Charles Harkins Bel Air High Bel Air, Md.

# FISHES & FISHING IN SUNAPEE LAKE WILLIAM CONVERSE KENDALL Quer Bur, Fisherics Doc. No. 783 excellent material on Sundpier Golden Troot and confusion with Rangely Blueback,

November 30, 1976

Mr. Roger C. Keim 51 Norfolk Street Bangor, Maine 04401

Dear Roger:

I can state without doubt that the Dublin Pond char (which, by the way, will be resurrected as a valid, albait extinct, species, <u>Salvelinus</u> <u>agassizi</u>, by the American Fisheries Society) is not an introduced Dolly Varden or a hybrid Dolly Varden x brook trout. The mottled markings of the dorwal and caudal fins, the low number of vertebrae and higher number of pyloric caeca separate it from any known form of <u>S. malma</u>.

The Dolly Varden was never a popular fish; often considered as vermin to be eradicated in its native range. As such it was not a likely species for peopagation. The only record I know of propagation was in California in 1893-94. The Sisson Hatchery near Mt. Shasta raised the McCloud River Dolly Varden and made brook trout x Dolly Varden hybrids. I don't believe any left the state, but this was many years after the discovery of the Dublin Pond char. Transcontinental shipment of fish eggs and fry did not occur much before 1872. The basic features of the Dublin char show relationships to <u>S. fontinalis</u>, not the <u>S. Alpinus</u>, <u>S. malma evolutionary lines</u>. The Sunapee and blueback char, however, are certainly of the <u>S. alpinus line</u>, and are no more than disjuont relicts of alpinus separated from the rest of the species by the retreating glacial fronts within the past 10,000 years. The nearest known Dolly Varden population in relation to New England occurs in the Saskatchewan drainage (Hudson Bay watershed) of Alberta.

I believe the reference to the Sunapee char x brook trout hybrid appeared in Forest and Stream, 1890, 35:429 : "To the golden trout a hybrid". To this I would say, no, but the Sunapee char is virtually identical with the blueback char of Maine. I don't believe, however, that the Sunapee char was introduced by man. What is the present status of the char of Sunappe Lake? They were believed extinct in the lake but introductions had been made and I was once told a new population was established in a pond, I believe, called "Tewsberry" Pond, New Hampshire.

Keep me informed on anything new you turn up in Kendall's notes andlletters. Also there may be something of interest in John Quankenboe' book on brook trout, published in a limited edition by the New York Angler's Club. I don't have a copy but remember looking it over many years ago.

Sincerely,





Sport Fishing Institute 608 13th St., N. W. – Washington, D. C. 20005

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Mr. Robert Behnke Colo. Cooperative Fishery Unit Colorado State University Fort Collins, Colo. 80521

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P. R. NEEDHAM

# Memoirs of the Boston Society of Matural Mistory.

VOLUME 8, NUMBER 1.

P. 11 Busibranchial Teeth

Monographs on the Matural History of New England.

P. R. NEEDHAM

# THE FISHES OF NEW ENGLAND.

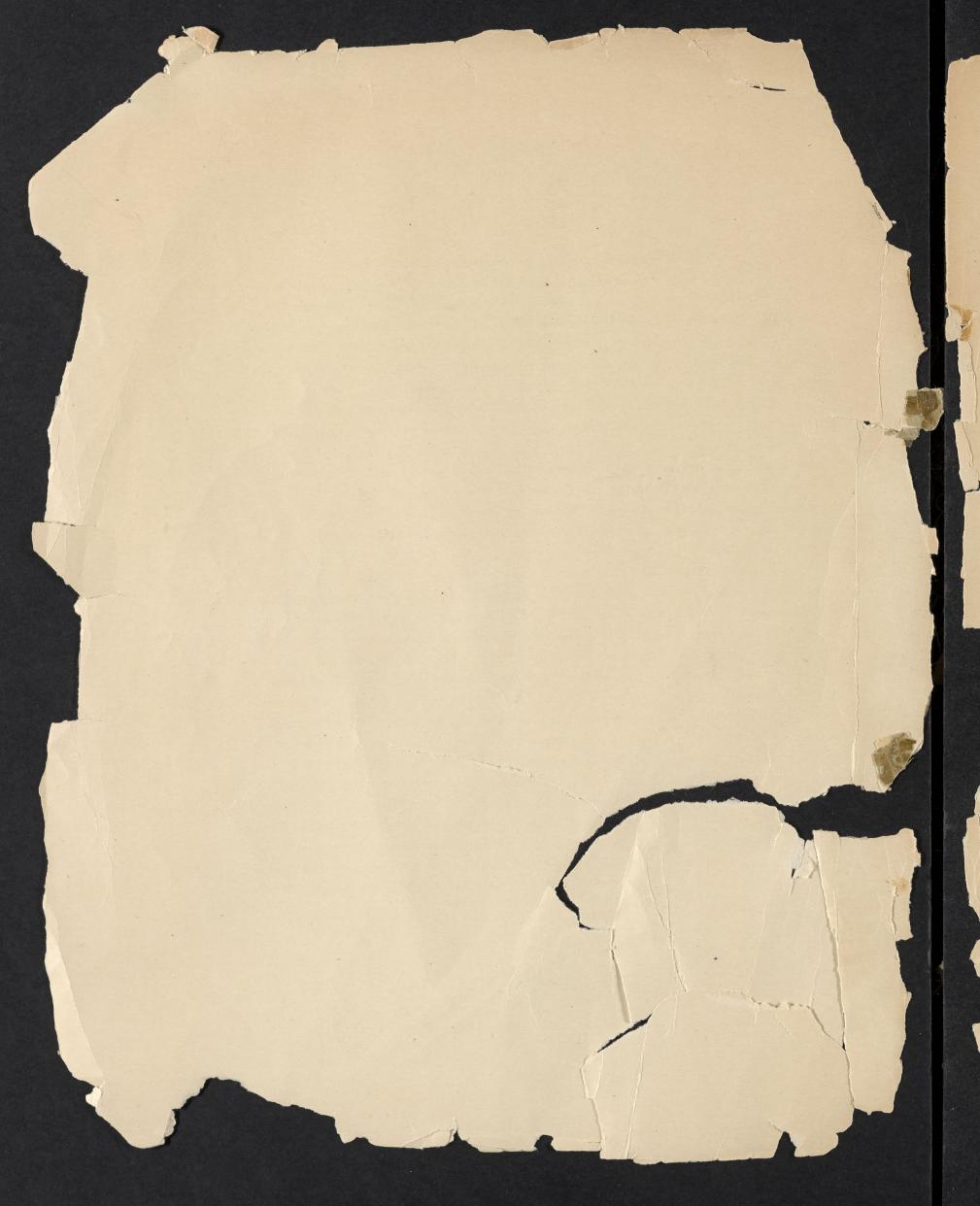
THE SALMON FAMILY. PART 1. - THE TROUT OR CHARRS.

BY WILLIAM CONVERSE KENDALL, Scientific Assistant, United States Bureau of Fisheries.

WITH SEVEN PLATES.

BOSTON:

PRINTED FOR THE SOCIETY WITH AID FROM THE GURDON SALTONSTALL FUND. JULY, 1914.



# PREFACE.

In compliance with an invitation from the Boston Society of Natural History, the present writer undertook the task of monographing the fishes of New England. The author agreed with the Society that it was best to issue the monograph in the form of parts, each comprising a small group of the fishes, as for instance, one family, or the species composing one or more genera. The New England trouts or charrs, coming nearest to meeting the requirements of time, convenience, and opportunity, were selected as the subject of Part 1. Of the freshwater species, these are the forms for which New England is most famous.

The natural fish fauna of New England is not rich in species compared with that of some other parts of the United States, but it does not conform to Agassiz's interpretation of it, except in the absence of some forms. Agassiz wrote:<sup>1</sup> "In this isolated region of North America, in this zoological island of New England, as we may well call it, we find neither Lepidosteus, nor Amia, nor Polyodon, nor Amblodon, nor Grystes, nor Centrarchus, nor Pomoxis, nor Ambloplites, nor Calliurus, nor Carpiodes, nor Hyodon, nor indeed any of the characteristic forms of North American treshwater fishes so common everywhere else, with the exception of two Pomotis, one Boleosoma and a few Catostomus,"

New England is not isolated even in its fauna but it lies on the outskirts of the faunas of some other States of the union. Since the days of Agassiz, through discovery, many more species have been added to the list, and of those mentioned as so common to the rest of North America, some are of more restricted geographical distribution than most of the species composing the New England fish fauna. Polyodon, for instance, is found only in the Mississippi Valley. One of the New England charrs (Salvelinus namaycush) occurs through the Great Lakes to Montana, British Columbia, and Alaska, and north to the Arctic Ocean. Agassiz did not name those that were common to New England and to some of the other States, as well as Canada, or those so common in New England and Canada and so scarce in the center of abundance of the genera enumerated by him. The fauna, especially of the fresh waters, is in every way much like that of New Brunswick, Nova Scotia, and Quebec south of the St. Lawrence River, and to some extent similar to almost all of eastern Canada extending to Hudson Bay. In fact, with New Brunswick and Nova Scotia, it is practically a southern extension of eastern Canadian fauna. Particularly in the northern parts of Maine, New Hampshire, and Vermont, it partakes of the character of the fauna of the Great Lakes and St. Lawrence River. There is a well marked dividing line in the Green Mountains of Vermont which excludes some of the Great Lakes

<sup>1</sup> Agassiz, L. Amer. Journ. Sci. and Arts, ser. 2, vol. 17, p. 364, 1854.

(3)

forms, or more particularly Lake Champlain species, from the region east of the mountains. But there are species common to the two regions, as well as distinct species in each.

Of the representatives of the southern extension of Canadian fauna, the charrs are the most common and characteristic. The Common Trout (*Salvelinus fontinalis*), while it has not so wide a distribution as the Lake Trout, is the most common form within its range, particularly in New England. The remainder of the charrs in New England seem to be restricted to but few localities and these somewhat isolated and remote from each other and from the northern region where related forms are more commonly distributed. They probably are the remains of a once more general distribution, having vanished from all but the present localities owing to unfavorable changes in the conditions. However, other localities in New England may yet reveal them, for it was only within a comparatively recent time that some of the forms were discovered. These forms are so closely related to other nominal species that they may be considered as one group whose geographical distribution encircles the northern hemisphere limited on the north only by the perpetual polar ice.

The beneficence of the Trustees of the Bache Fund made the illustrations of this part possible, for which the author here desires to express his grateful appreciation. The paintings were made by the painstaking artist, Walter H. Rich, of Portland, Maine, of whose work the only possible criticism is that it is too conscientiously true to life.

WASHINGTON, D. C.

December, 1913.

# THE SALMON FAMILY — SALMONIDAE.

e.

As at present restricted, the salmon family is not large but comprises some of the most highly esteemed game fishes and commercially valuable food fishes. The family is peculiar to the northern part of the northern hemisphere, in both salt and fresh water. Species of some of the various genera regularly enter the sea, some more or less irregularly, and others not at all. There are probably few, if any, species that would not go into salt water if it were conveniently accessible. The most valuable species commercially attain most of their growth in the sea and enter fresh water for reproduction only. The Pacific Salmon of the genus Oncorhynchus breed but once in a lifetime. The family is of recent geological origin as indicated by its structure, and very few fossils have been observed. Jordan says, in A Guide to the Study of Fishes : "Fragments of fossil trout, very imperfectly known, are recorded chiefly from Pleistocene deposits of Idaho, under the name of *Rhabdofario lacustris*. We have also received from Dr. John C. Merriam, from ferruginous sands of the same region, several fragments of jaws of salmon, in the hook-nosed condition, with enlarged teeth, showing that the present salmon-runs have been in operation for many thousands of years. Most other fragments hitherto referred to Salmonidae belong to some other kind of fish."

# CHARACTERIZATION.

No one of the external or internal structures usually enumerated as the chief characteristics of the salmon family will alone distinguish it. It is only by combinations of them that some other forms are excluded. Opinions vary regarding the value of the combinations and a satisfactory classification depends upon a thorough knowledge of the comparative anatomy of salmonoid and related fishes. From external structures alone, one might more consistently exclude the whitefish and admit the grayling and the smelt into the salmon family than to accept the present arrangement.

The osseus structures, especially of the head, afford the most dependable differential characteristics, but sometimes even these must be used in combination with other structures. Within the family the same conditions apply in the separation of other groups as subfamilies, genera, subgenera, and species.

In A Guide to the Study of Fishes, Jordan says: "The series or suborder *Salmonoidea*, or allies of the salmon and trout, are characterized as a whole by the presence of the adipose fin, a structure also retained in Characins and catfishes, which have no evident affinity with the trout, and in the lantern-fishes, lizard-fishes, and trout-perches, in which the affinity is very

-

remote. Probably these groups all have a common descent from some primitive fish having an adipose fin, or at least a fleshy fold on the back."

He gives the following as the chief external characteristics common to the members of the salmon family: "Body oblong or moderately elongate, covered with cycloid scales of varying size. Head naked. Mouth terminal or somewhat inferior, varying considerably among the different species, those having the mouth largest usually having also the strongest teeth. Maxillary provided with a supplemental bone, and forming the lateral margin of the upper jaw. Pseudo-branchiae present. Gill-rakers varying with the species. Opercula complete. No barbels. Dorsal fin of moderate length, placed near the middle of the length of the body. Adipose fin well developed. Caudal fin forked.<sup>1</sup> Anal fin moderate or rather long. Ventral fins nearly median in position. Pectoral fins inserted low. Lateral line present. Outline of belly rounded. Vertebrae in large numbers, usually about sixty."

The salmon family as now restricted consists of two well distinguished subfamilies: the Coregoninae, comprising three genera: Coregonus, Leucichthys, and Stenodus; and the Salmoninae in this country, also consisting of three genera: Oncorhynchus, Salmo, and Salvelinus. The subfamilies are thus superficially distinguished:

*Coregoninae:* mouth not deeply cleft; maxillary broad; mandible articulating with quadrate bone under or before the eye. Dentition more or less feeble or incomplete; scales moderate or large; anal fin rather long.

Salmoninae: mouth deeply cleft, the long lower jaw articulating with the quadrate bone behind the eye; maxillary rather narrow. Dentition strong and complete; conical teeth on jaws, vomer, and palatines; tongue with two series of strong teeth; scales small.

Anatomical characteristics of the Salmoninae.— Skeleton: the ossification of the skeleton is comparatively feeble; cranium mostly of an almost continuous cartilaginous capsule with separate bony coverings; occipital ridge short, terete, extending to the process of the epiotic and pterotic bones. Large posterior oculo-muscular canal penetrating the occipital region behind, covered below by the strongly bent parasphenoid and centrally divided anteriorly by Y-shaped basisphenoid; pharyngeal process wanting; orbits internally separated by a thick cartilaginous wall and the alisphenoid bones. Maxillaries elongate, strongly toothed, articulating in front with the rostro-ethmoidal cartilage between the pairs of premaxillaries, by which they are covered below, and palatines respectively; premaxillaries short, furnished with teeth as are the palatines. Supplementary maxillary present; vomer situated mesially of the under surface of the rostro-ethmoidal cartilage and anterior extremity of the parasphenoid, more or less furnished with teeth. Pterygoid slender, curved to unite the palatines and quadrate bones. The greater part of the roof of the mouth, formed by the broad, thin mesopterygoids. Branchiostegals 8 to 16.

