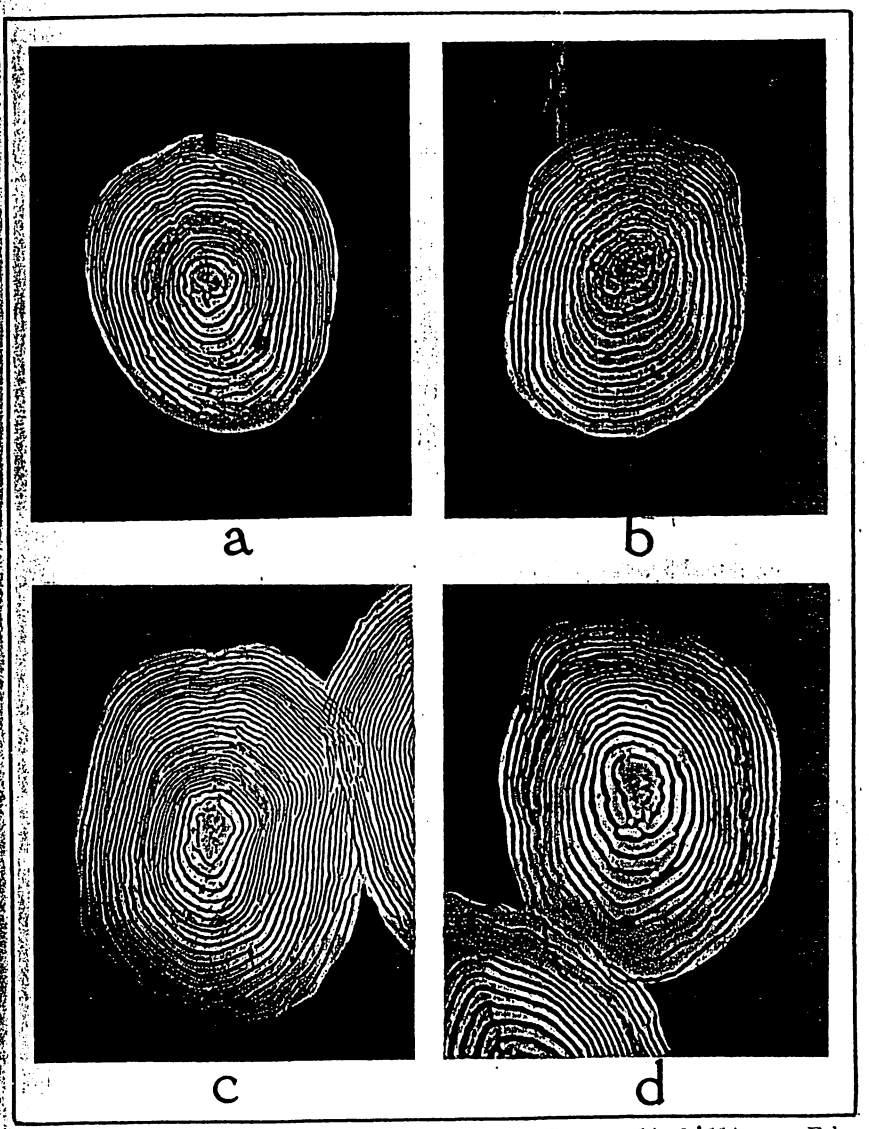

FIG. 36. Trout scales, Waddell Creek: *a*, 139 mm., January 14; *b*, 114 mm., February 5; *c*, 139 mm., February 11; *d*, 138 mm., March 10.

season, and considerably larger in size will have scales like *a* and *b* in figure 35. It will be seen that these differ from the smaller scales only in having additional growth rings. Later in the year an annulus

forms as in *c* and *d* of the same figure. Figure 36 is further instructive. The scale *a* taken from a fish January 14, measuring about 5½ inches, has completed its second season of growth. Both the fish represented by this scale and that by *b* have ceased active growth, whereas *c* and *d* are scales in stages of resumed growth that is very active.

Geographic location, variable seasons, food supply, temperature, and other factors influence growth, and growth in turn is reflected in the anatomy of the scale.

When the small trout enter the sea where food exists in relative abundance, a remarkably rapid growth follows. This is well shown in figure 37 where the area of the scale from the point marked *3* outward represents ocean growth.

The unusual activities attending migration and spawning together with the rapid development of eggs or milt not only arrest bodily growth at the time, but also cause such a heavy draft upon some of the tissues as to partly break them down. This condition becomes a matter of record in the scales, and leaves what is commonly called a spawning scar, visible at A and D in figure 37. This figure represents a fish that had migrated from the stream into the ocean in its third year of growth. It had successfully spawned two times as indicated by the scars, and returned again in its fifth or sixth year. This fish measured 25½ inches and was caught in Klamath River.

An examination of some Klamath steelheads reveals age, growth and spawning records as follows:

Stream	*Ocean*	*Spawned*	*Age*	*Length*
1 year	2 years	0 times	3 years	270 mm.
3 years	3 years	2 times	6 years	645 mm.
1 year	4 years	2 times	5 years	625 mm.
2 years	3 years	2 times	5 years	635 mm.
3 years	4 years	3 times	7 years	640 mm.
2 years	2 years	1 time	4 years	480 mm.
3 years	2 years	1 time	5 years	530 mm.
2 years	3 years	1 time	5 years	635 mm.
2 years	2 years	0 times	4 years	370 mm.
3 years	1 year	0 times	4 years	345 mm.

There is here a possibility of learning much of the life of a trout, as we are able to read the more or less accurate record preserved in the scales.

SPECIAL SENSES

There is little doubt that trout possess some of the special senses developed to a considerable degree of perfection. Sight is evident, but the degree of selective vision is in doubt. In inspecting an object on or above the surface the fish is at a disadvantage for its vision is directed through a surface film and against a strong light. Movement, whether of objects or their shadows, is quickly detected. Changes of bodily color are controlled to some extent through vision. Blind trout are very dark in contrast to the much lighter normal fish in a school. Hearing is limited, for there is neither a tympanum nor external ear. Vibrations produced by a footfall or crunching gravel are recognized. Taste and smell are closely associated, and it seems evident that food in the water may be detected by these senses as also by vision.

Trout are fish of simple habits, possessing none of the finer instincts such as parental care for the young.

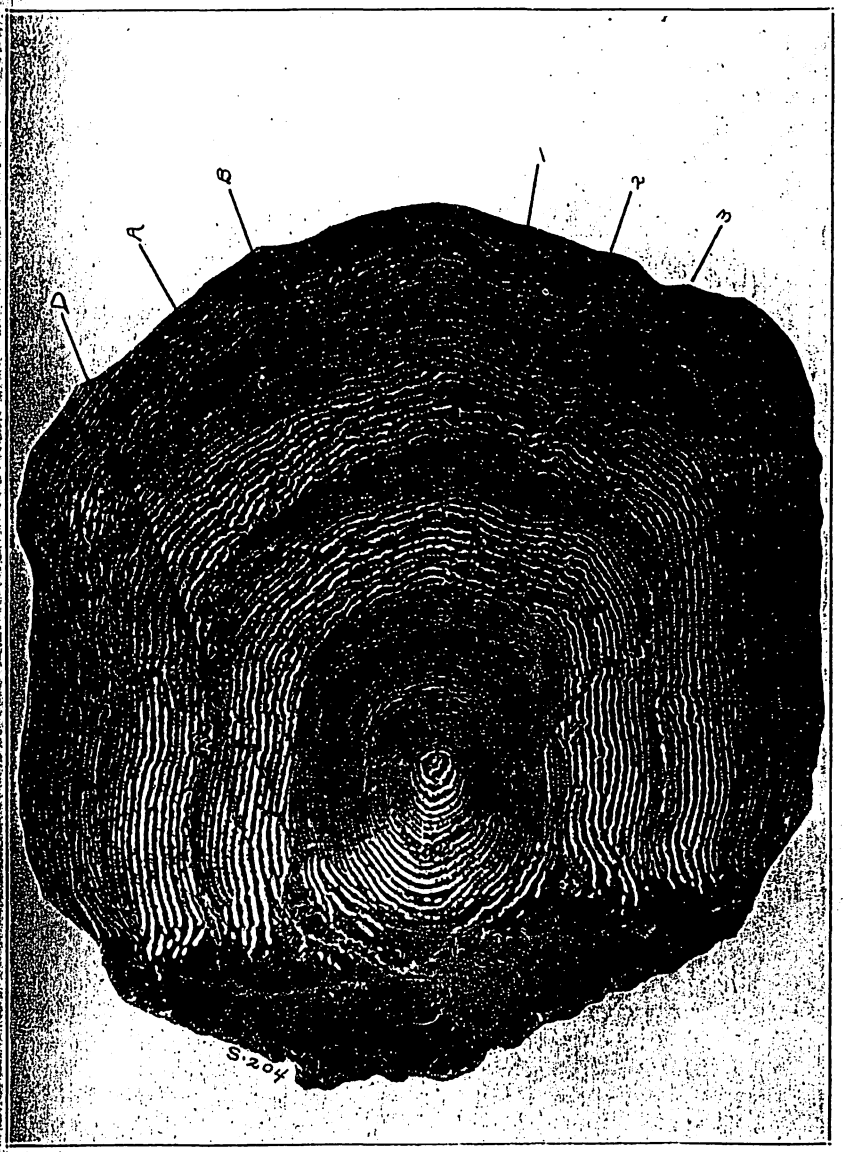

FIG. 37. A scale of a Klamath River steelhead with a three-year stream record. The fish returned to the river a third time after having successfully accomplished two previous spawning migrations.