<sup>1</sup> Not common to the family; to some genera and species only, except in the young.

### THE SALMON FAMILY.

Vertebral column: neurapophyses cartilaginous to which the neural spines are united merely by suture or mobile articulation, and loosely to each other, anteriorly right to left in each vertebra and posteriorly to the diapophysis. Neurapophyses disappearing posteriorly, replaced by the bases of the neural spines and connected to the vertebrae by firmer ossification, the spines of each vertebra coalescing; diapophyses decreasing and disappearing in the zygapophyses near the caudal region. The haemapophyses, scarcely evident on the first vertebrae, knob-like on the second; and from the third, each furnished with a rib, progressively increasing and ending on the caudal region in a succession of haemal spines, each bearing a pair of ribs on the posterior upper surface and approaching each other above to form on about the six last abdominal and the caudal vertebrae a closed haemal arch. On the haemal-spine-bearing vertebrae besides the upper are similar lower articular processes. Ribs very slender.

Shoulder girdle: clavicle broad and thin; upper arm comparatively short and the posterior consisting of three or four parts, *i. e.*, two or three upper, thin and flat, and one lower, pointed, rib-like.

Pelvis: bones simple, triangular, without notch in front and posterior process rudimentary.

Intestinal canal: simple and comparatively short, stomach normally siphonal; pyloric and duodenum provided with numerous coeca, directed forward. Coeca varying greatly in number in different genera and species; near the diaphragm the intestine abruptly turning backward and extending straight to the vent.

Liver: right lobe very small, left large; duct of the large gall bladder opening into the duodenum near the pyloric end of the stomach.

Spleen: large except for some time following the spawning function.

Kidneys: kidneys lying along nearly the whole length of the vertebral surface of the spinal column, penetrating to some distance into the haemal canal of the tail.

Testes: furnished with vasa deferentia.

Ovaries: have no special oviduct opening directly into the genital aperture, but a sort of a funnel formed by a fold of the peritoneum, with a slit-like aperture of greater or less extent at the posterior portion.

Air bladder: the pneumatic duct opens on the dorsal side of the oesophagus.

Recent ichthyological literature at present recognizes six living genera of Salmoninae: Oncorhynchus, Salmo, Hucho, Cristivomer, Salvelinus, and Plecoglossus. Of these, four occur in North America. The present paper, for reasons hereinafter presented, reduces the number of North American genera to three — Oncorhynchus, Salmo, and Salvelinus. They are distinguished as follows:

Oncorhynchus: anal fin comparatively long, of 14 to 17 developed rays; vomer narrow, long, flat, with weak teeth; Pacific species breeding but once in a life time and dying soon after spawning.

Salmo: anal fin short, of 9 to 12 rays, vomer flat, its toothed surface plane; teeth on shaft of vomer directly on surface of bone.

Salvelinus: vomer boat-shaped, the shaft strongly depressed, without teeth, the teeth confined to the head or chevron which is more or less prolonged backward, free from the shaft; scales comparatively small.

# THE CHARRS — SALVELINUS.

While most American ichthyologists include all but one or two of the charrs in the genus Salvelinus, most recent European authorities still regard them all as belonging to the genus Salmo, or admit them as a subgenus Salvelinus. The character of the vomer, however, should be regarded as a good generic distinction, especially as there are other well marked differences.

Generically, the charrs are of extended geographical distribution, occurring in many lakes and streams throughout Arctic Europe, Asia, Spitzbergen, Iceland, Greenland, and Arctic America, extending southward at the higher altitudes to the British Isles and Italy at least; the northern United States, in the Appalachian Mountains to Georgia and Alabama; on the west coast to northern California and correspondingly on the western Pacific shores to Japan. Wherever they occur, unless depleted by man, they usually abound. Formerly in Europe, many nominal species were recognized which later Von Siebold and Agassiz were inclined to consider as local variations or races of one comprehensive species. Now, ichthyologists as a rule regard them mainly as one species, *Salvelinus alpinus*. Smitt, however, indicates that there are two well marked sub-forms of "*Salmo umbla*" characteristic of different altitudes: *S. alpinus*, representing the higher altitudes and northern latitudes; *S. salvelinus*, lower altitudes and more southern latitudes, these also showing in each group local races and forms.

Among those recognizable as charrs, Linnaeus (Syst. Nat., ed. 10, 1758) names four species under the genus Salmo: — "Alpinus, Habitat in Lapponiae, Angliae alpibus, solus; Salmarinus, Habitat Tridenti in fluviis frigidis saxosis; Salvelinus, Habitat in Austria ad Lintz; Umbla, Habitat in Helvetiae, Italiae lacubus."

Subsequent writers have more or less confused the synonymy, but of these Linnaean species, S. alpinus and S. salmarinus are probably the same, and S. salvelinus and S. umbla undoubtedly identical.

According to Smitt the following characters distinguish the two forms of European charrs:

a. Distance between the ventral fins and the tip of the snout more than half the length of the body.

S. salvelinus.

b. Distance between the ventral fins and the tip of the snout less than half the length of the body.

S. alpinus.

### THE CHARRS — SALVELINUS.

Smitt says that in Scandinavia and the rest of Europe to the south, the charrs strictly belong to the mountain lakes, and hardly ever take up their abode in running water. In the Arctic regions south to northern Helgoland in Norway, they are marine, and like the salmon ascend rivers to spawn. In Greenland and the coast of Arctic North America, and as far south at least as the Gulf of St. Lawrence and Oregon and in Kamtschatka, they have similar habits.

The charrs of North America comprise two species peculiar to that country and several nominal species closely related to, if not identical with, the charrs of Europe. In 1780, Fabricius (Fauna Groenlandica) mentions or describes four species, S. alpinus, S. carpio, S. stagnalis, and S. rivalis. These have been reduced to one, some considering them S. alpinus, others as S. stagnalis. Most American writers refer to the Greenland charr as S. stagnalis. Richardson described several species from farther west, the proper status of which in classification is uncertain. Later, Günther described two small Arctic charrs, one of which was reputed to be the most northern locality for a salmonid known. The Peary party, however, collected some in the outlet of Lake Hazen, still further north.

Smitt recognized a S. stagnalis form but it is a question where one species of Arctic charr begins and where it leaves off in its geographical range, and whether or not they all should not be considered forms of S. alpinus. H. R. Storer described a sea-run charr of Labrador as Salmo immaculatus. By American ichthyologists this was subsequently relegated to the synonymy of Salvelinus fontinalis. Lately, however, it has been shown to be the S. stagnalis form. For convenience in distinguishing the S. alpinus-like charrs and the other two mentioned as peculiar to America, the former will henceforth be referred to as the saibling group, a modification of the German name for one of the European charrs, or alpinoids. No species of this group were described from any locality in America south of the Arctic regions prior to Storer. None afterward was discovered until Girard brought to the attention of scientists the Blueback of Rangeley Lakes, Maine. Since then three species have been described from New England and Canadian waters.

Southward these saibling forms exhibit the peculiarity mentioned by Smitt as possessed by the European fish, to the effect that a singular feature in its geographical range was its occurrence in certain lakes, and absence from others situated near them and apparently of the same nature.

The habits of these American saibling are essentially like those of their European congener. They are what may be termed deep-water fishes, at least in the southern part of their geographical range; and occur in shallow water, as a rule, only when the water is cool, principally in the fall breeding time and in early spring. Occasionally in summer one may be seen at the surface in early evening or on a cool, cloudy day, but it apparently does not remain there long. Such appearances at the surface seem to be on account of insects upon which the fish occasionally feeds.

Deep water in New England is affected undoubtedly on account of its coolness, as in the far north the fish are found not only in shallow lakes but in streams. The saibling of the far north and as far south as southern Labrador, the Quebec side of the Gulf of St. Lawrence and Newfoundland, in common with the "brook trout," has sea-run forms, as have the saiblings (S. *bairdii* and S. malma) of the Pacific. In fact, in those regions they are best known as "sea trout."

That the "sea-running" habit is not possessed by the more southern forms is easily accounted for by the remoteness of their habitats from the sea and the obstructions in the waterways.

The food of the different forms varies according to locality and size of the fish. In localities where fish are suited to their maw and taste such fish form their principal sustenance. They feed to some extent upon insects, especially the larval or aquatic forms.

The breeding habits also vary, as they do in the European saibling. Some forms ascend streams in the fall to spawn, others spawn upon shoals in the lakes.

# THE NEW ENGLAND CHARRS.

As has already been mentioned, the species of charrs are difficult to distinguish, but in the dim light of present knowledge it seems best to recognize those differences, however slight, if they appear constant, as of specific value, and await future light to establish its correctness. Adopting this view there are then, at present, five known species of charr in New England waters: Salvelinus namaycush, S. fontinalis, S. agassizii, S. oquassa, and S. aureolus. Of these, the first one is structurally and in other ways somewhat farther removed from the rest than the latter are from one another.

As indicated in the synonymy, Gill and Jordan distinguish the Great Lakes Trout from the Salvelini by the form of the vomer and situation of the vomerine teeth,—"a raised crest behind the head of the vomer and free from its shaft, armed with teeth." This form of vomer is not peculiar to the lake trout, but occurs not infrequently in other charrs, at least in the alpinoid group. The present writer has compared vomers of *S. stagnalis* and *S. aureolus* as well as *S. fontinalis* with typical "cristivomer" from the Lake Trout. Compared with *S. fontinalis*, the difference might be recognized, but Arctic and Labrador charrs show all sorts of forms passing from those characteristic of *S. fontinalis* to the form with the crest prolonged behind and furnished with teeth. A specimen from Labrador and a specimen from Flood's Pond, Maine, show each absolutely and exactly the formation of the lake-trout vomer, and the crest of each of the three was attached to the bottom of the boat-shaped shaft by a thin bony septum. While the genus cannot be distinguished by the character of the vomer, the fish presents characters

# LAKE TROUT.

that may possibly admit it as a subgenus, and upon investigation some other skeletal characters may be found to establish its generic rank.

In Fishery Industries Goode remarked: "It would perhaps seem like a hasty generalization to point to *Salvelinus fontinalis* as the form from which the lake trout has developed, but one may fairly take into consideration the fact that this species alone, of all the Salmo group, is usually associated with the fish under consideration, occupying the streams that flow into the lakes of northeastern America, and frequently entering these lakes. That *fontinalis*, even when retaining its predilections for the streamlets, shows tendency to extraordinary growth, when ample waters like the lakes of Maine or the lower stretches of the Nepigon, are accessible, is also known."

The skeleton of the togue appears to be more perfectly ossified than in the rest of the Salmonidae. This with its forked tail at all ages and the same character in the young of other charrs suggests that the Lake Trout may be an independent divergent of some older common forked-tailed stock rather than a derivative of any of the other charrs. It is nearer to the alpinoid charrs than to *S. fontinalis*, as is, partly at least, indicated by the presence of teeth on the basi-branchials.<sup>1</sup>

Of the five New England species of charrs S. *fontinalis* is of the widest and most common distribution. The Lake Trout comes next and the others occur in only more or less isolated instances, so far as known. Such peculiarity of occurrences has been noted by European ichthyologists in the distribution of the charr in some continental countries and in the British Isles.

#### SYNONYMY.

Salvelini Nilsson, Propr. Ichth. Scand., p. 7, 1832 (alpinus); (group name).

Salvelinus Richardson, Fauna Bor. Amer., vol. 3, p. 169, 1836 (alpinus); after Nilsson.

Baione Dekay, N. Y. Fauna, Fishes, p. 244, 1842 (fontinalis).

Umbla Rapp, Fische Bodensee, p. 32, 1854 (umbla = salvelinus).

Cristivomer Gill and Jordan, in Jordan, Manual Vertebrates of eastern U. S., ed. 2, p. 356, 1878, (namaycush).

#### LAKE TROUT.

#### Salvelinus namaycush (WALBAUM).

# PLATES 1, 2.

The name used above is the most distinctive one in general use for this fish as it is primarily and almost exclusively a lake trout. Other strictly New England names are togue, silver laker

<sup>1</sup> The bones have been incorrectly called hyoids or hyoid bones in most fish literature. Comparative anatomists name no hyoid bones but describe a hyoid arch which is composed of a number of bones bearing different names. The teeth referred to are not on the bones composing this arch. The "basi-branchials" are by some anatomists called "corpula."

and silver lake trout in Maine; laker and lunge in New Hampshire, and lunge in Vermont. Salmon trout is more or less common to the three States as well as elsewhere. In the Great Lakes, trout and Mackinaw trout are of local use. Gray trout is essentially a book name. Red trout and black salmon are said to be sometimes applied to it. Touladi is a name which in most fish books is said to be in use in Maine and to be derived from a lake of that name. As a matter of fact the name of the New Brunswick lake is derived from the Micmac Indian name of the fish. Namaycush or namecoos is applied to it by the Nepigon, Cree, and Labrador Indians.

The Lake Trout is of wide northern distribution extending from the Atlantic to the Pacific and to the Arctic Ocean. It is common in the Great Lakes and northward, and occurs sparingly in Idaho, the Frazer River basin, British Columbia, and in Alaska. Of the New England States it occurs naturally only in Vermont, New Hampshire, and Maine. Aside from Lake Champlain and Memphremagog, it is found in but a few localities in northern Vermont. In 1842, Thompson<sup>1</sup> said: "This fish was formerly common in Lake Champlain and in several ponds in the western part of the state, but like the salmon, it is now rarely caught in those waters. It is, however, still found in considerable plenty in several ponds in the northern part of Vermont, particularly in Orleans county. Bellwater pond in Barton, and several ponds in Glover, Charleston, &c., are much celebrated on account of the fine longe which they afford."

Evermann and Kendall<sup>1</sup> record it from Lake Champlain, Lake Memphremagog, Caspian Lake, Dunmore, Willoughby, and Maidstone.

The New Hampshire Fish Commissioners' Report for 1892 states that the fish was indigenous to only six lakes in New Hampshire, *viz.*, First and Second Connecticut Lakes, Squaw Lake, Winnipesaukee Lake, including Winnisquam, Newfound Lake, and East Pond in Enfield. The report also adds that it is said to have once been plenty in Maocoma Lake but none had been caught there for many years and it is supposed to have become extinct. In 1792, Belknap<sup>1</sup> said that in some of the bays of "Winipisogee" Lake and River, very large trout are taken with the hook. In New Hampshire, as well as in other New England States, its distribution has been extended by fish culture. A few have been found in Sunapee Lake, probably accidentally introduced.

In Maine, with the exception of a few isolated localities, the natural distribution of the togue seems to be restricted to certain waters of the Kennebec basin and the region to the northward and eastward. The report of the State Fish Commissioners for 1867 refers it generally to lakes of the Upper Kennebec, Penobscot, St. John's, and St. Croix systems, and especially to Thompson Pond in Poland, Wilton Pond in Wilton, and Tunk Lakes in Hancock County. Thompson Pond is one of the two or three instances and perhaps the only occurrence in the Androscoggin waters. It has been recorded from no other waters in Maine west of the Androscoggin. Its distribution in the basins where it is more common possesses peculiar exceptions.

<sup>1</sup> See synonymy.