COLOR

Adult trout, particularly those approaching the spawning season, exhibit a varied and brilliant display of color. Young trout, in common with most salmonids, are relatively plain except for parr marks along the sides. There are as many as 10 or 12 of these in some species, fewer in others. They sometimes persist for 2 or 3 years, occasionally remaining in adults. These particular marks may be regarded as a heritage from some primitive ancestor of the various salmons and trouts.

If, with a lens, one inspects the bright lateral stripe of a trout, the color whether black or red is seen to break up into minute specks. A greater magnification will resolve these specks into peculiar black and orange objects known as melanophores and xanthophores. They remind one of splotches of ink. A little further search brings out other elements which are involved in the production of color, and persistent investigation reveals a wonderful variety of chromatophores, pigment granules, and guanin crystals, together with a remarkable and little understood nerve control.

Pigment spots are capable of enlargement or contraction, thus increasing or diminishing the intensity of color. This may at times be brought about so rapidly that one may observe the fading hues as the fish is held in the hand. Something of the color of a fish may be preserved for a time by stripping off the skin, pasting it down on a piece of paper and drying it in the dark. A trout can not be accurately painted as there is no way of reproducing the beautiful metallic and opalescent reflections so often present.

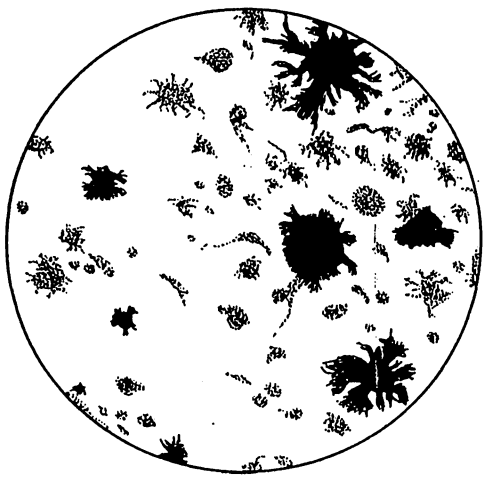

FIG. 38. A bit of trout epidermis, highly magnified to illustrate color pigment. The black spots are known as melanophores; the gray ones (orange in life) are xanthophores.

FOOD OF TROUT

Trout are carnivorous feeders and when considered at large they appear to eat anything that moves and some things that do not. The most delicate and ephemeral insects attract them to the surface at times, while at others they will swallow bottom larvae, stone- or stick-covered cases and all. They will eat the eggs and young of other fishes or of their own kind. They occasionally gorge until the food projects from their mouths and again they are able to fast for considerable periods without being much the worse for it.

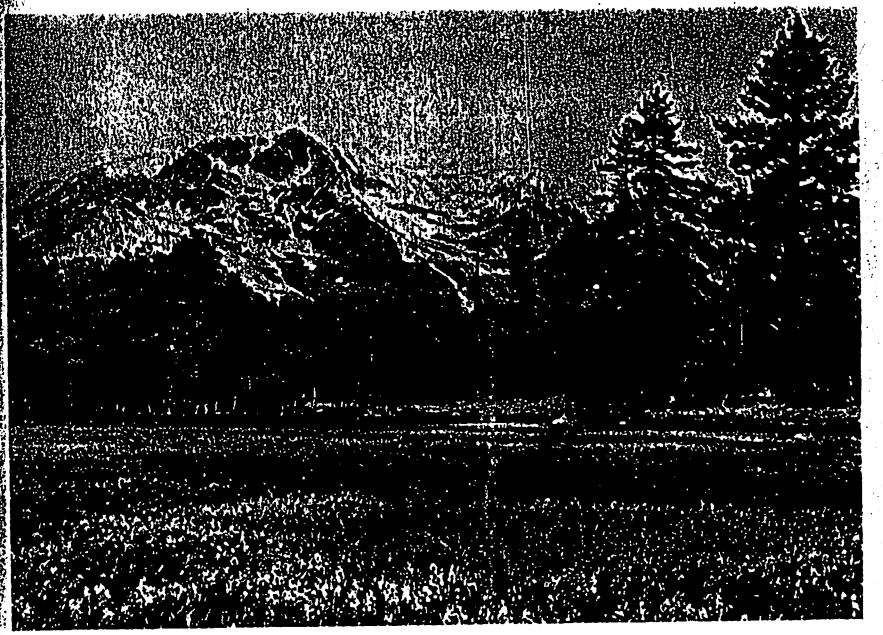

FIG. 39. A mountain meadow where the meandering stream is well supplied with trout food.

In studying the food of trout it is preferable to use net caught fish, thus avoiding a selection of hungry individuals. The stomachs should be opened at once and preserved before post-mortem digestion alters the contents.

The entire food supply of trout is derived either directly or indirectly from the land. If the land through which a stream flows is relatively barren, the food supply in the stream will be comparatively meager, while on the other hand, if the land is covered with vegetation like the forests, flowering grasslands, bogs and mountain meadows, fish food will be abundant because of what falls from the air or is washed into the stream by the rains or melting snows. Trout food is abundant in fertile waters, and waters are fertilized by what they receive from the land.

Deforestation, both from lumbering or fires, and overgrazing are two agencies largely responsible for scarcity of fish food in some regions. Of the two, the latter may perhaps be the more destructive, for what is not eaten by the animals is completely cut up and destroyed, even to the roots, by the sharp hoofs. It thus becomes evident that proper forestry procedure may contribute largely to the conservation of fish.

In so far as we know at the present time, California waters, with the exception of high, alpine, granitic lakes, and limited regions where artificially created adverse conditions prevail, are abundantly supplied with natural food, and the stream growth of trout and other fishes is fairly rapid.

It is thought by many anglers, and apparently with good reason that trout are very careful in their selection of insect food, and with this in mind a large number and variety of artificial lures have been constructed. Some of these resemble real insects with the greatest nicety, while others are admittedly monstrosities. They are often ingeniously made and very beautiful. It is not difficult for one to tie his own flies, make simple repairs to his worn tackle and keep his equipment in good shape. Some part of the pleasure of fishing comes from an appreciation of well kept tools.

Of late years there has been a disposition on the part of experimental investigators to uncover facts which seem to discredit the age old belief in the fine visual discrimination possessed by trout. Possibly the activities of such investigators should be curbed before they succeed in dispelling too much of the glamour attending these remarkable fish. It will be some time, however, before this approaching cloud comes to obscure the entire sky. In the meantime the royal coachman, the pale evening dun, the black gnat, and other old favorites will serve to decorate the fly book, while the occasional skeptic maintains that it is not so much what fly you fish as how you fish it.

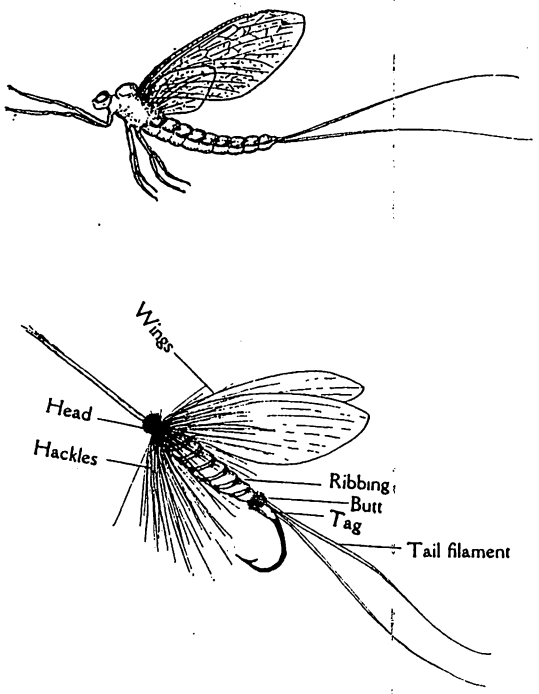

FIG. 40 *Above*, an ephemeral insect, and *below* an artificial trout fly that simulates an ephemeral insect.

BARRIERS TO MIGRATION

Trout perform various migrations. No matter where they are they tend to seek larger waters as they grow. They pass from shallow ripples to deeper pools, they drop down stream from small rivulets to the creeks or rivers, and they will pass out into lakes or the open ocean. They will return again to their native streams and tributaries during the spawning period. This migratory instinct permits the individual to attain large size, and at the same time the population increases. A steelhead stream could not support all its fish if a large part of the population did not move out to sea.

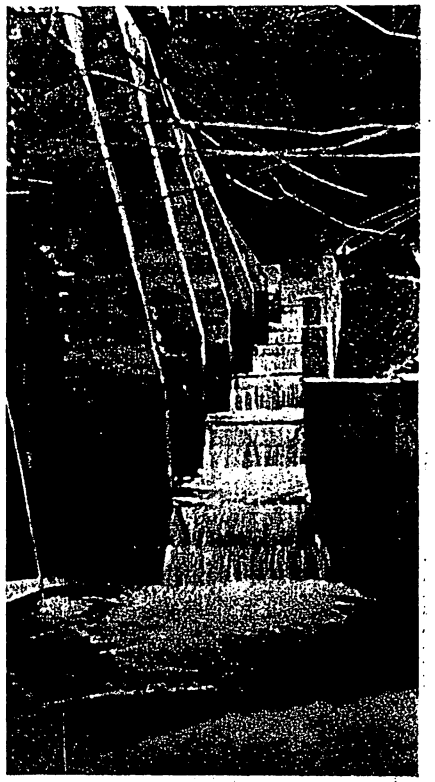

FIG. 41. A fishway at Benbow Dam. There are alternating miniature falls and resting pools. Photograph by John Spencer.

An impediment to migration may contribute to depletion or even extinction. Artificial barriers such as dams may check or stop a migration, or a diversion of water may lead to certain death. River pollution may be worse than an ordinary obstruction as it not only destroys the natural food and stops the migrating fish but sometimes kills them besides. Conservation and propagation must take account of such conditions.

Migratory fish are often assisted in passing dams by means of fishways. These embrace pools and little falls, gradually leading from the stream up and over the obstruction. They take advantage of the climbing instinct of the fish, the falling water indicating direction while the pool offers a resting place and room for the necessary start on another leap. The location and building of a successful fishway involve a knowledge of migrating fish and considerable engineering skill as well.

Diversions, usually caused by irrigation or the use of water for power, should be guarded by screens or deflections which prevent the passage of fish and hold them to the desired channel. These are of various types, some being so arranged as to revolve in a manner to carry over and dispose of floating debris.

The presence of barriers and diversions is no doubt responsible in a large measure for the depletion of trout and salmon. Protective laws and much firmness and diplomacy in their administration seem necessary if serious losses are to be prevented.

ARTIFICIAL PROPAGATION AND DISTRIBUTION

Artificial propagation of trout consists in securing and fertilizing the eggs and rearing the resulting fry and fingerlings until ready for introduction into suitable streams and lakes. At all stages it requires the skill of experienced men, and it is fraught with many difficulties. It is an interesting occupation which appeals to a particular type of

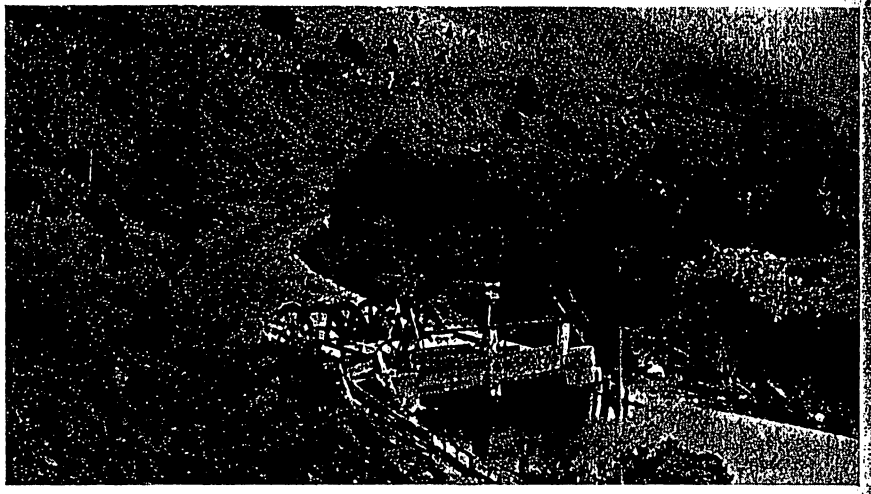

FIG. 42. A rotary fish screen which hinders the passage of small fish into a diversion.

FIG. 43. Spawning wild trout at the Chester Station. The racks rest against the trunk of a fallen pine.

man, as all who have inspected a well administered hatchery with its wonderful exhibit of developing eggs and growing fish will agree. Here under our eyes many secrets which nature had very carefully hidden in the tumbling and foaming waters of our mountain streams are brought to light.

Artificial propagation should supplement rather than supplant natural propagation. At its best it is self-sustained, depending upon brood fish for its eggs, thus taking nothing from the natural propagation of the streams. It accomplishes much when properly directed. It adds to the stock of depleted waters and it introduces fish where none was found in nature. It should not, however, be charged with the

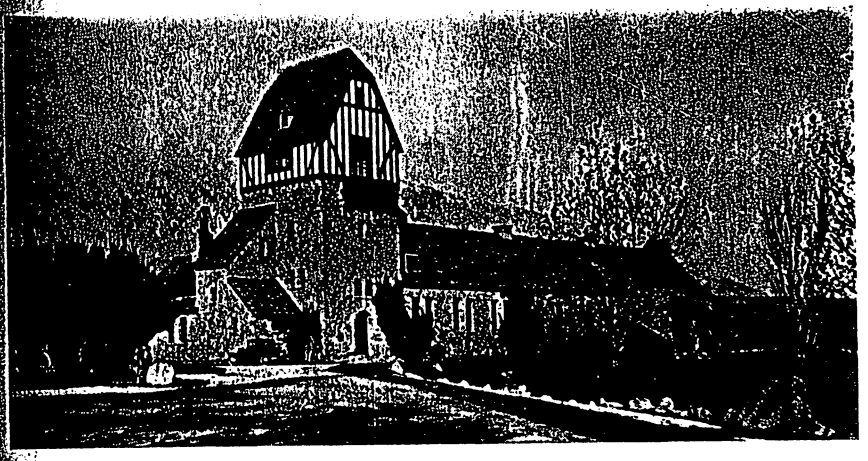

FIG. 44. The Mt. Whitney Trout Hatchery.

FIG. 45. A large distribution truck on the edge of a lake.

entire responsibility of maintaining an unlimited supply of fish against an uncurbed and irresponsible demand.

The success of a hatchery depends very largely upon its water supply. A sufficient supply of unpolluted spring water of a proper

temperature is desirable. Only one California hatchery has such a supply. Most of them receive their water from streams, and they are therefore subject to all the vagaries of stream conditions, such as extreme variation in temperature, loading with silt or mud, pollution, and disease carried by stream fish. With such a water supply there is a constant struggle against harmful factors which are beyond the operator's control. Such hatcheries can not carry fish for a year, nor can they profitably produce very large fish for planting, no matter how desirable it may seem to some.

FIG. 46. Packing fish in the high mountains. Photograph by C. J. Walters.

One of the greatest foes of artificial propagation is disease. The losses from its inroads have never been carefully measured but on every hand they are admitted to be serious. In the streams and lakes, trout are practically free from serious disease, but like human beings, when the population becomes unduly crowded trouble arises. In most cases diseases in the hatcheries are due to protozoans (minute animals), worms, small crustaceans, fungi, and bacteria. If properly diagnosed and treated, the ravages of fish disease may be checked and hygienic methods may prevent its appearance. The State Bureau of Fish Conservation has an agency for the scientific study and control of trout diseases.

The State maintains a large number of hatcheries and egg-taking stations, and some of these as Mount Shasta and Yosemite are annually visited by thousands of people. They produce millions of fingerlings and larger fish which are carefully distributed and planted in an effort to contribute substantially to the sport of angling.

The distribution of fingerlings (little fish produced by the hatcheries) usually begins in May, but July, August and September are the months of greatest activity. The early plantings often result from the necessary easements where fish become crowded, and these should be made in the headwaters where the native fish are small. Larger fish are available as growth is attained, and these are introduced as the spring freshets subside or the snow retreats in the mountains. In some localities many fish of large size are distributed.