# LAKE TROUT.

Hamlin<sup>1</sup> called attention to a "singular hiatus" in the distribution of this salmon that he said he was unable satisfactorily to explain. That was, why certain lakes connected with each other do not contain the fish. For instance, Phillips Lake in Hancock County contains the togue, while Green Lake, of equal depth, and connected with Phillips, but of lower altitude, does not. The little lakes tributary to Sebec Lake contain togue of great size but Sebec Lake. of greater size and greater depth of water, does not contain them. It would seem from this fact that the fish requires a certain altitude for its existence, but Phillips Lake is probably of less height above sea level than Sebec. The togue is indigenous to Moosehead Lake and a few smaller lakes in the Kennebec basin. It occurs in most of the larger lakes of the Penobscot, St. John's, and St. Croix systems, but in many smaller bodies of water connected with them it is absent. Kendall<sup>2</sup> records Hurd Pond, of the west branch, and Matagamon and Webster Lakes. of the east branch of the Penobscot; Telos, Chamberlain, Eagle, and Churchill Lakes of the Allagash branch of the St. John's; Beau and Glasier Lakes of the St. Francis, and Eagle Lakes of the Fish River, branches of the St. John's in Aroostook County. He also collected or observed it in Debsconeag Lake, of the west branch of the Penobscot, Grand Lakes, of both the east and west branches of the St. Croix. To all of these it was probably indigenous. It has, as previously stated, been spread by fish cultural distribution and later records may be results of such dissemination. The higher altitude theory of Dr. Hamlin will not account for the peculiarities, for it is found in Thompson Pond in western Maine at a considerably lower altitude than the Rangeley Lakes in the same river basin where it does not occur. It may be one of those disappearing forms of once more general distribution lingering only in waters where the conditions continued more favorable than in the others. In those waters, therefore, in which more nearly pristine conditions obtain, the fish retains the form and good physical condition of the typical Lake Trout. In others of less favorable conditions, the fish is perhaps deteriorating and producing the lean, black, parasitized, ill flavored forms. At any rate, New England contains only the southern fringe of its geographical range, and, with a few exceptions, the localities of its occurrence in New England suggest a St. Lawrence origin.

#### HABITAT.

The Lake Trout is essentially an inhabitant of the deep and cool, and usually of the larger, lakes wherever it occurs. In those waters, it frequents the deep water, especially in the summer time, approaching the shore and shoals at times for food and in the fall for spawning. This pertains particularly to the southern portion of its range. Preble<sup>3</sup> says: "Being partial to

<sup>1</sup> Maine Sportsman, see synonymy.

<sup>2</sup> See synonymy.

<sup>3</sup> E. A. Preble: A biological investigation of the Athabaska-Mackenzie region. North Amer. Fauna, no. 27, p. 510, 1908.

clear, deep water, it is seldom found in the main rivers, although when these become clear, as is sometimes the case in autumn, numbers of trout find their way thence from the lakes."

Hamlin stated (l. c.) that in his original description of the fish, he held that it was to be found only in waters of great depth, "and so it was believed at the time, but it seems there are exceptions, for the *toma* is found in Portage Lake, which is not over thirty feet in its greatest depth."

# FOOD.

Most of those who write concerning the feeding habits of the Lake Trout are united in the asseveration that it is a "ravenous feeder." Goode states 1 that it was found preying upon the cisco, a well known fish closely resembling the whitefish. He said that it was not uncommon for a trout to swallow a fish nearly as large as itself. He cited an instance where one 23 inches long contained a "lawyer" (Lota maculosa) which measured about seventeen inches. The fishermen of Port Huron informed Kumlien that it was not unusual to obtain whitefish two or three pounds in weight from the stomachs of large trout. "A twenty-pound trout was found to contain thirteen lake-herring and was caught biting at the fourteenth. They are as omnivorous as a codfish, and among the articles which have been found in their stomachs may be mentioned an open jack-knife, seven inches long, which had been lost by a fisherman a year before at a locality thirty miles distant, tin cans, rags, raw potatoes, chicken and ham bones, salt pork, corn cobs, spoons, silver dollars, a watch and chain, and in one instance a piece of tarred rope two feet long. In the spring wild pigeons were often found in their stomachs. It is thought that these birds frequently became bewildered in their flight over the lakes, settle on the water, and become the prey of the trout." (Here is a factor in the extinction of the wild pigeon that the ornithologists have not taken into account.)

Adams<sup>2</sup> says it repairs to shallows to feed on trout, smelts, and the like. Indeed, the last named fish would appear to constitute its favorite winter subsistence. It preys extensively, also, on eels and cyprinids, and is, in fact, a tyrant with an appetite so voracious that quantities of twigs, leaves, and fragments of wood are constantly found in its stomach.

Hamlin writes in Maine Sportsman (l. c.) that the togue is a nuisance in all lakes where the landlocked salmon occurs, and ought to be exterminated if the salmon is to be protected, for it is a most voracious eater and requires many fish to supply its appetite. A six-pound togue caught at Moosehead by General Locman, of New York, a few years ago, yielded, among the contents of its stomach, 115 little whitefish which it had caught within twelve hours. Besides these distinct fish there were a dozen more partly decomposed. The editor's note said: "This seems like a story that a fish of the size mentioned could contain, undigested, this number of

<sup>1</sup> Fishery Industries, sec. 1, p. 490, 1884.<sup>2</sup> L. Adams: Field and Forest Rambles, 1873.

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small fish in its stomach and still be voracious enough to seize the bait on the troll. As a matter of fact the editor of the Sportsman was present and aided in the counting of the fish, and can vouch for the accuracy of Dr. Hamlin's statement."

A correspondent of Forest and Stream of October 30, 1890, in an article entitled "Lake Trout Notes" says: "The voracity of the species may be appreciated from the fact that fiftynine smelts have been found in a 7 lb. individual caught at Bristol, N. H. Last winter at Winnesquam Lake a  $17\frac{1}{2}$  lb. fish, caught through the ice, had in its stomach a pebble about as big in circumference as a copper cent, and an entire, very rusty fish hook."

The present writer's notes contain mention of two togue weighing 3 and  $3\frac{1}{2}$  pounds, respectively, caught in Telos Lake, September 20, 1901, the stomachs of both of which contained only large quantities of sticklebacks (Gasterosteus). Another 5-lb. female caught in the river pool below Chamberlain Lake dam September 23, contained also some sticklebacks; another 5-lb. male, caught in Chamberlain Lake, September 25, contained a chub (*Semotilus bullaris*) about 5 inches long and a lot of sticklebacks, besides a piece of bark. A 4-lb. fish caught September 26, in Eagle Lake, contained many sticklebacks and one partly digested cyprinid. Three small togue caught in the same lake September 28 were full of sticklebacks and one contained two other fish, perhaps chubs. In 1902, May 25, at Moosehead Lake, a  $6\frac{1}{2}$ -lb. togue caught by trolling with shiner bait at the surface contained many dipterous insects resembling winged ants in size and appearance. Two *S. fontinalis*, one of 3 lbs. and one of 1 lb., caught at about the same time and in the same way were gorged with the same kind of insects, which were very abundant, having fallen upon the water.

# BREEDING HABITS.

The Fishery Industries states that in the spawning time they approach the shore, but do not ascend the rivers, and although they are known to exist in a few inland lakes, connected with the main lakes by rapids, there is no record of their having been seen or taken in the outlets. The localities selected by the trout for their spawning are usually rock bottoms in from fifteen fathoms to seven feet of depth.

They begin to spawn in the latter part of October in the Great Lakes region. Farther north they seem to begin a month or so earlier. In New England the season varies somewhat but does not differ much from that of the Great Lakes region. Not much seems to have been learned regarding its spawning habits and life history. Milner reported that a female of 24 pounds carries about 14,943 eggs. The fish is said to reach maturity at about three years of age, and as usually taken contains at that time not over 5,000 or 6,000 eggs, or about 1,000 to the pound of fish.

The eggs hatch in the spring when the water begins to warm. The Fishery Industries, quoting from Milner, says: "Of the habits of young trout I am entirely destitute of information.

I have seen one of eight inches of length and I learn of rare instances in which the fishermen have seen smaller ones."

Kendall and Goldsborough<sup>1</sup> mention that on July 16 and 18, 1904, in a spring rivulet, tributary of and not far above the mouth of the main inlet of the First Connecticut Lake, several young 2.08 to 2.37 inches long were caught and on August 10, in Alder Brook, tributary to the lake, four measuring 1.87, 2, 2.06, and 2.08 inches in length respectively were taken. Their stomachs contained insect eggs, Chironomus larvae, fragments of insects and mosquitoes. From these occurrences it would seem that like other Salmoninae the young resort to shallow water and when possible to little brooks.

# MOVEMENTS.

As previously stated, the Lake Trout inhabits deep water during the warm months but even in those months it approaches the surface at times, especially in the first of the evening, and in the early fall is often observed at the surface basking in the sun or lazily swimming about with dorsal fin above water. Hamlin (l. c.) mentions this fact, saying: "Three years ago, while steaming slowly over Moosehead Lake, when the water was perfectly calm, my Indian guide called my attention to three great togue sunning themselves on the surface, with their dorsal fins projecting out in the sunshine, like the swordfish or basking shark. A short distance beyond passed four more togue, sunning themselves in the same manner."

On September 6th, 1901, the present writer saw many large togue "rising" in Matagamon Lake, and on September 14th, several were seen at the head of Webster Lake swimming about with dorsals out of water. On the 15th, large togue were observed rising at the mouth of Thistle Brook, which flows into Webster Lake, but they would not take a fly or bait.

# FOOD QUALITIES.

In the Great Lakes the Lake Trout is of considerable commercial importance as a food fish. In regard to it as a food, tastes differ, and the same taste differs at different times and with different fish. King said of the Arctic fish that when in good condition it yielded much oil, the flesh appearing reddish or orange colored but getting paler as it went out of season, but at all times the stomach when boiled was a favorite morsel with the Canadian voyageurs. Preble (1908) states that they are caught in large numbers and furnish a rich and nourishing food, but cannot be eaten steadily, as they soon pall upon the appetite. In New England, by some the togue or lunge is regarded with favor, by others held in ill repute as a food fish. This is due, as previously suggested, to the difference in the fish and the season of the year. The

<sup>1</sup> Fishes of the Connecticut Lakes. Bureau of Fisheries Doc., no. 633, p. 52, 1908.

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present writer's experience with the togue was one that prejudiced him against it. But the fish was a long, gaunt, dark-colored September "racer" of Telos Lake. When the fish was boiling it smelled like scalded chicken feathers and its flavor was about as it smelled. The odor and flavor were doubtless due to the oil in the fish, particularly that fat immediately beneath the thick tough skin. However, his prejudice was removed by boiled togue with mayonnaise sauce served at a summer camp in May at Moosehead Lake. The season was different, the fish was different, likewise the cooking and the way it was served. All of these things obtain with almost any fish.

The plump, fat silver lakers of some waters have a red or reddish-yellow flesh. Others are more or less white-meated. The red-meated fish are regarded as the better flavored. It is the oiliness of the fish that causes it to pall upon the appetite.

# GAME QUALITIES.

As a game fish it is also held in various esteem. The Fishery Industries says the togue or lunge of our northeastern boundary is held in much higher favor by the angler than farther west. Its game qualities consist wholly in strong dogged resistance. It is not particularly rapid in its movements and never leaps from the water. In the spring and early summer and in some localities occasionally throughout the summer, it is usually taken by trolling with natural or. artificial fish bait at or near the surface. During the summer it is sometimes taken at baited places by deep-water still-bait fishing. It has the reputation of not rising to the fly. Hallock states that the young rise freely to the fly in rapid water. In the Maine Sportsman previously referred to, Hamlin says: "A few years ago a big togue rose to within a foot of the surface and seized my fly, which had sunk a few inches below the surface of the water. The togue behaved much like trout and I didn't suspect the fish to be otherwise until I landed it." The present writer caught a 5-lb. togue on a brown-hackle trout fly in a pool below the Chamberlain Lake dam. It behaved much like a Brook Trout and it required much care to keep it from submerged logs and timbers of the dam in the half hour it took to land it.

In Forest and Stream of May 10, 1902, E. D. T. Chambers wrote: "A seventeen-pound lake trout (*Salvelinus namaycush*) was captured in Lake St. Charles, near this city (Quebec) a few days ago by an angler using a rod and short line with minnow bait. While it is not, of course, unusual for the lake trout to take the minnow bait, it is very seldom that it is taken so near the surface of the water as upon this occasion. Except in the earliest days of spring and in far northern waters, namaycush is a resident of very deep water, and as most anglers very well know, it is usually to be had only by deep water trolling. Yet there are instances on record where it has taken the angler's flies. One of these occurred a few years ago in the same Lake St. Charles to which reference has already been made. Mr. Lacon Walsh, of this city, noticed

that swarms of minnows were leaping out of the water together at some distance from where he was fishing, and rightly assuming that they were fleeing from some powerful foe, he cast his flies over the surrounding water and was fortunate enough to hook a rising fish of large dimensions. It was saved after a struggle lasting nearly fifty minutes, and was found to be a lake trout of sixteen pounds. On this occasion, as upon that mentioned above, the catch was made almost immediately upon the breaking of the ice, and it is rather surprising that more anglers do not cultivate the sport in question, though, of course, it can only be had for a few days each year, and even then only in comparatively high latitude. The late James W. Milner found that in Lake Michigan the 'lakers' remain in the deepest part of the lake all the year round except in the spawning season, which is usually about the end of October, so that fly-fishing for them thereabouts would be absolutely useless.

"There are very few instances on record where the lake trout has been taken on the fly in the earliest days of spring in both Grand and Moosehead lakes in Maine, but it is fully admitted that even in that latitude they are rarely taken with a surface line, more than three or four pounds in weight. In the always cold water of the Nepigon we have upon the authority of Mr. W. H. Vail, of Cincinnati, writing in 'Fishing with a Fly,' that *Salvelinus namaycush* will occasionally rise to the fly, and take it with much the same kind of a swirl as the speckled brook trout does."

#### SIZE.

The Fishery Industries states that it is the largest of the Salmonidae, according to tradition, attaining in the Great Lakes a weight of 24 and  $36\frac{1}{2}$  pounds. It is said that they were very frequently taken weighing 15 pounds.

Richard King (l. c.) wrote that in the Arctic regions it surpassed the Common Salmon in size, individuals having been captured weighing sixty pounds, and it was said to attain one hundred and twenty, although none came under his observation exceeding a weight of fifty pounds.

Preble remarks (1908) that in northern regions, in large bodies of water, Lake Trout frequently attain a weight of 50 pounds and occasionally a little more. In some New England lakes it reaches a considerable weight. In Vermont, Williams (History of Vermont, 1794) says that in a pond in Leicester, in that State, some have been taken which weighed twenty-five pounds. Thompson (History of Vermont, 1852) says: "They usually vary from half a pound to 10 pounds, but are often much larger. Individuals are said to have been taken recently in Glover weighing 25 pounds, and in Charleston exceeding 40 pounds." In Belknap's History of New Hampshire, 1792, the following appears: "In some of the bays of Winepisogee Lake and river very large trouts are taken with the hook. Those from 6 to 10 lbs. are common, and some have been caught of 20 lb. weight."

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Prescott (1851, see synonymy) says that in Winnepesaukee they are not infrequently taken weighing twelve to fifteen pounds. The largest reported to have been taken weighed twentyfive pounds. In May, 1889, one weighing 29 pounds and 9 ounces, measuring 3 feet in length, was reported from Newfound Lake, Laconia. In May, 1892, a 21-pound "lunge" and others from 6 to 10 pounds, were authentically recorded from the Connecticut Lakes the previous winter and one of 8 pounds in May. A 27-pound fish was recorded from Lake Paugus in 1906.