The cost of rearing and distributing large fish is considerable and one may arrive at some notion of it when he considers that it takes

about four pounds of animal food to produce one pound of small fish. Of five-inch fish there are about sixteen or seventeen in a pound, while of nine- to eleven-inch fish there are only two or three in a pound. To the expense of food must be added that of labor and distribution. The cost of distribution rises very rapidly with increased size of fish.

Distribution is carried on by means of railroad cars, especially fitted for the purpose, trucks, pack-horses, and in some cases the cans are carried on the backs of men. A great deal is invested in the necessary equipment for distribution, but its successful operation depends largely upon the friendly cooperation of the railroads, sportsmen's organizations and other groups of willing people.

FIG. 47. Pack train laden with golden trout at Muir Pass. Photograph by F. A. Bullard.

ROUGH FISH AND THE TROUT

Through the ages the native trout have lived, multiplied, and held their own in the presence of the so-called rough fish—minnows, suckers, sculpins, and others. Some western minnows, as the Sacramento pike and the hardhead, for example, grow to large size, and with growth become voracious like true carnivorous fishes. It may be that these minnows, permitted to increase while the trout have become depleted, are correspondingly more dangerous. The suckers are not known to interfere with trout. Sculpins eat both eggs and small fish, but they are fortunately not abundant. The most destructive and despicable rough fish is the introduced carp. Trout may have suffered as much from black bass as from any native fish.

Depletion of the trout has lately attracted attention to almost every possible cause except the increased activities of anglers. A great hue and cry has been directed toward the rough fish. Some of these may be very destructive in certain places, but there appears no direct or very convincing evidence against them. The entire matter of the

ecological relations of these fish and the trout deserves careful investigation and if some species are found to be detrimental, then measures of control, which may take advantage of what is learned of their habits, should be devised.

CONSERVATION

It is a matter of common observation of late years that trout are rapidly becoming less abundant in some quarters and literally disappearing in others. The causes of depletion or extermination are well known, but means of conservation and the reparation of losses are not so apparent.

FIG. 48. Fall Creek. Fish were planted in barren waters above the falls.

Conservation of trout includes (1) the protection of young and adults at critical times and in exposed situations, from enemies, including man, and (2) artificial methods of propagation and distribution. Measures or means of conservation and their rational administration or application rest entirely upon what is learned from careful research. Research in this case includes the discovery of facts and a study of their interrelations. Sound measures of conservation can rest upon nothing else, and laws and regulations resulting from hearsay and guesses are futile. Conservation requires first of all a thorough knowledge of the situation and then a willing or enforced cooperation of all concerned in carrying out such measures as have been devised. Many who have carefully considered conservation in its broadest sense have concluded that education of the public and especially of its younger members, should form an essential part of the program.

The people of this State are responsible for the conservation within its borders of some of the most remarkable and beautiful trout known to the world. They have created a particular agency, the Division of Fish and Game, and honored and trusted it with this responsibility. The future will hold it accountable.

THE SPORT OF TROUT FISHING

There is no sport that has developed greater refinement of apparatus or technique than that of trout fishing. Lures, leaders, lines, reels and rods have reached a degree of adaptability and perfection of beauty in construction and workmanship that is difficult to surpass. The mate-

FIG. 49. A catch of golden trout from Rock Creek near Lone Pine. Photograph by Burton Frasher.

rials of a good outfit are collected from the ends of the earth and when properly finished and fitted in the best proportion, they contribute to an ensemble that is well worthy of admiration. Part of the pleasure and enthusiasm of the angler centers about the fine and well kept tools of his sport.

There is no need here to direct the novice or to enlarge upon the outfit or the ways of the successful angler.[3] Two or three popular books will offer ample food for thought, together with a sufficient volume of contradictory statements and lengthy arguments as to whether it is best to fish up or down stream, use wet or dry flies, tie your own or use the store product, select a tapered or a level line, a silver or copper spinner, or what not. Perhaps the most fortunate thing in relation to the suggestions of the various books is that the angler need not take them too seriously nor is he thereby forced to abandon his own

[3] An excellent article under the authorship of Donald H. Fry, Jr., entitled "Trout fishing in southern California streams—instructions for the beginner," appeared in CALIFORNIA FISH AND GAME, vol. 24, pp. 84-117, 1938.

initiative. The inquiring fisherman will meet with friendly suggestions on every hand. The supply houses are replete with tackle and information. Much of it is good, some of it indifferent or even bad. It is the privilege of the angler, and a part of the game to choose.

ANGLERS' CONTRIBUTIONS

Anglers may offer substantial contributions to the ichthyology of trout. Their notes should take account of locality and date. Color descriptions should follow the nomenclature of external anatomy. The spots may be enumerated and localized by dividing the body into four parts by means of a vertical line through the anal opening across the lateral line. The size of the scales is expressed by counting the lateral

FIG. 50. Opening day on the San Gabriel and an angler on every pool.

series. Measurements should include the length from the tip of the snout to the base of the caudal fin, the depth at the deepest part of the body, length of head and of maxillary, length or height of fins, especially the length of the caudal from its base to the tips of the middle rays. (See Fig. 52.) The skin of a trout may be removed and dried, thus preserving the scales and much of the color.

Scales for age determination should be removed from near the middle of the body. They should always be labeled with the species name, the length of the fish, the locality and date.

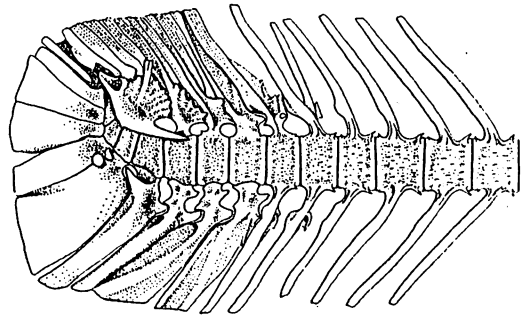

FIG. 51. A dissection of the tail with 13 vertebrae. The last two or three should not be overlooked in vertebral counts.

Vertebrae may be accurately counted after slightly cooking the flesh in hot water and brushing and scraping it away. The last small and partly developed vertebra in the tail should be included. (See Fig. 51.)

DESCRIPTIONS OF CALIFORNIA TROUT

As in the case of some peoples, American Indian and Asiatic Mongol for example, so with the trouts, cut-throat and rainbow alike, the distinguishing traits which separate them are difficult to set down in writing. Yet when one becomes familiar with them they may usually be recognized with certainty. The shape of the head and body, the dentition, the red throat mark, the squamation, the habits, etc., are not in each case always to be depended upon. Large acquaintance with them will demonstrate the futility of attempting an identification of their species by means of artificial keys or brief descriptions.

Coast Rainbow Trout

Salmo irideus Gibbons [4]

Rainbow trout inhabit the coastal streams from the northern border of the State southward wherever the water is of sufficient volume to support them. Entering the streams as steelheads, they migrate to the uppermost tributaries, where they spawn and then return to the sea. The progeny of the steelheads remain for a time as stream trout

[4] The use of the specific name *S. irideus* is here used instead of *S. gairdneri* for the simple reason that no particular trout can be recognized with certainty from Richardson's description published under the latter name.

Of this name, Gunther (Catalogue of fishes, vol. 6, p. 118, 1866) says "The material on which this species has been founded was quite insufficient for that purpose, and the species for which this name has been intended is not likely to be ever recognized."

Jordan (Copeia, no. 121, p. 86, 1923) believed that Gairdner was referring to the blue-backed salmon, *Oncorhynchus nerka*. This seems possible as Richardson quotes Gairdner's notes: "Colour—Back of head and body bluish-grey; sides ash-grey. Belly white. The only trace of variegated markings are a few faint spots at the root of the caudal."