Regarding the Maine togue, Adams (1873) says: "The average weight of the togue is seemingly about nine pounds but this may not be altogether correct. I have seen individuals weighing fifteen pounds, and fishermen and Indians speak of having captured togues from twenty-five pounds to thirty pounds, and even forty pounds, in weight."

In 1905, H. W. Rowe, publisher and editor of the Maine Sportsman, stated that the largest togue or Lake Trout of which he had any knowledge was caught during the preceding spring in Cold Spring Pond, Enfield. He said that he saw the fish only after it was dressed and stuffed but it was a 'whopper,' and was alleged to have weighed 31 pounds when taken from the water, and  $24\frac{1}{2}$  pounds after having the entrails removed.

Records of the catches of togue in the Maine Sportsman from 1894 to 1908 show the following. The largest was taken in Moosehead Lake in 1897 and weighed 32 pounds. In the same lake, two of 25 pounds each were recorded in 1897 and 1907, respectively; one of 22 pounds was taken in 1908 and another of 21 in 1895. The other records ranged from 11 to 19 pounds. The next largest was the one previously mentioned of 31 pounds from Cold Spring Pond. One of 30 pounds, which measured  $35\frac{1}{2}$  inches in length, was caught in Munsungan Pond in 1899. One of 25 pounds was taken in Big Spencer Pond in 1908, and one of 24 pounds was caught in Schoodic Lake in 1897. No others reached 20 pounds, but they ranged from  $10\frac{1}{4}$  to  $19\frac{1}{2}$  pounds.

#### VARIATIONS.

The Fishery Industries says that every lake of northern New York and New England has its own variety, which the local angler stoutly maintains to be a different species from that found in the next township. Some are black, some brown with crimson spots, some gray with delicate reticulations like the pickerel. There is also a great variation in the proportions of fish not only from different waters but sometimes from the same body of water. The popular and scientific names which have been given to this species are due to the wonderful tendency to variation in size, shape, and coloration.

The Forest and Stream of October 30, 1890, says: "Mr. Walter Aiken has informed us that the lake trout in Winnipiseogee Lake, N. H., are usually long and lank fish, with flesh of a pale color and an inferior taste, yet the landlocked smelt, which is considered one of the best food species for the lake trout to feed upon, is abundant in the lake. In Newfound Lake, according

to Mr. Aiken, the lake trout are shorter and thicker and the flesh is more highly colored and has an excellent flavor."

In the Fishes of New York (Bull. N. Y. State Mus., no. 60, Zoology 9, p. 269, 1903), Bean remarks that Commissioner N. Wentworth, of Hudson Center, N. H., forwarded two New Hampshire Lake Trout, one from Newfound Lake, the other from Winnepesaukee. They were sent to determine whether the trout of the two lakes, which the fishermen assert are different species, really are distinct. The Commissioner wrote that "the Newfound fish has a darker flesh, more like the sea salmon. This is not caused by their food, as both lakes are alive with smelts. The Winnepesaukee lake trout are better biters; tons of them are caught through the ice every winter. The Newfound trout are hardly ever caught through the ice. A few were caught last winter for the first time to my knowledge. I am sure there is but one variety in Newfound Lake. We had one in the tanks this fall that would weigh 25 pounds. The only differences to be found on examination were such as relate to the depths at which the two races habitually live; one is the slim, dark colored tuladi, and the other the common lake trout of the Great Lakes."

A Moosehead Lake guide once told the present writer that in that lake there were two forms, one a long, slender, and dark-colored fish called the "togue," the other plump, lightcolored, and silvery called the "silver laker."

With such extreme variations it is quite obvious that no technical description drawn from one individual will apply to all forms of the species. For that reason a somewhat modified description of the Winnepesaukee fish is abstracted from Prescott's description of *Salmo symmetrica* and another from Hamlin's description of *Salmo toma*. To these descriptions are added notes taken from other individuals from Maine and New Hampshire, respectively, and comparison of proportional measurements of a New England fish made with one from the Great Lakes. While these show no specific differences, they indicate local variations that perhaps are more than ontogenetic.

# DESCRIPTIONS.

# "Salmo symmetrica. Winnipisseogee Trout.

"There are many points of resemblance between this trout and the Salmo confinis, or lake trout of Dougherty, and the Salmo amethystus, or Mackinaw trout of Kirtland. Yet in many of its characteristic markings it obviously differs from each. We observe first as to the form: while the Winnipisseogee trout is slender and symmetrical in form, a specimen measuring twenty inches in length weighing but thirty ounces, and another of thirty-six inches but twelve and a half pounds; the lake trout, as described and figured by DeKay, has a robust body and is comparatively short in proportion to its weight, a specimen measuring thirty-one inches weighing fifteen pounds.

"Second, with regard to the number and arrangement of the teeth: According to DeKay, the lake trout has numerous curved teeth along the central furrow of the tongue and many series of acute teeth on the vomer and palatines. But the Winnipisseogee trout has no teeth on the central furrow of the tongue and but a single row on each of the other parts, and also on the pharangeals.

"Again, DeKay remarks that the first dorsal fin of his specimen, measuring thirty-one inches, 'commenced *one* inch nearer the nose than the extremity of the caudal rays." In the Winnipisseogee trout of twenty inches in length it was *two* inches nearer the anterior extremity.

"Body slender, subcylindrical; general appearance symmetrical. Scales very small; caudal deeply forked. Head slightly flattened between the eyes; jaws equal and pointed, the extremity of the lower received into a cavity in the upper, which at that place is destitute of teeth; eye 9 in head, 3.6 in interorbital; snout 3.75 in head; origin of dorsal somewhat in advance of ventral; length of head 2 in distance from tip of snout to dorsal, and about 3.22 in the distance from tip of snout to adipose fin, and about 2.11 in the distance from tip of snout to ventral; base of dorsal 2.25 in head; longest ray or height of dorsal equal to length of pectoral, ventral and longest ray of anal; base of anal 3 in head.

"Color, light to dark brown on the back and upper part of the head, sides dark gray above lateral line, lighter below, in some approaching to light salmon; lower jaw, chin and abdomen white, mottled with fuliginous; pectorals and ventrals gray, their anterior part being shaded faintly with pink. Dorsal and caudal fins dark gray,<sup>1</sup> the whole fish, including the dorsal and the caudal fins, thickly sprinkled with small circular spots, of a drab color on the sides, above on the back approaching to light salmon below. These spots become elongated and variously curved on the top of the head, and of an olive color, giving to the part a marbled appearance. (Color from a fish some time dead.)"

#### "The Togue.

# "Salmo toma, Hamlin.

"In shape it is not so elegant as that of some other species of Salmonidae, but its whole form indicates strength and swiftness, although it has the reputation of being slow and sluggish. The female is more perfect in its proportions than the male, not having that gibbous appearance at the nape, where the outlines of the head pass into those of the back, and, besides, its general contour is more delicate. Its proportions are quite harmonious. Scales small and elliptical,

<sup>&</sup>lt;sup>1</sup> "It is worthy of remark, that the color of this fish, in common with many others, is very much influenced by the nature of the bottom upon which it feeds, being uniformly much darker when frequenting muddy than gravelly bottoms, or rapid streams. The color varies also with age and in many instances there is a marked difference between the color of the male and the female."

decreasing toward the thoracic arch; 53 in cross series anterior to the ventrals, 24 above lateral line. Ventrals under sixth ray of dorsal, dorsal midway tip of snout and base of caudal; caudal deeply forked. Maxillaries, intermaxillaries and palatines each with a row of conical and inflected teeth; those upon the lower maxillaries large and strong; those upon intermaxillaries next in size; upon maxillary and palatines next in size, and those upon vomer smallest, numbering only three or four, and not confined to the anterior extremity but extending a good way backward. Length 18 inches, depth less than head, which is 4 in the total length; pectorals about 1.56 in head; ventral about 2.11 in same; length of anal 2 in head; length of dorsal slightly greater than anal. Br. 12; D. 13; A. 11–12; coeca, 113. Vertebrae, 65. A rich pearly luster ventrally deepening toward the lateral line; deep mottled gray above, still deepening into blue on back; opercles pearly and gray; circular unocellated spots and markings on sides of light sienna, appearing indistinct and grayish on dorsal and base of caudal; brighter during spawning season."

The following description was drawn from specimens collected in Second Connecticut Lake, New Hampshire (Kendall and Goldsborough, see synonymy): head in length to base of caudal, 3.79; eye in head, 7.58; snout, 5.05; maxillary bone, 2.45; mandible, 1.59; gill-rakers 8 to 13 on each side, the longest about 1.7 in eye; branchiostegals 12 on right side and 11 on left; dorsal 11; anal 10; scales 32–180–32. Head comparatively long; eye small; distance from tip of snout to posterior extremity of maxillary 1.97 in head; body rather more slender than that of the trout or salmon; pores of lateral line about 120 in number; pectoral moderate, 1.68 in head; first rays of dorsal and anal longest, much overlapping the others when depressed, especially in the anal; caudal deeply forked.

Head, back, and upper parts of side dark greenish gray, the color most intense on edges of scales, clearly defining their outline; belly silvery white with darker shade defining margins of scales; light golden yellow spots on cheeks and opercles and all parts of body except ventral region, from tip of lower jaw to base of anal, the spots lighter posteriorly; dorsal olive, spotted with pale yellow and broadly margined with same shade; pectorals and ventrals pale yellow below, dusky above with broad margin of pale yellow; anal dusky, with ends of rays pale yellow, first rays white; adipose and caudal dusky, spotted with greenish yellow. Description taken from a male specimen 15.5 inches long caught in Second Connecticut Lake, September, 1904.

A specimen 11.25 inches long caught at the same time, also a male, has a longer head, larger eye, longer snout, and somewhat longer fins. The color often varies from very dark, almost black, with dull yellowish or soiled white spots, to bright silver with more sharply defined, cleaner spots of white, gray, or yellow.

# LAKE TROUT.

# Descriptions of Salvelinus namaycush which served as Subjects of the Illustrations of this Species in the present Paper.

*Male.*— Head long, 3.56 times in length without caudal; eye 6 in head; snout, 4; upper jaw, 1.87; lower jaw, 1.62. Body stout and heavy, strongly curved forward, the depth 4.03 in length without caudal; caudal peduncle slender, its least depth 1.17 in the distance from anal to lower base of caudal; dorsal rays 11, the fin inserted slightly nearer tip of snout than base of caudal, its height or longest ray about 2, and its length of base slightly over 2, in length of head; distance from tip of snout to base of pectoral, 1.09 and length of pectoral 1.71 in length of head; ventral length equaling height of dorsal, the distance of its base from base of pectoral equaling head, 3.56 in length without caudal; distance from base of ventral to origin of anal about 1.5 in distance from pectoral to ventral; base of anal 2.6 and its height 2.14 in head, distance from origin of anal to middle base of caudal about equaling length of head; anal rays 10; distance from tip of snout to ventral about equaling distance from ventral to fork of caudal. Caudal strongly forked, the shortest or middle rays about one third the length of the lower or longest ray.

*Coloration.*— Above, dark grayish olive, fading downward toward middle longitudinal axis of body to paler color with pinkish bloom, becoming less green and changing to grayish pink on abdomen and lower part of body; almost white below. Sides of upper part of body with irregularly shaped yellowish-olive spots, growing smaller downward and disappearing along the side below lateral line; dorsal with dusky-margined lighter olive spots between the rays, the margins disappearing toward the tip of the fin; adipose darker than back with olive-green spots; caudal darker than back, gray green, lighter gray at tips, incompletely cross-barred with dusky (about eight bars), becoming less distinct as they approach the tips of the fin; small yellow spots on base; pectoral, ventral, and anal fins light dull reddish at tips, with faint dusky bar across the middle, fading to lighter color, dull yellowish white on bases; pectoral with six or eight small black spots on each ray.

Head darker than body but of same colors, becoming paler on sides, with iridescent luster of yellow and pale pinkish; lower jaw light greenish gray, fading into whitish, with faint dusky shadings. Iris dull orange, clouded with dusky.

Specimen,  $15\frac{7}{8}$  inches long, from Thompson Pond, Oxford, Maine.

*Female.*— Head long, 3.77 times in length without caudal; eye 5.6 in length of head; snout, 4.3; upper jaw, 1.91; lower jaw, 1.78.

Body stout, heavy, and strongly curved dorsally forward; depth 4.26 in length without caudal; caudal peduncle slender, its least depth about 1.33 in the distance from posterior end of anal to lower base of caudal, and about 3.33 in the greatest depth of body; dorsal rays 11; the fin inserted somewhat nearer tip of snout than middle base of caudal, the longest ray 1.62

Measurements and Counts of Salvelinus namaycush from New Hampshire and Vermont.<sup>1</sup>

Locality	a+	a	b/a	m/a	n/a	o/a	y/a	j/a	v/a	p/a	1/a	x/a	c/b	e/b	h/b	g/b	Gill-rakers	Br.	D.	А.	Sex
Newfound Lake, N. H.	$24\overline{2}$	535	.256	.511	.125	.142	.218	.583	.125	.166	.761	.095	.139	.232	.511	.302	9 + 13:22	11	11	10	0 <sup>7 2</sup>
Winnepesaukee Lake, N. H.	$27\frac{1}{8}$	602	.272	.540	.106	.117	.213	.614	.123	.149	.796	.101	.115	.238	.594	.349	8 + 12:20	12/13	10	10	07 3
Roxbury, Vt.	22	496	.230	.512	.108	.416	.217	.596	.116	.193	.794	.096	.138	.250	.527	.250	8 + 12:20	12	10	10	Q 4

<sup>1</sup> Explanation of symbols used in the tables.— The proportional measurements are expressed by decimal fractions. The parts or structures are indicated by letters and the proportions designated by the letters in the form of algebraic common fractions. Thus: b/a signifies that the proportion is obtained by dividing the measurement of part b by the dimension of a.

- a+. Total length in inches from tip of snout to tip of tail.
- a. Length in mm. from tip of snout to end of lateral line.
- a<sup>1</sup>. Least depth of caudal peduncle.
- b. Length of head from tip of snout to gill-opening.
- $b^1$ . Length of head from tip of shout to hape.
- $b^2$ . Perpendicular diameter of head through middle of eye.
- c. Length of eye.
- d. Greatest depth of body.
- e. Distance from tip of snout to front of eye.
- f. Distance from tip of snout to posterior edge of preopercle.
- g. Width of interorbital space.
- h. Distance from tip of snout to posterior extremity of maxillary.
- $h^1$ . Width of maxillary.
- $h^2$ . Length of supplementary maxillary.
- $h^3$ . Width of supplementary maxillary.
- *i*. Distance from tip of snout to base of pectoral fin.
- j. Distance from tip of snout to ventral fin.
- k. Length of lower jaw to junction with the quadrate.
- *l*. Distance from tip of snout to anal fin.
- m. Distance from tip of snout to origin of dorsal fin.
- n. Length of base of dorsal fin.
- o. Height of dorsal fin.

- p. Length of pectoral fin.
- q. Distance from base of pectoral to base of ventral fin.
- r. Length of longest upper caudal ray.
- s. Length of ventral fin.
- t. Distance from base of ventral to origin of anal fin.
- u. Length of longest lower caudal ray.
- v. Length of base of analfin.
- w. Length of middle caudal ray.
- x. Length of longest ray of anal fin.
- y. Distance from posterior end of dorsal to adipose fin.
- $y^1$ . Length of base of adipose fin.
- z. Distance from posterior base of adipose to upper base of tail.
- $z^1$ . Distance from posterior base of anal to lower base of tail.
- Br. Number of branchiostegal rays, upper right, lower left side.
- Gr. Number of gill-rakers on both arms of first branchial arch.
- D. Number of fully developed dorsal rays.
- A. Number of fully developed anal rays.
- J. Male.
- Q. Female.
- ?. Not determined.

<sup>2</sup> Color notes, according to Bean: "The body is gray, darker on the back. The outer edge of the pectoral and ventral and front margin of the anal are white as in *fontinalis*. A white spot up to the lower caudal lobe and a very small one at the top of the dorsal. Otherwise the coloration is like that of the ordinary trout, which have the pectoral, ventral and anal chiefly vermilion in the breeding season."

<sup>3</sup> "The ground color is a little lighter than the Newfound Lake trout, and the vermilion of the pectorals, ventrals and anal is less intense."

4 "The pectorals, ventrals and anal are chiefly vermilion, as in the male from Newfound Lake. The body is silvery gray with numerous small whitish spots; these present also on the dorsal."

Locality.	a+	a	b/a	o/a	p/a	c/b	e/b	h/b	k/b	o/b	.p/b	Gill-rakers	D.	А.
Telos Lake.	18	331	.326	.153	.182	.147	.294	.529	.617	.470	.558	$     \begin{array}{l}             3 + 10:13 \\             3 + 10:13         \end{array}     $	9	. 8
Pool below Chamberlain Dam.	24	535	.285	.130	.154	.125	.291	.520	.666	.458	.541	${6+11:17}$ 7+11:18	10	8
Eagle Lake.	$20\frac{3}{4}$	452	.260	.126	.140	.125	.270	.554	.675	.486	.545	5+ 9:14 5+11:16	10	. 9
cc cc	$21\frac{3}{4}$	490	.259	.129	.146	.125	.275	.550	.675	.500	.575	$ \begin{cases} 7+12:19 \\ 6+11:17 \end{cases} $	10	10
" "	$20\frac{1}{2}$	452	.267	.126	.151	.131	.289	.539	.657	.473	.565	$\begin{cases} 7+12:19 \\ 7+12:19 \end{cases}$	10	9
"	$21\frac{1}{2}$	471	.303	.135	.168	.111	.266	.511	.677	.444	.555	$\begin{cases} 7+12:19 \\ 7+12:19 \end{cases}$	10	10

# Measurements and Counts of six female Salvelinus namaycush from the Allagash Branch of St. John's River, Aroostook County, Maine.<sup>1</sup>

Comparison of Proportional Measurements and Counts of two female Salvelinus namaycush of the same Length. 1.— Eagle Lake, Allagash River, Me. 2.— Lake Michigan.

\*

	a+	a	b/a	o/a	p/a	c/b	e/b	h/b	k/b	o/b	p/b	Gill-rakers	D.	A.
1	$21\frac{1}{2}$	471	.303	.135	.168	.111	.266	.511	.677	.444	.555	$\begin{cases} 7+12:19 \\ 7+12:19 \\ 7+13:20 \end{cases}$	10	10
2	$21\frac{1}{2}$	475	.269	.143	.122	.117	.242	.476	.585	.531	.335	7+13.20 7+13:20	10	10

<sup>1</sup> For explanation of symbols used see opposite page.

LAKE TROUT.

and its basal length 1.83 in length of head; distance from tip of snout to base of pectoral 1.28, and length of pectoral 1.52 in length of head; ventral length about equaling dorsal height, 1.62 in head, its distance from pectoral to its base considerably more than length of head, 3.39 in length of body without caudal; distance from base of ventral to origin of anal about equaling distance from posterior dorsal to adipose, and from origin of anal to lower base of caudal, 1.53 in distance from base of pectoral to base of ventral; base of anal 2.39 and its height 1.89 in head; distance from origin of anal to middle base of caudal greater than length of head, 3.45 in length of body without caudal, or about equaling distance from base of pectoral to base of ventral; anal rays 11; the distance from tip of snout to ventral about equaling distance from base of ventral to fork of caudal. Tail strongly forked, the shortest ray less than one third the length of the lower ray.

*Coloration.*— Above, deep olive, irregularly spotted with lighter olive, both body color and spots becoming lighter downward toward the longitudinal axis of the body, the spots becoming smaller and fainter until lost in the pale olive yellow of the lower parts, lightening to Naples yellow, and in the lower line of the body to yellowish white; color of dorsal similar to back lightening toward tip with yellow dusky-margined spots on the interspinous membrane, growing fainter and the dusky margins disappearing toward the upper margin of the fin; adipose darker than back with olive spots; caudal olive green; darkest basally, lighter toward the terminal margin, with about five indistinct and incomplete black cross-bars on the upper and lower margins of the fin and a few small yellow spots at base of fin; pectoral, ventral, and anal pale pinkish at tips, median faint dusky bar, growing yellowish on pinkish base, all the colors blending into each other with no sharp demarcation; narrow white anterior margin.

Head, color of back, darker on top, paling on sides, with coppery and yellowish-green iridescence; lower jaw pale yellowish green to whitish; iris dull yellowish orange clouded with dusky.

Specimen  $16\frac{1}{8}$  inches long from Thompson Pond, Oxford, Maine.

# SYNONYMY.<sup>1</sup>

Namaycush \*\* Trutta lacustris generis PENNANT, THOMAS, Arctic Zoology, vol. 1, Introduction, p. exci, 1784, "Hudson's Bay Lakes far inland," and Salmon, Namaycush, Supplement, p. 139, 1785, "Lakes of Hudson's Bay."

Salmo namaycush WALBAUM, JOHAN JULIUS, Petri Sueci Genera Piscium, p. 68, 1792, (after Pennant).
 — GARMAN, S., "The American Salmon and Trout, including introduced Species," Nineteenth Annual Report of the [Mass.] Commissioners of Inland Fisheries, p. 73, figs. 10, 11, 1885, "The great lakes and their tributaries, eastward to the Atlantic, northward to Hudson's Bay."— THOMPSON, ZADOCK, History of

<sup>1</sup> Excepting the original, all of the references are the most important of those pertaining only to New England.

#### BLUEBACK TROUT.

Vermont, Natural, Civil and Statistical, part 1, chapter 5, "Fishes of Vermont," p. 140, fig., 1852, "Longe or Salmon Trout," "Lake Champlain and several ponds in the Northern part of Vermont."

- Salmo symmetrica PRESCOTT, WILLIAM, "Descriptions of New Species of Fishes; from a Synopsis of the Fishes of the Winnipisseogee and its connecting waters." Read before the Association of American Geologists and Naturalists held in Boston in Sept., 1847. Amer. Journ. Sci. and Arts, ser. 2, vol. 11, p. 340, May, 1851, "Winnipisseogee Trout."
- Cristivomer namaycush EVERMANN, B. W., and KENDALL, W. C., "Annotated List of the Fishes known from the State of Vermont," Report U. S. Commissioner of Fish and Fisheries for 1894, p. 591, 1896, Lakes Champlain and Memphremagog, (Lake Trout, Longe, Togue).—KENDALL, W. C., and GOLDS-BOROUGH, E. L., "The Fishes of the Connecticut Lakes and Neighboring Waters," Bureau of Fisheries Document, no. 633, p. 50, 1908, ("Laker," "Lunge"), Connecticut Lakes, N. H.—KENDALL, WILLIAM C., "Fauna of New England, List of the Pisces," Occasional Papers Boston Soc. Nat. Hist., vol. 7, no. 8, p. 45, 1908, (Great Lakes Trout, Mackinaw Trout, Namaycush, Lunge, Togue, Laker, Lake Trout). ME.—Most deep lakes in eastern and northern Maine. Thompson Pond in Poland; Tunk Lakes in Hancock County; Lakes of the Upper Kennebec, Penobscot and St. John's Rivers, and the St. Croix system. N. H.—Winnepesaukee Lake; Squam Lake; East Pond in Enfield; Newfound Lake and First and Second Connecticut Lakes. VT.—Lake Champlain; Bellwater Pond in Barton and several ponds in Glover and Charleston; Lake Memphremagog; Caspian Lake; Dunmore; Willoughby; Maidstone.

Salmo salar WILLIAMS, SAMUEL, The Natural and Civil History of Vermont, pp. 121, 122, 1794 (Salmon Trout), Lake Champlain and in the rivers and ponds connected with it; pond in Leicester.

- Salmo tructa? BELKNAP, JEREMY, The History of New Hampshire, vol. 3, p. 179, 1792 (Salmon Trout, in part), Some bays of Winnipiseogee lake and river.
- Salmo toma HAMLIN, AUGUSTUS C., Brochure on the togue (privately printed, about 1853); and in HOLMES, EZEKIEL, Second Annual Report on the Natural History and Geology of Maine, p. 109, 1862, "Great lakes and deep mountain tarns of Maine and New Brunswick"; also Maine Sportsman, p. 173,<sup>1</sup> May, 1903.

#### BLUEBACK TROUT.

#### Salvelinus oquassa (GIRARD).

#### PLATE 4, FIG. 5 (male); FIG. 6 (female).

The Blueback is a representative of the group of alpine or northern charrs which at the time of its first description was known from no other waters in this country. It was later recognized as a close relative of certain Arctic forms. It is closely allied to the Sunapee Lake White Trout and the Canadian Red Trout, the latter having been designated by some ichthyologists as a subspecies of the Blueback, and it was at one time contended by many that the former was derived from Bluebacks that had been planted in the lake. It has been suggested that all of the nominal

<sup>1</sup> "The Salmo Toma or Togue," by Augustus C. Hamlin, M. D.: "A half a century ago, I described the great trout of our lakes known as the togue, after the noble Indian Peol Toma, of the Passamaquoddy tribe. The description and name bestowed still hold good."

species of this group are really specifically identical but subject to considerable local variation in form, color, and habits. In Forest and Stream of December 14, 1882, p. 389, writing of the Blueback, Dr. David S. Jordan said: "No specimens are on record from any waters in the United States other than the Rangeley Lakes. It has, however, been recently discovered and described as a new species by Dr. Günther as *Salmo naresi* (Proc. Zool. Soc. London, 1877, page 476) in lakes of Arctic America about Discovery Bay. Dr. Bean has also found it in Kumlien's collection from Cumberland Gulf. It is probably an Arctic fish, which for some reason keeps its hold in the Rangeley chain, but has become extinct in the other lakes of northern Maine, if it ever lived there."

In a special supplement of Forest and Stream, dated April 4, 1889, devoted to "Salmon and Trout," Dr. T. H. Bean says: "The blueback is known certainly only from lakes and streams of western Maine; its range would be extended northward to Arctic America if we included Nares trout under this name, but the justice of this course is open to question, and we ought to devote a little more study to the subject before uniting the two."

Unless the Blueback is identical with the other forms mentioned, its known range was until 1905 restricted to the Rangeley Lakes. In the Maine Sportsman, February, 1905, page 117, the present writer recorded it from Rainbow Lake, the headwaters of a tributary of the West Branch of Penobscot River, Piscataquis County, Maine, and later additional specimens were secured from the same place. Very possibly careful search would reveal them in other northern Maine waters.

This fish was first called to the attention of naturalists by Dr. Charles Girard at the meeting of the Boston Society of Natural History of October 20, 1852. In this communication he said: "The abode of the 'Blue Back' is, as stated above, the Moosemegantic Lake, in which it is concealed during the greatest part of the year; but about the 10th of October, it comes near shore and ascends in shoals the Kenebago for the purpose of spawning. Half a mile above its mouth, the Kenebago receives the outlet of Lake Oquassa; the trout there leaves the Kenebago to the left and runs towards Oquassa Lake, where its voyage comes to a close. After the middle of November it goes back into Moosemegantic Lake and is seen no more until October of the next year."

In the previously mentioned article Dr. Jordan further said: "As to the habits of the Blueback nothing seems to be known beyond the following from the original description," which is then quoted. And up to the present day, it may be added, outside of articles that have appeared from time to time in sportsmen's journals and magazines, there is very little published information. For that reason the essential matter pertaining to this species appearing in those journals is quoted in the following pages.

In an article entitled "Blueback Trout," Mr. J. G. Rich wrote (Forest and Stream, January 4, 1883): "In the year 1844 I visited the Rangeley Lakes, and heard from settlers about the

# BLUEBACK TROUT.

above named fish. They called it simply 'blueback,' and did not class them with trout. At that time all that was known of this fish was that about the 10th or 20th of October of each year they ran up what was called 'Toothaker Cove' from Rangeley Lake into a small brook, the outlet of Quimby Pond.

"The blueback was never seen in any of the other lakes until after the building of the 'Upper Dam,' about the year 1858, when hunters discovered them below the dam, where they stayed until the river was entirely frozen up. This was above the Mollychunkamunk Lake, into which they probably finally went. At no other time of year are they now, or ever have been, seen, except the late fall months. About this time (1858) they were discovered in the Kennebago River, and Rangeley Stream (outlet of Rangeley Lake) above Indian Rock, but I believe were never fished for there. I have fished all of the lakes from Rangeleys to Umbagog, winter and summer since that time (1844), but have never seen a blueback in any other place than the above, or at any other time of the year. And I have never seen them in any river or stream contiguous to these lakes, although I have fished Magalloway, Parmachenee, Cupsuptic, Beema, Kennebago, rapid rivers and smaller streams for the last thirty-five years."

In a later article in the same paper of the same year, Mr. Rich states that in 1842 they were taken in nets at only one place, then known as Dodge Pond Outlet, which emptied into Toothaker Cove, since called Mings Cove. In the previous article the statement that the brook was the outlet of Quimby Pond was a reference to the same brook as it is the joint outlet of both ponds.

Further on in this article Mr. Rich said: "In later years they have made their appearance in other localities, probably forced to scatter by the obstructions to the free course of their original spawning place. They now appear each year about the same time as formerly, in Rangeley Outlet, Upper Dam, and (I am told by some person who sent me a postal and signed his name 'Informer') below the Middle Dam."

A correspondent of Forest and Stream of December 15, 1887, p. 408, wrote: "It is a fact worthy of note that the little bluebacks, usually seen in great numbers at the Upper Dam during the autumn run of these fish, have been very much less than usual at that point. Still it is also curious to note that a new spawning ground of these trout (bluebacks) has been discovered this fall. The point is at the mouth of Sawmill Brook, at the head of the Upper Richardson Lake; or rather the trout were found well up in the narrow rugged stream."

# SIZE.

Girard stated that it was from 8 to 10 inches in length. In the Maine Fish Commission Report for 1874 it was said to attain a length of 8 inches, and the Report for 1878 says they are quite small in size, usually averaging about four or five to the pound. In 1883, Mr. Rich stated

that he had never seen one that weighed over 6 ounces and in another place said that they were from 5 to 8 inches long, weighing from 4 to 6 ounces. And Mr. Stanley wrote in his letter to Mr. Mather, published in Forest and Stream of May 5, 1887: "As I understand the Sunapee trout are caught of various sizes. The blueback never. Out of a thousand I do not think you could select two that will vary of one ounce in weight; or that you could pick up five (take them as they come) that will vary an ounce from a pound. Five to the pound is the rule."