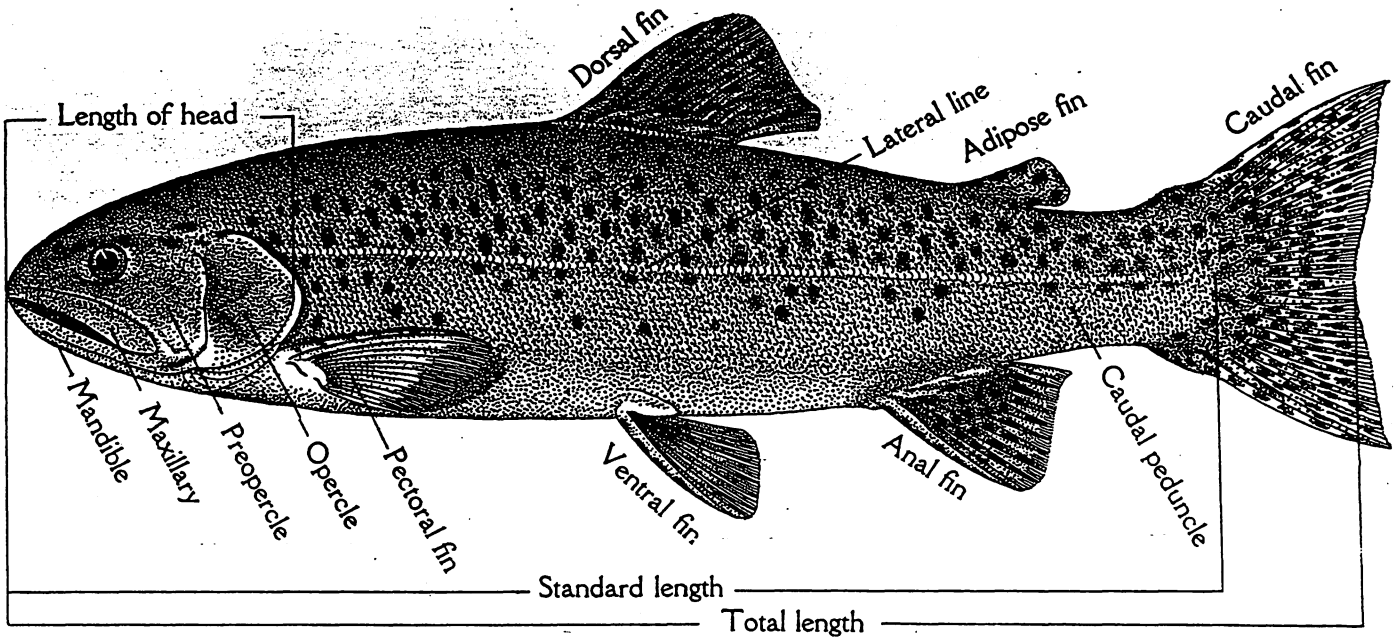

FIG. 52. Drawing of a trout which may be of use in making notes or interpreting descriptions.

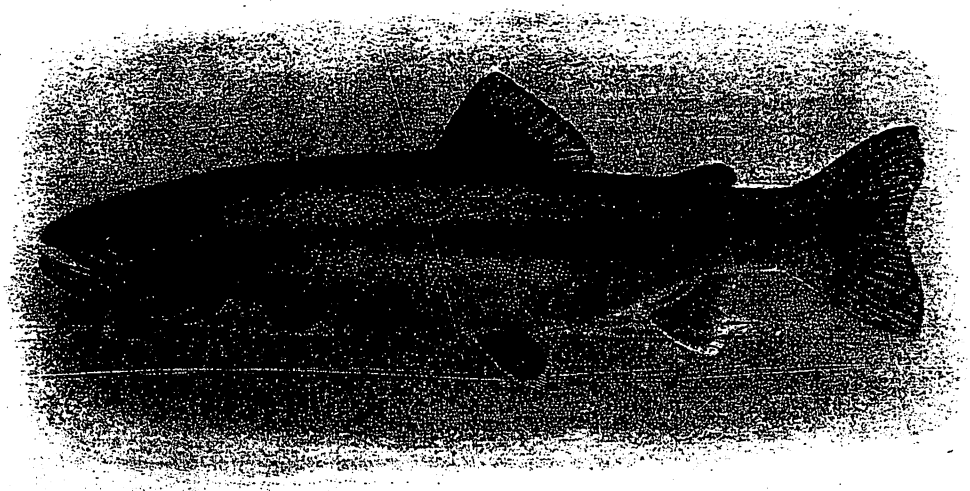

PLATE I. Coast rainbow trout, *Salmo irideus* Gibbons.

drifting toward deeper water as they grow larger, some remaining three years or more before entering the ocean. In large bodies of water, lakes and river channels, are resident trout which behave in their spawning migrations just as do the steelheads, seeking turbulent, well aerated water in which to deposit their eggs.

The coast rainbow trout or some of its near allies, has been extensively propagated by artificial means and widely distributed over the world. It is able to adapt itself to considerable ranges of temperature and a variety of natural conditions. It is generally conceded that some of its brilliant color, its sprightliness, and its fighting spirit is lost when it is removed from its native waters. However, some anglers hold that introduction to foreign streams is attended with an improvement of these qualities.

The color forms are varied and individuals from one stream are apt to differ from those of another. A typical rainbow may resemble that presented in the color plate or it may be much darker or lighter, with the lateral color stripe broader or narrower, the fins lighter, pink or bronzy, the dark spots less numerous, larger and more rounded. In lakes or in silty water the spots contract and become linear, and the general color is relatively pale and silvery.

The scales are large, the lateral series numbering 120 to 150 or so.

Growth varies with conditions. In the streams 4 or 5 inches are often attained the first year and a length of 6 to 9 inches or more during the second. Examples measuring 9 or 10 inches or even more have been reported for the first year. In general a 9- or 10-inch fish is in its third year or it may be older.

An 18- to 22-inch fish may weigh 2⅜ to 4¼ pounds; a 24- to 28-inch fish, 5½ to 9¼ pounds; a 30- to 34-inch fish, 10 to 12 pounds. Rainbow trout weigh much more than cut-throat trout of the same length.

Shasta Trout

Salmo stonei Jordan

The Shasta trout should be referred to as *Salmo stonei*, as it and *Salmo shasta* are synonymous, and *S. stonei* was first described. No specific characters can be found to distinguish between these two nominal forms.

The writer has never had an opportunity to carefully examine specimens of the Shasta trout. It is described as a variant of the rainbow, inhabiting the waters of the upper Sacramento and its tributary the McCloud. Writers have distinguished it by the smaller scales, 150 to 165 in the lateral series, and by its color.

It is olivaceous above and paler below, with a brownish-red stripe. The opercles are washed with brownish-red. The under parts and the fins are yellowish. The tips of the dorsal, anal and ventrals are white.

Particular attention was early directed to the trout of the Sacramento and McCloud rivers because of its wide use in fish cultural operations and its popularity with sportsmen. It is difficult to find any anatomical characters to distinguish it from the rainbow of the coast. It has somewhat smaller scales, but it attains no larger size as has been said. One authority states that it has 63 vertebrae instead of 60 as in the case of the steelhead. Coast steelheads have from 60 to 63 or more

vertebrae. A careful count of the vertebrae of 175 Klamath River steelheads stands as follows:

Number of vertebrae	60	61	62	63	64	65
Number of examples	7	42	57	50	15	4

The curve or variation here exhibited is normal and it is typical of most specific characters which are capable of enumeration. A count of a like series of Shasta trout would probably show similar variation.

Kern River Trout

Salmo gilberti Jordan

As its name implies this form is limited to Kern River.

It resembles the coast rainbow in form and color as distinguished from the golden trout. It is profusely and closely spotted over the entire body and fins, a concentration of spots occurring on the caudal peduncle.

In life the dorsal surface is dark olivaceous or lighter and usually with fine yellow or orange specks. A broad, rich rosy band extends from the opercle to the anal base, the band growing wider toward the middle and somewhat darker posteriorly. Below the lateral band the body is strongly suffused with greenish-blue. The ventral surface of soiled white is washed with gold. The cheek and opercles are rosy, the head above is greenish-olive, the side of the jaw brownish. The dorsal and caudal are tinted with blue and olive, the pectorals, ventrals, and anal suffused with brown and pink, the tips of ventrals and anal white. The body and fins are closely spotted, the spots of the fins oval or elongate. The upper part of the head bears round spots, and there are a few similar spots scattered on the sides of the head.

Considerable variation in the number, size and shape of the spots appears, and the general brilliance of color differs among individuals.

Trout from Kern Lake, a widening of the river, are larger and less brightly colored than those of the river proper.

The scales number about 155 in the lateral series, actual counts resulting in 151 to 162.

The Kern River trout is not easily distinguished from the Shasta trout. It may possibly be a color variant among others of a more or less differentiated group of fine scaled rainbow trouts which inhabit the series of rivers entering the Great Valley from the western slopes of the Sierras. It so happens that particular attention has been directed to the trout of Kern River and to those of the upper Sacramento with is tributary the McCloud, while the Feather, American, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, Kings and Kaweah river systems have been ignored. If the two trouts in question are to be regarded as distinct species, the geographic range of each must be considered and this involves the identity of the trout native to the streams mentioned above, a matter of no little difficulty.

PLATE II. Kern River Trout, *Salmo gilberti* Jordan.

South Fork Golden Trout

Salmo agua-bonita Jordan [5]

This trout inhabits the South Fork of the Kern River and Volcano Creek. It, like some other species, has been successfully introduced elsewhere, notably Cottonwood Lakes and Cottonwood Creek.

This is the most brilliantly colored trout. It occurs at an elevation of about 10,000 feet. It has fewer spots on the body than *S. whitei*. The scales are very small, 180 or thereabouts in the lateral series.

In life the top of the head, the back and the upper part of the sides are light yellowish olive. On the sides, extending from the head to the caudal peduncle, is a bright carmine stripe. The sides below the lateral line are bright golden yellow, fading below into greenish white. On the belly is a broad cadmium or orange-yellow area from the throat to the anal fin, the color deepest between pectoral and ventral fins. Ten or so vertically oblong parr marks appear on the sides. The cheeks and opercles are bright rosy. The dorsal fin is tipped with light orange; ventrals and anal tipped with white. The dorsal and adipose fins are well spotted; the other fins without spots. The head and body are frequently spotted down to the lateral line, spots covering the caudal peduncle. In many individuals (*S. roosevelti* Evermann) the spots are less numerous, sometimes confined to the region of the caudal peduncle.

Individually, much variation in color is seen, the general type and plan persisting. The parr marks usually persist. Introduction into new localities may be attended with considerable variation, particularly in loss of color and increase in size.

This trout and likewise *S. whitei* are to be regarded as having a rainbow ancestry, the great reduction in the size of the scales and their consequent increase in number being associated with alpine, *i.e.*, boreal conditions.

To prevent the complete extinction of this species is a problem for the present and future.

Soda Creek Golden Trout

Salmo whitei Evermann

The trout of Soda Creek, Coyote Creek, Wet Meadow Creek and Little Kern River were referred by the author of the species to *S. whitei*. It will be noted that of these streams, Coyote Creek is tributary to Kern River and is thus separated from the Little Kern basin.

The presence of small black spots on the top of the head and all but the lower one-third of the side is said to distinguish this from other species of golden trout. The described differences between this and *S. agua-bonita* in so far as color is concerned appear to be slight. The scales of the latter appear to be larger, however.

In life the dorsal region of head and body is a light yellowish-olive, the color becoming lighter and assuming a light lemon tint on the lower sides. The ventral surface is reddish-orange between the throat and anal fin. A rather narrow, orange-red lateral stripe extends

[5] Brian Curtis, in a study of the habits of the golden trout (CALIFORNIA FISH AND GAME, vol. 21, pp. 101-109, 1935) seems to have shown that no constant character distinguishes *S. roosevelti* from this species.

from opercle to the base of caudal. Subocular area pinkish, cheek lemon, opercles orange. Dorsal fin light greenish-olive, tipped with yellow. Lower fins yellowish, the ventrals and anal tipped with white. Upper half of body and head, dorsal and caudal fins are abundantly provided with round and oval black spots, all smaller than the pupil. A few spots appear on the opercle.

There are about 200 scales in the lateral series. They are minute, frail and well imbedded.

This trout is fully as handsome as *S. agua-bonita*. The parr marks are said to be always present, they are rather narrow and a series of intermediate small rounded ones are present in a line below.

It is said that the trout of Coyote Creek exhibit greater variation than those of other localities; also that trout localized in the stream because of falls show an appreciable amount of distinctive coloration.

Culver Lake Trout

Salmo rosei Jordan and McGregor

This species was described from trout taken in an unnamed lake, later called Culver Lake, in the High Sierras. The lake is tributary to the Big Arroyo, a stream flowing into Kern River. It lies north of Five Lake Basin at an altitude of about 10,500 feet.

It is a large-headed, stocky fish with relatively small, generally scattered spots. The maxillary is long, and the upper contour of the head is markedly concave.

Its relationships are said to be with the golden trout of the region. There is difference of opinion as to whether this is a native fish or one introduced through artificial stocking.

In life it is described as having roundish black spots on the back and along the sides above the lateral line, some of which are nearly as large as the pupil. The spots on the sides below the lateral line are dash-like and less distinct. Spots are almost entirely absent on the top of the head. The ventrals are slightly dusky, with some red. There is a rather conspicuous rosy band along the lateral line. A faint cut-throat streak occurs on inner edge of the mandible.

San Gorgonio Trout

Salmo evermanni Jordan and Grinnell

The native trout of the upper Santa Ana River in the San Bernardino Mountains is referred to this species.

It is distinguished from the coast rainbow by the finer scales, and the large round spots which are scattered evenly over the upper part of the head and body. The head is large and long and the snout sharp.

The scales in the lateral series number 162 or so.

An exact count of all the spots on one side of the body in an example resulted in 82, and most of these were about the size of the pupil.

The trout of this species are isolated from the rainbows of the lower courses of the river by high falls. Individuals may pass down stream, and they do at times, but no trout from the river below enters their domain above the falls. However, several years ago a ditch was

PLATE III. Golden trout, *Salmo agua-bonita* Jordan.

constructed which diverts water from above the falls to feed a small lake. The lake is stocked with rainbow and Loch Leven trout. Both fishes are said to have invaded the territory of the San Gorgonio trout and it is to be doubted if one could find a specimen of the native trout at the present time.

Eagle Lake Trout

Salmo aquilarum Snyder

This species is indigenous to Eagle Lake and its tributary stream Pine Creek.

It is robust in form with a deep caudal peduncle and very large adipose fin. The rayed fins are large and strong.

In life, the body above and down the sides nearly to the lateral line is a rich dark olive, each scale brassy and very conspicuous. The sides below the olive region and the ventral surface are deep coppery-red with bright metallic reflections. The sides of the head are cherry-red, very rich in color. A trace of red beneath the mandible; iris brassy. The pectorals are broadly and conspicuously edged with olive. The color as here described is of a male at the time of spawning. The female is very different. It is light olive above where each scale is silvery with greenish reflections. The sides are lighter, the scales more green than those above, the ventral surface silvery, tinted with pink. A very distinct pale reddish stripe extends along the side of the body, mostly below the lateral line. The cheeks and opercles are red, the iris orange. The ventrals and anal are suffused with red and distinctly edged with the same. When in the water the males are easily distinguished as their sides appear a deep coppery-red and the cheeks are particularly brilliant. There are very few black spots on the head. The middle of the back from the occiput to the dorsal is without spots. The unpaired fins and the upper part of the body have large rounded or elongate spots.

The lateral series of scales numbers 136 to 140; scales above lateral line 29 to 32; anal rays 11.

The flesh of this trout is deep red, very firm and fatty, far superior to that of the Tahoe trout. A considerable number were seen in May during the spring migration of 1913. They were very uniform in size, measuring 18 inches or so in length.

The native trout of Eagle Lake leads a precarious existence. The only spawning and nursery stream is Pine Creek, a small tributary with a fitful flow. Often many spawning fish are cut off by low water before they return to the lake, and many young trout are destroyed in like manner. Formerly Indians, and later some of the white population, by building weirs and traps and arming themselves with spears, took a considerable toll from the migration.

The species is of particular interest, as closely allied to and scarcely distinct from the rainbows of the western slopes of the Sierras, it occurs in the Great Basin drainage. The other fishes of Eagle Lake, suckers and minnows, belong to the Lahontan fauna, while the Tahoe trout, characteristic of the Lahontan region of the Great Basin is not found there. The royal silver trout, although a member of the rainbow group, does not appear to be closely related to the Eagle Lake trout.

According to report it is difficult to catch this trout in the lake.

Royal Silver Trout

Salmo regalis Snyder

This species is known only from a few examples caught in Lake Tahoe. There is every reason to believe that it is rare and not simply overlooked. Fishermen are apt to confuse silvery examples of the Tahoe trout with this fish, although when placed side by side, a glance serves to reveal the difference.

It is a small-headed fish with a short, rounded snout, a narrow, weak maxillary scarcely extending beyond the orbit. The opercles and branchiostegals are thin and papery. The jaws are weak and the teeth small. The gill rakers number 19 to 21, small and pointed. The scales number 144 to 150 in the lateral series; they are very thin and not deeply imbedded. The fins are all thin and relatively frail, the pectorals and ventrals sharply pointed.

The royal silver trout is distinguished at once among all other California species by its unusual color, deep blue on the dorsal surface which in some lights is slightly shaded with olive, the blue extending downward on the sides to about the sixth row of scales above the lateral line, where it gives place to the most brilliant or burnished silver. The silver sheen dulls toward the ventral surface, the abdomen, throat and chin being dead white. No dark spots appear except a few very small ones on the dorsal and caudal fins. No red or yellow color is to be seen anywhere except on the cheek, where it glows faintly through the silver.

Nothing is known of the spawning habits of this species, and the young have never been recognized.

The species appears to be related to the emerald trout, *S. smaragdus* of Pyramid Lake, a fish equally rare and possibly soon to disappear as one of the last relics of the ancient Lake Lahontan. Both are apparently of rainbow stock long separated from those fishes west of the Sierras.