One of the most recently published general ichthyological works, A Guide to the Study of Fishes, by David Starr Jordan, 1905, says: "The species rarely exceeds the length of a foot in the Rangeley Lakes, but in some other waters it reaches a much larger size," although Jordan and Evermann previously stated in American Food and Game Fishes, 1902, that the blueback formerly attained a size of only 6 to 10 inches and 4 to 6 the pound, it is now sometimes caught weighing as much as  $2\frac{1}{2}$  pounds, and is known only from the Rangeley Lakes.

In American Fishes by G. Brown Goode, 1888, a brief reference to this fish is as follows: "Salvelinus oquassa inhabits the lakes, thence introduced into New York and New Hampshire. This is, says Bean, a small species, not known to exceed ten inches in length from existing collections. It is probably a landlocked form of *S. stagnalis*, and specimens of much larger size may be expected. Its distribution, also, will be found to be more extensive."

In the edition of 1903 revised by Dr. Theo. Gill the following fact is mentioned: "Few or none ascend their old accustomed streams. Anglers now and then, however, catch what seem to be 'Blue-back'; they weigh as high as two and a half pounds."

## HABITS.

Girard's account of the habits of the Blueback has already been quoted.

The Report of the Commissioners of Fisheries of Maine for 1874 states that the Blueback remains in the deep water of the lake from near the middle of November until the middle of October when they ascend brooks in countless numbers to spawn, the run lasting about three weeks. The male Brook Trout, it is stated, visits the spawning bed and prepares it for the use of the females before they arrive, but the Bluebacks go up in pairs, male and female, using spawning beds cleared, used, and vacated by Brook Trout. The runs occur at night but in the height of the season many fish remain up through the day hidden beneath rocks and stumps. The Report for 1875 adds that it is never seen but once a year when it comes from the depth of the pond where it lives, to spawn in some sandy, pebbly-bottomed brook.

The Report for 1878 says that they are rarely seen, excepting the last of October, when in immense numbers they enter the brooks to spawn, on the same ground as the trout.

In Forest and Stream of November 26, 1874, the following appears: "On the 10th of October — or within three days of that date — the outlets of Gull Pond and Dodge Pond, both

#### BLUEBACK TROUT.

emptying into Rangeley Lake at points six miles apart, and the outlet of Rangeley Lake, six miles from Dodge Pond, are thronged by myriads of this exquisite fish. The waters of the streams are actually filled with this crowding, springing multitude, gathering as do smelts and alewives, to deposit their spawn. They do not make a 'spawning bed,' like the salmon and trout, but deposit their eggs in all parts of the stream, remaining about ten days, when they return to the lake, and are never seen until the 10th of October the following year." In the same journal for December, 1874, Mr. E. S. Merrill says: "Five or six years ago I spent the month of October in the Maine woods, and for the first time saw the Blueback trout, of which I had heard. This was in Androscoggin River, between Indian Rock and the dam. The trout came from the Cupsuptic or Mooselucmaguntic Lakes. They came up from Indian Rock to the dam. In the pool below the dam there were myriads, the water being literally black with them, and under every stone, slab, or log in the stream, scores would shoot out when disturbed; you could scarcely step anywhere in the stream without starting some, and so of the streams emptying into Rangeley Lake."

In American Angler of April 14, 1873, Mr. Rich wrote that they ran up the brook at night and back in the morning.

Regarding the run of Bluebacks in Sawmill Brook in the fall of 1887, a correspondent of Forest and Stream of December 15, 1887, wrote that one reliable guide, Mr. Oscar Cutting, said that the stream was lined with them for a long distance up into the running water. The Bluebacks were so intent upon breeding or reaching their breeding grounds that they were literally piled up in the shallow water in the little pools and eddies.

Captain F. C. Barker, in Forest and Stream, January 12, 1888, writing regarding the disappearance from below Upper Dam and appearance in Sawmill Brook, said that the disappearance was plainly due to the fact that the water in the lake below was so high that it backed up over the "rips" where they have usually done their spawning, rendering the whole line of "rips" as quiet as a mill pond. Their leaving this point altogether is probably the cause of so large a number in Sawmill Brook, but no doubt there has always been more or less of them spawning there.

J. Parker Whitney, in a letter to Forest and Stream written in October, 1896, and reprinted in the Report of the Commissioner of Inland Fisheries and Game of the State of Maine for the year 1896, wrote: "Now the latter part of the month the blueback (*Salmo oquassa*) are spawning, and swim in large quantities in the shallows below Upper Dam. They are invisible by day, but at night come on in large numbers, and do not appear at any other season of the year. They undoubtedly inhabit the deepest water of the lakes. They remain on the spawning beds during the nights of about a week in the latter part of October, and sometimes in such numbers that barrels full could be taken if nets were used."

The only mention of the food of the Blueback is the statement of J. Parker Whitney (l. c.) who said that their teeth were very fine and plentiful, and that they evidently live on ground

feed and the variety of Infusoria which are so plentiful in the lakes. Mr. Whitney, in a letter to the same paper in 1900, explained that "ground feed" of the lakes is an important element with all fish, composed of "insectivorous varieties and largely of viscous matter, which settles profusely."

The stomachs of the Rainbow Lake specimens of Bluebacks,  $7\frac{1}{2}$  to 9 inches long, were full of insect larvae of various kinds and a large number of Entomostraca.

In a letter to Col. Fred Mather, published in Forest and Stream of May 5, 1887, Commissioner Stanley wrote: "They are a very hardy fish and tenacious of life, nearly as much so as the eel or bullhead. I have frequently seen them alive in the morning, when they have lain on the shore all night."

J. Parker Whitney (l. c.) wrote: "They are much more tenacious of life than the ordinary trout. I have had them out of water an hour, and apparently lifeless, and resuscitated them by putting them in water again, and a number will live in a barrel of water without change for weeks, which would be fatal to the ordinary trout." In his 1900 letter (l. c.), Mr. Whitney reiterates this assertion.

# CAPTURE.

George Shepard Page, in 1874, (l. c.) wrote: "Notwithstanding the great number of anglers who have frequented the 'Rangeleys' during the recent years, fishing all portions of the lake with all manner of bait on the surface and down in the deep, no one has ever caught a blueback. They have never been at the surface. Among the settlers the 'blueback mystery' has been an annual subject of discussion at the husking, quilting and fishing parties, and the country store, for over forty years. They never take a fly or bait. I state this as a fact, notwithstanding the possibility of contradiction by as good an authority as our worthy president of the American Fish Culturist Association and my esteemed friend, that expert angler, Hon. Rob't. B. Roosevelt. When last we met at Rangeley, some four years ago, Mr. R. awaited with deep interest the advent of the bluebacks. They came at the appointed day in millions. Our friend had caught nearly every species of fish that swims in salt or fresh water, and he insisted that these beauties could be tempted by the gaudy fly. So day after day he stood on the apron of the old dam and fairly exhausted the treasures of his famous fly book. I shall never forget his overflowing enthusiasm and boundless joy as he entered camp, bearing a single blueback attached to a diminutive fly hook. He loudly declared 'the beauty bit,' but we who had watched the angler casting the trio of sharp baited lures among the swimming thousands in the pool, wondered that such exquisite skill in casting had not resulted in hooking out three at a time."

Mr. E. S. Merrill, 1874, (l. c.) said that his party did take a few with bait in Rangeley Stream. The Maine Commissioners' Report for 1874 says: "They are rarely seen but in the spawning season. Now and then in deep fishing with bait in the lake one is caught, but rarely

# BLUEBACK TROUT.

or exceptionally as the ordinary sucker; like the latter, they will in the breeding season take a bait but it is the exception and not the rule. The blueback is not considered a biting or game fish, yet I have caught a bushel and a half in a day with a baited hook. They are mostly caught in dip nets."

But the Report for 1878 states that they haunt the deep water in ponds, where they may be freely taken in summer with a baited hook in about forty feet of water. In the Forest and Stream for January 4, 1883, Mr. Rich states that in 1844 they were taken in large quantities by the Rangeley people, mostly the poorer classes. The fish were never fished for with a baited hook but either netted or speared. The method of netting, he states, was usually with "nets" consisting of bags with ash bows and handles which were set at the ends of sluice ways made for the purpose of guiding the fish into the nets. In this way several bushels would be secured by each man in a night. In the American Angler of April 14, 1883, Mr. Rich says that they run up the brooks at night and back in the morning, so that the only time to get them was during the night, and large quantities of them were secured. Fish ways were made through which they had to pass, and improvised hand nets were used, and an equal chance was given all the settlers that went for them. Mr. Rich continued: "These fish are sometimes taken with a baited hook, so I am informed by our Fish Commissioner, Mr. Stanley; yet I have tried them time and again with fly and bait, but never succeeded in taking one or even attracting their attention."

Mr. H. O. Stanley, writing in Forest and Stream of May 5, 1887, said that they were not biting fish any more than the sucker, but that he had occasionally caught one or two at a time when fishing in deep water in the summer.

Captain F. C. Barker (l. c.) stated that the Blueback would sometimes take a bait in deep water, but knew of no case of their taking a fly. Mr. J. Parker Whitney stated (l. c.) that they were caught by wading in the shallows with a lantern and a dip net.

The Forest and Stream of August 6, 1898, contained a communication from a Rangeley Lakes correspondent in which it was stated that a Blueback was reported to have been taken recently by trolling.

#### USES.

Referring to a special exemption of the Blueback from protection by the law applying to other trout, the following appeared in Forest and Stream of November 26, 1874: "This exemption is properly and wisely made, as it enables the settlers in that section to supply themselves with quantities of superior fish food, which smoked and salted adds very materially to the limited bill of fare for the season."

From the Forest and Stream of November 15, 1877, it seems to have been marketed to some extent. The following report is quoted: "The first of the Rangeley blue-backs have come to the market from Maine and will be as usual at Mr. E. G. Blackford's stall in Fulton Market."

Mr. Rich stated that the settlers prepared those caught on the spawning beds in the fall for their use as food in the following winter and summer. Some were cured by salting, others by drying and still others by smoking. Some dressed them, others cured them whole. He wrote: "It is proverbial of certain families that they lived on bluebacks and crossbills," and that the crossbill, a small bird, was cured whole.

Quality as food.— Girard (1853) said: "The flesh of this fish is highly flavored, and more delicate than that of the brook trouts in Europe and America. It resembles that of *S. umbla*, of the Swiss Lakes, both in the peculiarity of its habits and its delicacy. *Salmo umbla* is a lake trout, an inhabitant of the deep, making its appearance near shores in January and February to spawn, and never ascending the brooks or rivers, tributaries of these lakes."

Mr. E. S. Merrill in the article which has already been quoted, said: "We ate them several times, and found them a nice pan fish — juicy, tender and delicate, but from my little experience I would not give up the brook trout for them."

The Commissioners' Report for 1874 says regarding it: "As a table fish we can not speak advisedly, never having eaten it except when taken on the spawning bed. To us they are not palatable, but as much so as the trout under the same circumstances." In the Report for 1875, however, the statement is made that it is an excellent table fish, "most persons deeming it equal in flavor to the brook trout."

The Maine Fish Commissioners' Report for 1878 said that they were much esteemed as a fine pan fish.

A correspondent of Forest and Stream of December 15, 1887, wrote that some captured all that they cared for and tried them cooked, but were not generally pleased with the flavor, though they selected the males for the purpose.

In Forest and Stream of November 24, 1900, Mr. Whitney said: "For food purposes it is inferior, though claimed by many to equal the ordinary trout, but to my taste it is soft and muddy."

#### PROTECTION.

From the foregoing it has been seen that the principal importance attached to the Blueback was its abundance and consequent availability as a food supply to early settlers. Later it found its way into the markets, or rather some shrewd "settler" having been prohibited from marketing the Common Trout, apparently saw a way of "turning an honest penny" by supplying the market with trout when the protected fish was forbidden.

The first protective law for trout was enacted in 1869, Chapter 20, Section 18: "There shall be a yearly close time for landlocked salmon, trout and togue, during the months of October, November and December, January and February, during which none of the fish mentioned above shall be taken or killed in any manner, under a penalty of not more than thirty or less

#### BLUEBACK TROUT.

than ten dollars for each fish so taken or killed,— providing that this section shall not apply to the taking of 'blueback trout' in Franklin or Oxford Counties."

The great abundance of this fish was maintained for many years, notwithstanding the many killed on the "spawning beds" and the lack of regulative laws regarding the methods and time of capture. This fact indicated to many that no protection was needed and its importance in the economy of the "settlers" rendered such protection undesirable. In reference to this exemption Mr. Page wrote in 1874 that he considered it proper and wise. But in the Maine Fish Commissioners' Report for the same year it is said: "There is a special statute allowing these fishes to be taken in Franklin and Oxford Counties during close time for other fishes. We think it a great mistake to allow these beautiful fishes to be taken at all, as we attribute mainly to them the great size of the Rangeley trout, and we opine that as they diminish in numbers so will those far-famed Mooselucmaguntic trout.... The blueback is to the Rangeley what the myriads of smelt are to Sebago Lake and Reed's Pond."

This appears to be the first suggestion of the Blueback's place in the natural economy of the lake, and the first intimation of the need of protective laws.

Writing in Forest and Stream of January 12, 1888, Captain F. C. Barker said: "They are very valuable to any body of water where brook trout are, in the way of food for them. It is a very common occurrence to catch a trout in deep water in the lakes with a blueback in it, partly digested. This was very common when we used to fish in winter in deep water through the ice."

In the nineties a comparatively rapid decrease was noticed in the number of Bluebacks appearing in their accustomed spawning places, and this became so marked that protective legislation was urged, but it was not until 1899 that a law was passed providing that "it be unlawful to fish for, take, catch, or kill any blueback in any waters of the state at any time," (Chap. 42, Sec. 5, Public Laws, 1899). But the stable door was not locked until after the horse had been stolen.

In the fall of 1900 the present writer visited Oquossoc Lake with a letter from Commissioner Stanley to Mr. George Esty, the well known, well informed, efficient and reliable fish and game warden of that region. Mr. Esty's aid in every way possible was requested in the letter. A man in whom Mr. Esty had confidence agreed to watch a certain stream where the fish used to fairly swarm, and, as Mr. Esty said, were dipped and hauled away by the barrel and cartload. This man watched the stream throughout the spawning season without seeing a fish. This was the famous outlet of Dodge and Quimby Ponds. At Kennebago Stream the Oquassoc Angling Association caught one pair of Bluebacks. The male had been liberated but the writer secured the female, which weighed about one pound. In 1902 a few large Bluebacks were taken by spawntakers, and in 1903, five more, all that were taken, were secured by the writer. In 1904 another visit was made by the writer to Oquossoc Lake. The State Fish Hatchery located on Rangeley Stream was then in operation and the fish culturists were taking trout and salmon in

Rangeley Stream by means of a weir and in Kennebago Stream by seine. Only three Bluebacks, these ranging as high as 2 or  $2\frac{1}{2}$  pounds, were secured or observed, although they were looked for at all of their former breeding places. The writer has been unable to learn that even a single specimen has been taken since. It would therefore seem that the Blueback is probably extinct in the Rangeley Lakes. In the Maine Sportsman of February, 1905, referring to the probable cause of the decrease in numbers of Bluebacks, the present writer said: "There is evidently a recent decrease in the numbers of this fish, almost to a complete disappearance from their usual spawning grounds. On the other hand, occasionally fish larger than used to be caught, even up to two or two and one-half pounds, I am told, are caught by anglers, when fishing for other trout and the salmon, both in Mooselucmaguntic and Oquossoc lakes. That these fish are verging on extinction in these waters cannot, I think, be wholly ascribed to excessive fishing. For much more than 50 years such fishing has been carried on with but little appreciable diminution of their numbers. Of course, injurious effects are sooner or later inevitable from such draughts upon them. But in their case it seems as if there must be additional factors at work. Here again our conditions of growth and existence may be brought into consideration. If trout depended largely upon bluebacks for subsistence, salmon rapidly increasing in numbers in these waters would doubtless come in for their share. Recognizing this possibility, the state commission planted smelts in the lakes in 1891. They have also flourished and waxed great in numbers."