It has been taken with both fly and spinner. Its capture furnishes a real surprise to the angler when a prodigious leap from the surface of the water in true rainbow fashion reveals a dash of blue and a shimmer of silver not generally associated with trout.

Coast Cut-throat Trout

Salmo clarki Richardson

This trout is a native of the streams in a narrow coastal region extending from Redwood Creek northward. It has been recorded from Eel River, but examples from that stream have never come to the writer's notice. Considerable seining there has not caught any young of the species.

The writer fished the streams of this region in 1897. At that time trout of this species were abundant in Redwood Creek, but almost impossible to find in either the Klamath or Smith rivers. Observations continued through a period of years since that time have added nothing to this apparent condition except that the trout have become considerably depleted. Just why Redwood Creek should be favored as a habitat for this species instead of Eel, Mad, Klamath or Smith rivers

is an example of some of the puzzling questions relating to adaptation and geographic distribution which frequently confront the investigator.

During the migrations of some years the cut-throats appear to about equal the rainbows in number in Redwood Creek, while usually the rainbows are more numerous.

Small cut-throats may be taken in some of the tributaries of the lower part of Klamath River but no adults have as yet been recorded there in a winter migration. An occasional cut-throat steelhead makes its appearance among the late summer rainbow steelheads. These look like the latter in shape and color, and unless the scales are carefully observed they may pass as rainbows. They are then very rare, however, one cut-throat among thousands of rainbows.

The scales in the lateral series number from about 160 to 200 or so. Between the lateral line and the back there are 34 to 39 or 40.

In the month of January or sometimes earlier the cut-throats come into Redwood Creek to spawn. They find their way up the tributaries, and those entering Prairie Creek seem to be particularly well colored. In seeming keeping with the dark redwood forest with its fern lined mossy banks, the fish are very sombre. Their backs and sides are suffused with deep olive. In some examples the lower sides are yellowish. There is generally present an indefinitely outlined purplish lateral stripe extending from the opercle to the caudal fin. The pectorals are tinged with yellow, and the ventrals with salmon-pink. The jaws and sides of the head are yellowish. The upper part of the opercle is yellowish or occasionally golden, the lower part sometimes purple. The red gash under the mandible is bright salmon or red, very conspicuous and always present. An occasional individual has a small rounded golden spot somewhere on the lower part of the body.

This particular characteristic, a coinlike golden spot, may be seen on an occasional brightly colored Tahoe cut-throat.

The black spots are large and pretty well scattered over the head and body. Actual counts show from 26 to 71 on the head; 322 to 577 on the body. All of the fins bear spots.

Tahoe Cut-throat Trout

Salmo henshawi Gill and Jordan

The Tahoe trout is a mountain cut-throat indigenous to streams of interior drainage. It is to be caught in Lake Tahoe and other waters of the Truckee system and in Walker, Carson and Owens rivers. Whether it is native in the latter stream is questioned. Its distribution has been somewhat extended by artificial propagation.

This trout occupies a region of great diversity of natural conditions and it seems to respond accordingly. Its color varieties might offer an open and fertile field to the systematist prone to describe geographic forms.

It would perhaps be a matter of convenience to apply a specific name to the Pyramid Lake trout, its distinctness being a matter of color and restricted distribution, the habitat being Pyramid and Winnemucca lakes and the lower Truckee River.

Although spawning occurs in the streams tributary to Lake Tahoe in April, examples in nuptial color may be seen even late in June. The

males are then of a dark, yellowish-olive color, with a faint metallic sheen, the dark color being usually uniform from the back to the ventral surface. On the side is a broad pinkish stripe, indefinite in outline

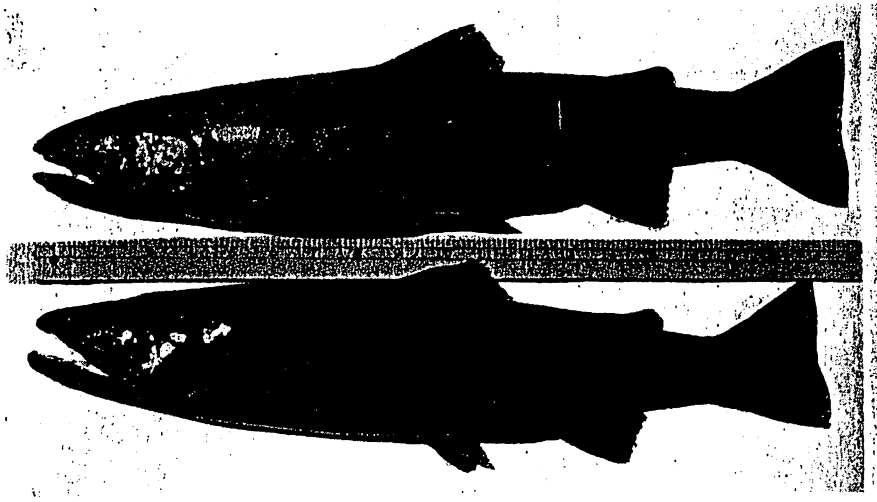

FIG. 53. Tahoe cut-throat or black-spotted trout, *Salmo henshawi*. Photographs of specimens (female above, male below) from Heenan Lake, Alpine County, May, 1939, by A. C. Taft.

FIG. 54. A pair of silvery Tahoe trout caught in deep water with trolling tackle.

and about ten scales wide. It originates on the opercle and extends to the tail where it gradually fades out. Each scale included in this stripe, and also in a broad area above and below, is narrowly edged with pale

yellow. The sides of the head and a triangular spot above the axil of the pectoral are scarlet or yellowish-scarlet. The under surface of the lower jaw has two parallel stripes of bright red. Even the tongue is tipped with crimson. One or more small, coin-like, golden spots may occasionally be found on the head. 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. Because of these spots, the Tahoe cut-throat is often called black-spotted trout. The females are lighter in color, though preserving the same general pattern.

Frequently individuals, large in size, fat and in fine condition are taken in deep water. They are very silvery and the spots are narrow and elongate. They are locally known as silver trout, and check lists

FIG. 55. Dark colored Tahoe trout caught near the edge of the green water.

still recognize them as *Salmo tahoensis*, a proceeding entirely unwarranted.

The Tahoe trout is a comparatively slender fish with a rather long and pointed head. Examples, 18 to 20 inches long, weigh from 1½ to 2½ pounds; 24 to 28 inches, 3½ to 7½ pounds. The scales run from 153 to 163 in the lateral series and 29 to 38 above the lateral line. Gill rakers, 23 to 25; branchiostegals, 10 or 11; cæca, 70 to 85.

The lake fish feed largely on minnows which occur abundantly and of several species. At times they consume insects which have fallen upon the surface or are brought out by the streams. They are not to be regarded as surface feeders, and as the summer season progresses they go to deeper water, following the minnows which in turn seem to follow the plankton.

When taken with light tackle the Tahoe trout puts up a strong fight, but not so spectacular as that of the rainbow. They are said to reach a weight of 20 or 30 pounds.

Marked depletion of the Tahoe trout resulted first from the activities of market fishermen. It is now continued by anglers who persist in catching the small fish of the tributary streams before they have an opportunity to enter the lake where they would soon reach a large size.

Piute Trout

Salmo seleniris Snyder

This newly described species is an isolated variant of *S. henshawi*, differing markedly in the absence of spots on the body, the more slender form, and the relatively small and more numerous scales.

The outstanding characteristic of this trout is the color, well portrayed in Plate IV. No two observers agree in a description of its colors, tints and shades, some of which seemingly come and go with every changing whim of the fish. Moreover, its swimming movements are often accompanied with opaline reflections of varied intensity, and the skin in some places has a peculiar translucent appearance, so much so that on the head some of the cranial bones are partly outlined through the overlying tissue. A sudden disturbance will occasion the appearance of much green color on the body, thus imparting a greenish olive to the dorsal surface and a paler green to the region below the lateral stripe. The ventral surface may at times darken considerably.

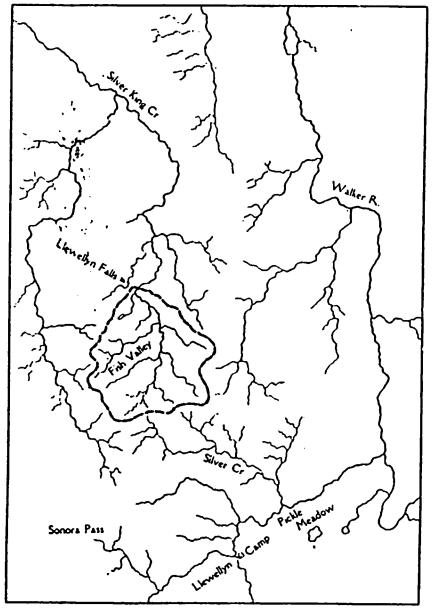

FIG. 56. Sketch map showing Fish Valley, habitat of the Piute trout.

The normally clear white ventral surface is unusual, particularly on the throat where it forms an advantageous background for the extensive orange-red areas beneath the mandible. As in the case of other cut-throats, an occasional example bears one or more small, golden, coin-like spots, located anywhere, but usually on the ventral surface. There are no dark spots on the body and they are not numerous on the dorsal and caudal fins. In some examples the caudal is almost immaculate. The major parr marks are ten in number, the first immediately bordering the gill opening, the last at the end of the caudal peduncle. All are crossed by the lateral line, the posterior ones bisected by it, the anterior ones two-thirds below. Of the secondary row, sixteen in number, every alternate spot dips between the nearby primary ones. The mid-dorsal region is marked by a narrow dark line.

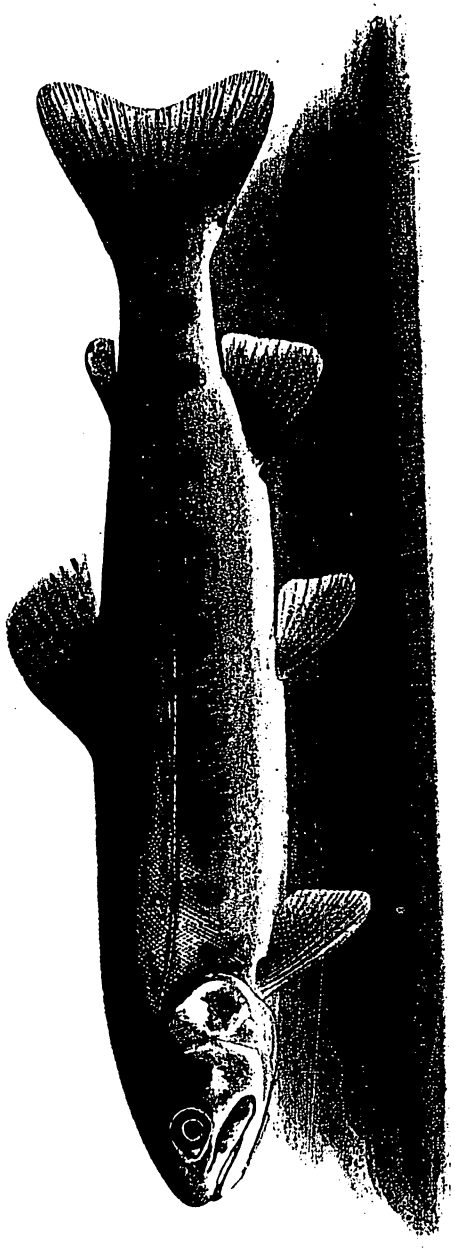

PLATE IV. Piute trout, *Salmo seleniris* Snyder.

The body is comparatively long and slender, so much so as to attract attention at once. The fins are rather weak.

This trout is found only in the little streams of Fish Valley, a remote region in Alpine County east of the Sierra Divide. Its native habitat is restricted by Llewellyn Falls, which form an impassable barrier between the waters above and Silver King Creek below, which in turn flows into Carson River. The waters of the latter eventually disappear in Carson Desert to the eastward. Carson River was once tributary to the Quaternary Lake Lahontan which covered a considerable area in Nevada.

Trout from below the falls are different from those immediately above in that their bodies and dorsal and caudal fins are well covered with large and very conspicuous roundish black spots. They are also considerably deeper and more robust in appearance. The colors are not nearly so bright. An enumeration of the spots on several examples from the stream below the falls will be of interest.

Spots on side of head	10	18	5	5	4	5	6
On body above lateral line	32	93	38	58	37	36	22
Body below lateral line	25	57	34	17	34	8	33
On tail above lateral line	20	36	26	24	12	19	17
Tail below lateral line	18	21	19	13	17	9	17
On dorsal fin	33	34	38	41	25	28	30
Caudal fin	55	66	67	21	33	13	43

As the region of Fish Valley presents an apparently clear-cut and unusual biological demonstration in nature, fishing there is now prohibited by order of the State Division of Fish and Game. To further insure the survival of the species, a number of piute trout have been transplanted to some formerly barren lakes near Lake Tahoe, where at last reports they were thriving.

Colorado River Trout

Salmo pleuriticus Cope

The Colorado River trout has come into the State by way of overflow waters passing into Salton Sea. It has been variously reported as abundant or scarce, but no authentic information relating to it is at hand. It is improbable that it will thrive in the waters of the sea because of high temperatures, and it may not maintain itself for lack of spawning places.

The relationships of this species are to be traced to the trouts of the eastern slopes of the Rocky Mountains and the Great Basin including *Salmo henshawi* of Lake Tahoe and *S. utah* of the Bonneville system. Through these a relation may be seen with the cut-throats of the Columbia system.

This is described as a brightly colored form with a red lateral band and with red or orange fins. The spotting is variable, some examples having the body fairly covered while others have spots only posteriorly. The head is usually immaculate.

Salton Sea examples are said to be very light in color.

The scales are small, there being 185 to 190 or more in the lateral series.

Loch Leven Trout

Salmo levenensis Walker

The Loch Leven trout of Scotland and the brown trout of Europe (*S. fario*) were early introduced into the waters of this country. In the hands of fish culturists they were eventually cross bred to such an extent that perhaps now no clear strain of either remains. Characteristic of hybrids the fishes now held in breeding ponds exhibit a variety of color pattern, occasional individuals resembling one or the other of the parent stock, while many differ from both.

This fish is valued particularly because it spawns in the fall and affords a relatively large growth before the time of summer planting arrives, and also, it seems to thrive in certain situations not so well adapted to other forms. It is not always easy to catch and is therefore less likely to be fished out.

FIG. 57. Loch Leven trout, *Salmo levenensis*. Photograph of fish at Rush Creek Egg Collecting Station, October, 1939, by Elden H. Vestal.

The back and sides are brown, olive-brown, greenish or grayish, lighter on the sides, and silvery or almost white beneath. The back is covered with dark spots, very black in some examples, while on the sides the spots are red, surrounded by a light ring of varying width.

This trout has been planted in many parts of the State and is now to be found in many streams and lakes, particularly in the Sierras.

Dolly Varden Trout

Salvelinus spectabilis (Girard)

In California this species is found only here and there in the upper tributaries of Sacramento River, especially the McCloud. It extends northward, growing more plentiful toward British Columbia and Alaska, and grading into *S. malma*, if indeed it really differs from that species.

It may be regarded as a native western representative of the brook trout, which it resembles somewhat in size, color and form. It is, however, more slender, and the back and the dorsal fin are without blackish vermiculations, markings and blotches.

Dolly Varden trout are not in favor with fish culturists because of their predatory habits.

In life the color is olive above, lighter or darker as the case may be, light olive or grayish or greenish on the sides and white beneath. The

iris is brassy. The fins are light olive with a brassy metallic sheen. The anterior rays and membranes of the ventrals are orange, whereas the distal half of these rays is edged with dead white. The anterior two or three of the anal rays are orange, the lower anterior edge of the fin white. The spots on the sides of the body are bright orange or dark yellow.

The Dolly Varden is a beautiful fish, perhaps a little slow for the impatient angler and not overly demonstrative when hooked.

Eastern Brook Trout

Salvelinus fontinalis (Mitchill)

The eastern brook trout was early introduced into the State where it now thrives in the cold waters of the high mountains. It is extensively propagated and used to stock depleted or barren waters.

The mottled or marbled color pattern, red spots on the sides and the reddish lower fins, broadly edged with white, serve to distinguish this trout, or rather charr, from the black-spotted natives.

In life the head, dorsal part of the body, dorsal and caudal fins are variously spotted and vermiculated with dark olive or black. The sides are covered with yellowish, greenish and bright red spots which form the centers of grayish or greenish circular areas. The lower parts of the sides and the ventral region are reddish, sometimes very deep and brilliant in color. Lighter examples have the head and back grayish-green, mottled with dark green or olive-black. The red spots on the sides are surrounded with light greenish-brown or gray areas. The ventral surface is tinted with pink.

The parr marks, eight or so in number, often persist in large fish.

The scales are very small and so deeply imbedded as to usually escape notice.

FIG. 58. Eastern brook trout, *Salvelinus fontinalis*. Photograph of a fish at Carmen Lake Egg Collecting Station, October, 1939, by Elden H. Vestal.

This species is abundant in the Tahoe region, the Sierran lakes and streams, and in scattered localities in mountainous regions. It exhibits great variation in color. It is wary and some skill is required in its capture.

It spawns from early in October until well into December. The eggs are very small when compared with those of native trout, and they are deposited in a nest-like cavity and covered with gravel.