The decrease in numbers of Bluebacks was synchronous with the increase in abundance of salmon and coincidently the last Blueback, was taken in the year following the largest catch of salmon up to that date. There can be no doubt but that the Blueback entered largely into the food of the salmon, especially prior to the introduction of smelts, living as it did in the deep waters to which salmon resorted in the summer months, and the introduction of smelts and later legislative action were both too late to save it. On the other hand the large size of the few surviving Bluebacks was very probably due to the smelt. Although the food of the Blueback was formerly the smaller animal life of the lake, probably largely consisting of Entomostraca and insect larvae and worms, the smelt afforded it an abundant additional supply of food owing to the fact that while almost in a larval stage young smelts frequent deep water after leaving their birthplaces in the brooks.

#### DESCRIPTIONS.

Girard (1853, p. 262) described the Blueback as follows: "It is from eight to ten inches in total length. The body is subfusiform, slender, and the most graceful in the trout family. The head is proportionally small, conical, coregonoid in shape. The mouth is smaller than in *S. fontinalis*. Differences are likewise observed in the structure of the opercular apparatus.

#### BLUEBACK TROUT.

The fins have the same relative position as in the brook trout, but are proportionally more developed, with the exception of the adipose, which is considerably smaller; their shape is alike, except that of the caudal, the crescentic margin of which is undulated instead of being rectilinear. The scales are somewhat larger, although they present the same general appearance as those of the brook trout. The lateral line is similar in both of these species. A bluish tint extends all along the back from the head to the tail, so that when seen from above, the fish appears entirely blue; hence the name of *Blue Back*, given to it by the settlers of that neighborhood. The sides and abdomen are silvery white in the female, and of a deep reddish orange in the male, spotted in both sexes with orange of the same hue as the abdomen. The dorsal and caudal fins are brownish blue, bordered with pale orange in the male, the pectorals, ventrals, and anal of a fiery orange, blackish blue at their base, with their margin of the purest white. When just taken out of the water it is impossible to imagine any thing more beautiful and more delicate in the way of coloration in fishes of the temperate zone."

Mr. Page said of them (l. c.) that they had no bright vermilion spots, the ventral, anal, and pectoral fins bright scarlet but without the black and white lines so conspicuous on the Brook Trout, and the tail more forked.

In Forest and Stream of December 10, 1874, p. 277, Mr. C. A. Kingsbury, of Philadelphia. stated that he had received some Bluebacks, a careful, critical examination of which led him to believe them to be an undescribed species, and at the meeting of the Philadelphia Academy of Sciences of the 17th of November, 1874, he had presented the specimens and given a minute description of them under the name of Salmo caeruleidorsus. This communication was referred to the Standing Committee on Ichthyology and at the suggestion of Dr. Leidy the specimen was sent to Professor Baird who advised him that it was the Salmo oquassa of Girard, and in the same paper, on the same page, was published a description of the fish by James W. Milner. under date of November 29, 1874, to whom it appears Mr. Blackford had sent specimens. He stated that the form of oquassa was much more slender and with a tendency to prolongation not seen in the Brook Trout; thus in the length of body and of head compared with their lengths, the pectoral fin prolonged to a slender point, the two lobes of the caudal extended in the same way, showing a decided furcation, and the opercular bones prolonged into a more acute angle. On the contrary the maxillary bone extends much less far back of the position of the eye, or toward the hinder end or hinge of the lower jaw in the Oquossoc trout. The interopercular bone, he states, is much larger in S. oquassa and the suboperculum is wider and the tail in Salmo fontinalis is more truncated than in any species it is likely to be confounded with.

The Maine Commissioners' Report for 1874, pp. 17, 18, says: "This beautiful little fish takes its name from a bluish tint on the back, not unlike the bloom of a plum. They are spotted like a trout, and to a casual observer the difference in a basket of fishes would not be noted. But like the togue they have only the yellow and black spots but not the red. Their tints and

coloring are very beautiful, particularly in the male, the pectoral fins rivalling in color the autumn-tinted maple leaves; like the dying dolphin, their brilliancy of color is lost or fades away with their lives. They are more delicate and symmetrical in shape than the brook trout and have the tail forked."

In his letter to Mr. Mather in 1887 (*l. c.*), Mr. Stanley says: "The adult fish does not have any white on the fins at all like the brook trout. The fins of the male are bright red, or the color of bright autumn leaves. When taken from the water they are of a dark color, but after death turn to a light yellowish cast. The spots are very minute, very thick, very bright yellow and red. Both thicker and brighter than in the brook trout."

# Descriptions of Recent Large Salvelinus oquassa from Rangeley Lakes, Maine.

*Male.*— Head 4 in length without caudal; snout, 3.66; eye, 6.11; upper jaw, 1.98; lower jaw, 1.57. Body robust, symmetrical, fusiform, the depth equaling head, 4 in length of body without caudal; dorsal situated midway between tip of snout and middle base of caudal, rays 11, the longest longer than base, 1.77 in head; base 1.68 in head; distance from posterior end of dorsal base to adipose fin about equaling the distance from insertion of adipose to middle base of caudal, 4.4 in length without caudal; distance from tip of snout to base of pectoral 1.20 in distance from dorsal to adipose, just 2 in distance from tip of snout to dorsal; pectoral much longer than ventral, 1.57 in head, the distance from its base to base of ventral 3.66 in length without caudal; ventral situated under anterior fourth of dorsal, nearer tip of snout than base of caudal, the distance from its base to origin of anal less than length of head and 4.15 in length without caudal; anal rays 9, the longest about equaling in length one half the distance from ventral to anal, slightly less than the length of anal base and slightly greater than the distance from anal to caudal, 2.11 in head; distance from posterior end of anal base to lower base of caudal greater than distance from adipose to caudal, containing the least depth of caudal peduncle 1.25 times; 49 pyloric coeca.

Coloration.— Above dark bluish, irregularly and finely mottled with darker, the blue fading into pale pinkish purple near the middle axis of the body, thence into bright lemon yellow, becoming a very rich deep yellow on lower part of body; spots orange yellow along sides; head dark bluish, becoming greenish with metallic reflections and faint spots of lemon and golden yellow; dorsal, deep bluish of back becoming greenish and finally yellowish at upper margin; adipose, darker shade of color of back; caudal, blue color of back changing through greenish to greenish yellow at posterior margin; and with a lower margin of yellow of body; pectoral, ventral, and anal fins yellowish orange at tips deepening to orange pink, then dusky pinkish basally; anterior margins white with slight black line behind.

Specimen  $13\frac{5}{8}$  inches long.

#### BLUEBACK TROUT.

Female.— Similar in form to male but somewhat deeper, with shorter head and head parts, excepting larger eye, and smaller fins. Head 4.48 in length without caudal; snout, 3.91; eye, 5.75; upper jaw, 2.3; lower jaw, 3.48. Depth of body 4.03 in length without caudal; the dorsal situated more posteriorly than in male, the distance of its origin from tip of snout about equaling distance from origin to upper base of caudal, the distance from posterior end of dorsal base to middle base of caudal about equaling distance from front of orbit to origin of dorsal: dorsal rays 11, the longest longer than the base of the fin, 1.43 in head; dorsal base 1.28 in longest ray and 1.84 in head; distance from posterior end of dorsal base to adipose fin about equaling the distance from insertion of adipose to middle base of caudal; about 4.84 in length without caudal; distance from tip of snout to base of pectoral about 1.06 in head, and 2.37 in distance from tip of snout to origin of dorsal; pectoral equaling ventral in length, 1.19 in head, the distance from its base to ventral 3.82 in length without caudal; ventral situated under the origin of dorsal nearer tip of snout than middle base of caudal, the distance from its base to origin of anal greater than length of head and 4.11 in length without caudal; anal rays 9, the longest more than one half distance from ventral to anal, slightly longer than base of anal, and greater than distance from anal to caudal, 1.43 in head; distance from posterior end of base of anal to lower base of caudal greater than distance from adipose to caudal, containing the least depth of caudal peduncle 1.42 times.

Coloration.— Similar to male but paler; blue of back less decided and with scarcely a trace of mottling; median portion of body paler rose; abdomen lemon yellow; body spots much smaller and of lighter orange. Dorsal similar to male but with a white dot at base of each ray. Pectoral, ventral, and anal fins lighter than in male.

Specimen  $14\frac{5}{8}$  inches long.

# Description of Salvelinus oquassa, var., from Rainbow Lake, Maine, from Specimens serving as Subjects of the Illustrations in this Paper.

*Male.*— Head 4.06 in length without caudal; snout, 3.42; eye, 6; upper jaw, 2.08; lower jaw, 1.52. Body symmetrically fusiform, the depth 4.87 in length without caudal; dorsal situated midway between tip of snout and middle base of caudal, length of its base about equaling length of longest ray, about 1.80 in head, rays 10; distance from posterior end of dorsal to adipose about equal to distance from insertion of adipose to middle base of caudal, about 4.33 in length of body without caudal; distance from tip of snout to base of pectoral equaling distance from dorsal to adipose; length of pectoral equaling length of ventral, 1.5 in head, the distance from its base to base of ventral, 3.48 in length of body without caudal; ventral situated under the anterior third of dorsal nearer tip of snout than middle base of caudal, distance from base to beginning of anal 3.9 in length of body without caudal; anal rays 9, its

height about equaling one half the distance from ventral to anal, 1.92 in head, and the length of base 2.4 in head; distance from posterior end of anal to lower caudal base, somewhat more than base of anal and about equaling distance from adipose to upper base of caudal, the least depth of caudal peduncle being 1.51 in this distance.

*Coloration.*— Head and back purplish blue fading downward through lighter tones to steel blue, with purplish iridescence on sides, becoming pale rose, thence through deepening shades into deep crimson on under parts; ventral line whitish. Spots on sides dull orange above lateral line, becoming darker with an infusion of crimson below; dorsal like back, purplish brown on upper posterior margin; caudal of lighter purplish blue than back; pectoral, ventral, and anal fins deep crimson with white anterior edges.

Specimen  $8\frac{3}{8}$  inches long.

*Female.*— Head 4.39 in length without caudal; snout, 3.66; eye, 4.88; upper jaw longer than in male (unusual), 2 in head; lower jaw, 1.82. Body somewhat more robust than in male, the depth equaling head; dorsal, situation similar to male, its rays 11, the longest equaling length of base, 1.62 in head; distance from posterior end of dorsal to adipose about equaling the distance from insertion of adipose to middle base of caudal, about 4.1 in length of body without caudal; distance from tip of snout to base of pectoral somewhat less than from dorsal to adipose; length of pectoral greater than that of ventral, 1.41 in head, the distance from its base to base of ventral 3.32 in length without caudal; ventral situated as in male, nearer tip of snout than middle base of caudal, the length 1.57 in head; distance from base of ventral to beginning of anal 3.71 in length without caudal; anal rays 9, the longest about equaling one half the distance from base of ventral to anal, and its base 2 in length of head; distance from posterior end of anal base to lower caudal slightly greater than the distance from adipose to upper base of caudal, the length of head; distance from posterior end of anal base to lower caudal slightly greater than the distance from adipose to upper base of caudal, the length 0.12.

Coloration. — Similar to male but much lighter shades and having smaller spots. From specimen  $8\frac{1}{8}$  inches long.

#### SYNONYMY.

Salmo oquassa GIRARD, CHARLES, Proc. Boston Soc. Nat. Hist., vol. 4, p. 262, meeting of October 20, 1852, date of publication March, 1853.— HOLMES, EZEKIEL, "Catalogue of Synopsis of a Part of the Fishes of Maine, arranged according to Prof. Gill's Classification," Dr. Holmes Report on the Fishes, of Maine, Part 2, Second Annual Report on the Natural History and Geology of Maine, p. 62, 1862, (Blueback); and "Familiar and Scientific Description of some of the Maine Fishes named in the foregoing Synopsis," *ibid.*, p. 113, (Blueback Trout), "Lakes at the head of the Androscoggin River, in Franklin County" (after Girard).— GARMAN, S., "The American Salmon and Trout, including introduced Species," Nineteenth Annual Report of the [Mass.] Commissioners of Inland Fisheries, p. 74, fig. 13, 1885, (outline Blueback), "Found only in Maine, in the Rangeley lakes, their tributaries and outlets; Androscoggin River."

a+	a	b/a	m/a	n/a	o/a	p/a	q/a	s/a	t/a	√/a	x/a	y/a	y1/a	z/a	z²/a	c/b	e/b	h/b	k/b	c/g	y/a1	z <sup>1</sup> /a <sup>1</sup>	a <sup>1</sup> /z	a/z1	Gr.	Br.	D.	A.	Sex
$13\frac{5}{8}$	308	.243	.435	.126	.139	.155	.288	.133	.224	.107	.116	.237	.016	.097	.120	.160	.320	.613	.693	.461	2.92	1.48	.833	8.32	${7+12}{7+13}$	<b>9</b> 6	11	11	57
$14\frac{3}{16}$	313	.242	.460	.121	.146	.159	.290	.127	.223	.121	.115	.255	.012	.095	.121	.157	.276	.513	.631	.486	2.96	1.40	.900	8.23	{7+12	$\frac{10}{9}$	10	10	07
$14\frac{1}{2}$	326	.251	.447	.116	.159	.159	.285	.134	.223	.110	.125	.263	.012	.092	.101	.146	.317	.573	.658	.444	2.96	1.13	.966	9.87		$\frac{10}{9}$	10	9	57
15	336	.250	.431	.130	.141	.163	.279	.142	.199	.113	.125	.241	.014	.107	.110	.142	.309	.583	.642	.428	2.79	1.27	.805	9.08	$   \begin{cases}     7+12 \\     9+12   \end{cases} $	$\frac{9}{10}$	11	11	57
$15\frac{3}{8}$	340	.229	.458	.120	.129	.147	.305	.117	.241	.105	.120	.264	.016	.100	.117	.153	.269	.500	.602	.444	3.33	1.48	.794	8.50		$\frac{10}{9}$	10	10	ę
16 <u>1</u>	375	.229	.466	.112	.133	Contract of the second	Contraction of the second second	Salar Beching and	12145 ALESS 8201 V	115 YON MILL MARK	Contraction of the second		2.1. 1. 2. 2. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.	PARTY CONTRACTOR OF THE	1. S. C. S.	Contraction of the second second	CALL STREET, SALES	CARLES CONTRACTOR	1.20 A 84 C 2 K 1 C		and the first statements	ST	Contraction of the last	AND A DOMESTIC OF STREET	$\begin{cases} 8+14\\ 7+13 \end{cases}$	$\frac{9}{10}$	10	9	ę

Table of Proportional Measurements and other Characters of large Salvelinus oquassa from Rangeley Lakes, showing Variation in Sexes and Individuals.<sup>1</sup>

Proportional Measurements and other Characters of Salvelinus oquassa, var., from Rainbow Lake, Maine.<sup>1</sup>

a	a+	b/a	d/a	m/a	n/a	o/a	i/a	p/a	q/a	s/a	t/a	v/a	y/a	y1/a	z/a	z1/a	c/b	e/b	h/b	k/b	c/g	z/a1	z1/a1	a1/z	a1/z1	Gr.	Br.	D.	A.	Sex.
$7\frac{3}{8}$	160	.237	.205	.443	.118	.131	.225	.162	.312	.131	.212	.087	.267	.018	.106	.118	.223	.236	.421	.552	.772	1,66	1.58	.600	.631	{8+13 8+13	$\frac{9}{10}$	10	10	57
81/2		E. C. S.	Contraction of the second		Contraction of the second	and a straight a	Contraction of the local distance of the loc	Contraction of the second second	1	1.10.1000 (100.90)	C ROSINGER	S. Street M. Long M.		C. C. SHERE S. C. C.	100000000000000000000000000000000000000	100 - 100 D.		Contract and a second	Contraction of the	ALC: CARDON ALCON	CALLS AND		CONTRACTOR STAT	1.	10 CA 38 PT 5 COLOR	(8+13) (7+13)	100 Statistics and	10	9	o <sup>7</sup>
83	190	.247	.205	.468	.115	.157	.234	.168	.310	.136	.242	.078	.247	.023	.100	.136	.244	.244	.500	.638	.821	1.26	1.73	.789	.576	$ \begin{cases} 7+12 \\ 7+12 \end{cases} $	$\frac{10}{9}$	10	8	o <sup>7</sup>
9	195	.235	.205	.461	.123	.148	.220	.169	2	2	2	.089	.251	.030	.097	.138	.239	.239	.456	.586	.814	1.46	2.00	.684	.481	${6+10? \\ 8+12}$	$\frac{9}{10}$	10	9	o <sup>7</sup>
$8\frac{5}{16}$	183	.227	.218	.448	.120	.133	.218	.163	.295	.120	.251	.098	.245	.019	.103	.109	.240	.240	.457	.602	.909	1.26	1.33	.789	.750	${7+13}{7+13}$	$\frac{9}{10}$	12	10	ę
81/2	185	.225	.194	.446	.118	.128	.225	.169	.312	.123	.230	.097	.251	.028	.102	.123	.222	.222	.454	.568	.909	1.53	1.84	.650	.541		<u>10</u> 9	10	10	ę
834	195	.237	.194	.448	.124	.129	.221	.162	.318	.124	.232	.097	.248	.021	.097	.097	.223	.223	.431	.590	.714	1.20	1.40	.833	.714	${6+11}{6+11}$	$\frac{9}{10}$	11	9	ę

Explanation of symbols used in the tables .-- The proportional measurements are expressed by decimal fractions. The parts or structures are indicated by letters and the proportion designated by the letters in the form of algebraic common fractions. Thus: b/a signifies that the proportion is obtained by dividing the measurement of part b by the dimension of a.  $h^3$ . Width of supplementary maxillary.

Distance from tip of snout to base of pectoral fin.

- a+. Total length in inches from tip of snout to tip of tail.
- a. Length in mm. from tip of snout to end of lateral line.
- Least depth of caudal peduncle.  $a^1$ .
- Length of head from tip of snout to gill-opening. Ъ.
- Length of head from tip of snout to nape. b1.
- b2. Perpendicular diameter of head through middle of eye.
- Length of eye. C.
- Greatest depth of body. d.
- Distance from tip of snout to front of eye. е.
- Distance from tip of snout to posterior edge of pref.
- opercle. Width of interorbital space. g.
- Distance from tip of snout to posterior extremity of maxillary.
- Width of maxillary.  $h^1$ .
- $h^2$ . Length of supplementary maxillary.

- Distance from tip of snout to ventral fin. j.
- Length of lower jaw to junction with the quadrate. k.
- l. Distance from tip of snout to anal fin.
- Distance from tip of snout to origin of dorsal fin. m.
- Length of base of dorsal fin. n.
- Height of dorsal fin. 0.

i.

- Length of pectoral fin. р.
- q.
- Distance from base of pectoral to base of ventral fin. Length of longest upper caudal ray.
- T. Length of ventral fin. s.
- t.
- Distance from base of ventral to origin of anal fin. 21.
- Length of longest caudal ray.
- v. Length of base of anal fin.
- w. Length of middle caudal ray.

<sup>2</sup> Ventral fins absent; distance from tip of snout to ventral divided by a, .538.

- x. Length of longest ray of anal fin.
- y. Distance from posterior end of dorsal to adipose fin.
- $y^1$ . Length of base of adipose fin.
- Distance from posterior base of adipose to upper base z. of tail.
- $z^1$ . Distance from posterior base of anal to lower base of tail.
- Br. Number of branchiostegal rays, upper right, lower left side.
- Gr. Number of gill-rakers on both arms of first branchial arch.
- D. Number of fully developed dorsal rays.
- *A*. Number of fully developed anal rays.
- o<sup>7</sup> Male. Female.
- Q Not determined.

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#### WHITE TROUT.

Fario ——? HOLMES, EZEKIEL, "Synopsis on the Fishes of Maine, in part," Dr. Holmes Report of the Elementary Principles of Ichthyology, Part 1, p. 32, (l. c.).

Salmo caeruleidorsus KINGSBURY, C. A., Forest and Stream, December 10, 1874, p. 277.

Salvelinus oquassa BEAN, TARLETON H., "The Red-spotted Trout of New England," Shooting and Fishing, January 10, 1889, p. 6, fig. (Blueback Trout), "Rangeley Lakes."—KENDALL, WILLIAM C., "The Trouts of the Rangeley Lakes," Maine Sportsman, February, 1905, p. 105, "Rangeley Lakes, Maine," and *ibid.*, p. 117, "Rainbow Lake, Maine."—KENDALL, WILLIAM C., "Fauna of New England, List of the Pisces," Occasional Papers Boston Soc. Nat. Hist., vol. 7, no. 8, p. 47, 1905, (Blueback Trout; Blueback) ME.— Mooselucmaguntic and Oquassa lakes, Kennebago Stream; Rainbow Lake, Piscataquis County.

# WHITE TROUT.

# Salvelinus aureolus BEAN.

# PLATE 5, FIG. 7 (male); FIG. 8 (female).

To the fish culturists, this charr is known as the "Golden Trout" or "aureolus" and sometimes as Sunapee Trout or Sunapee-Lake Trout. The latter names are owing to its having been first discovered in Sunapee Lake, New Hampshire. The name "Golden Trout" is derived from its technical name, *aureolus*, which was given to it in reference to the golden sheen of the living fish in the water. It is known as White Trout at Sunapee Lake and it is in this way distinguished from the Common Trout (*Salvelinus fontinalis*) which at Sunapee Lake is called "Native Trout," owing to the popular impression, doubtless, that the White Trout was introduced.

About the time the fish was discovered at Sunapee Lake, there was an animated discussion regarding its identity, some claiming that it was the result of introduction of Saibling (*Salvelinus alpinus*) from Europe. But it was pretty conclusively shown that none of the lot brought from Europe was placed in Sunapee Lake or into any waters from which it could gain access to that lake. Others claimed, with more basis for their claim, that it was a Blueback, which there is no doubt was introduced some five years before the so called discovery of this fish, which had attained a large size owing to favorable conditions in the lake. Some individuals were not wanting who averred that they had known the fish for many years prior to the introduction of Bluebacks.

This protracted and animated discussion in various sportsman's journals and other publications never settled the question nor can it ever be positively determined. All that can be done now is to deduce approximate probabilities from the known facts bearing on the matter.

The Reports of the New Hampshire Fish and Game Commissioners indicate that on April 26, 1878, and again on June 13, 1879, 3,000 and 4,000 young Bluebacks were respectively planted in Sunapee Lake, surely a small number from which to expect immediate extensive results.

According to Dr. John D. Quackenbos,<sup>1</sup> so far as is known, the first specimens of this new

"The Sunapee Saibling: a fourth New England variety of Salvelinus." Trans. N. Y. Acad. Sci., vol. 12, p. 140, 1893.

fish to be distinguished from the well known forms were taken in Sunapee Lake during the summer of 1881. The fish taken weighed from two to three pounds each.

In Forest and Stream, December 18, 1890, p. 435, Dr. T. H. Bean adduces evidence that the White Trout is indigenous to the lake, from information furnished him by Commissioner Hodge. Commissioner Hodge was an earnest advocate of the idea that it was native and the various disputants discredited this evidence. While it has not been admitted in the discussion of the trout in this paper as positively authentic it is in line with what has been stated regarding what usually occurs when a strange fish is discovered. Dr. Bean writes: "During a visit to New Hampshire, in October of this year, the writer first met his friend and correspondent, Col. Elliott B. Hodge, a gentleman whose name is thoroughly identified with fish culture and protection in the State which he loyally serves as Fish and Game Commissioner. We were at Plymouth and Sunapee Lake together, and discussed many objects of mutual interest, among them the golden trout, which Col. Hodge first brought to the notice of ichthyologists and which was introduced to the general public through the columns of 'Forest and Stream.' From him I learned many interesting things relative to the history and habits of the new trout, and, as they have an important bearing upon the inquiry now being made into the relationship of the golden trout to the introduced saibling, I think this an opportune time for making the information public.

"Mr. Pike, who was born and brought up at Sunapee Lake, says that about twenty-five years ago he and his father saw a great school of trout in the lake. They caught a good many of them, but never looked for them again because they supposed it to be a mere chance occurrence.

"Mr. Nat. Lear, of Newbury, N. H., told Col. Hodge that when they were building the Concord & Claremont railroad, in 1872, shortly after the introduction of smelt, he and some others were catching smelt at the mouth of Beech Brook one night (this brook is a tributary of Sunapee Lake), when they saw what they supposed to be a large sucker and dipped it up. It proved to be a white trout of 4 lbs., and looked to him, as he remembers it, just like the *aureolus*, which he has seen since. It was very white and silvery.

"Mr. Moses Gould, of Bradford, N. H., who was one of the earliest trout fishermen on the lake and fished from boyhood, claims that in 1875 he caught two large trout of this kind in Sunapee and showed them to a number of persons as a very peculiar trout.

"About 1873 or 1874 Thomas Roach caught two trout through the ice in Sunapee, one of which weighed more than 7 lbs. Up to 1871 Sunapee Lake was practically unknown as a fishing lake for trout, and there were scarcely any boats on the lake. The little fishing that was done was chiefly for pickerel. No one fished in deep water for trout until their accidental discovery in great depths about 1881 or 1882. The *aureolus*, being a very late spawner, came on to the shoals at a time when there was little or no travel across the lake.

"A Mr. Peabody stated that in 1881 or 1882 he saw a big school of suckers on the shoals south of Loon Island, Sunapee Lake. Of course, there is little doubt that these were golden trout."

#### WHITE TROUT.

Dr. Quackenbos states (*l. c.*) that in the two years following 1881, a sufficient number were taken to excite comment. In October, 1885, Col. Elliott Hodge, then State Fish and Game Commissioner of New Hampshire, had his attention called to the fish, accidentally discovered in vast numbers on a "mid-lake rocky shoal." He wrote to Dr. Quackenbos: "I can show you an acre of these trout, hundreds of which will weigh from 3 to 8 pounds each. I could never have believed such a sight possible in New Hampshire."

Thus it appears that three years after the first lot of Bluebacks was planted specimens were taken weighing 2 and 3 pounds and still more and larger ones in the next few years. In five or six years at most they occurred in prodigious numbers "hundreds of which would weigh from 3 to 8 pounds each."

Taking into consideration the probable abundance of food in the form of smelts, it would not be surprising that in six years the fish might attain six pounds or more in weight, allowing an average increase of one pound to the year, which is a stated estimate for the Common Trout under favorable conditions. But when the abundance of predaceous fishes like the Common Trout, Land-locked Salmon, Perch, and others is taken into consideration, it might be doubted that in that length of time such a multiplication of the species would result from such a small plant as 7,000, even under the most favorable of other conditions, especially when the extinction of the Blueback in the Rangeley Lakes, as has been pointed out, is doubtless due to Landlocked Salmon.

The Rangeley Blueback has been planted in various other lakes of Maine and New Hampshire where the conditions were apparently fully as favorable for it as in Sunapee Lake, and none has since been reported. This, however, does not prove that Sunapee is not an exception, but is collateral evidence. Furthermore, the same White Trout has been discovered in other New Hampshire, Maine, and Vermont waters where no red, white, or blue trout has ever been planted and where they could not gain access from their native waters save through the instrumentality of man; and it is not impossible that it may yet be found in waters where it is not at present recognized. The later discoveries just referred to do not prove that the Sunapee White Trout did not result from the Blueback introduction but it is also evidence to the contrary showing that it is not necessary to account for its presence in Sunapee Lake by man's intervention. There is no record of the introduction of any other fish than the Blueback which could possibly account for its presence. It has been absolutely proved that none of the products of European Saibling eggs ever reached Sunapee Lake. If not a Blueback or a Saibling and not indigenous, where did it come from?

The fact that it was "never observed" prior to this time may be a matter of not recognizing it as distinct from the Common Trout or as Dr. Quackenbos suggests (l. c.), "in the ignorance of the few who in old times may ever have seen it, and who cared for nothing beyond the fact that it was good to eat."

It is quite possible that the Sunapee White Trout was once, before the smelts were introduced, small like the Blueback of Rangeley Lakes and on that account never took the hook and was never observed as it did not ascend the brooks to spawn, and like the Rangeley Blueback it did not attain a large size until after the introduction of smelts; yet there is no way to prove it.

That a fish may exist in a body of water for many years without becoming generally known is not so strange as, at first thought, it seems. Many resident fishermen and even non-resident anglers have caught at times fishes that were more or less strange in appearance. In such cases they discuss its identity among themselves and perhaps come to the conclusion that it is a freak form of some other fish which it to some extent resembles. When not accounted for in that way it is usually ascribed to hybridization, or if a fish with which they are not familiar has been introduced it is likely to be considered that form. But seldom is it suggested that it is a hitherto unrecognized species, and usually instead of sending it to some competent authority for identification it is taken home and eaten or given to the cat or hens. But when some more observing person detects a hitherto unrecognized fish, many others remember that they have caught the same thing at one time or another. Of course, there are instances of forgotten or accidental introductions of fish which when discovered cannot be definitely accounted for, but in most instances such can be determined. The White Trout, for instance, was at first thought by some to be the result of a plant of some fish from the St. John's River, an account of which is given by Dr. Quackenbos (l. c.). But it is well known that no such fish occurs in the St. John's River and it was finally decided that the supposed St. John's River fish were Land-locked Salmon from Grand Lake Stream, Maine.

The White Trout has been found also in Dan Hole Pond, N. H., Flood's Pond, Me., and Averill Pond, Vt. Its discovery in these ponds precludes the necessity of going to Europe to account for its presence in Sunapee Lake. It seems unaccountable to many that the fish could have existed always in Sunapee, fished so much as it was, and not be detected before. As a matter of fact, it is not an unknown phenomenon. While the ponds subsequently found to contain White Trout were perhaps not fished quite as generally as Sunapee, yet they were probably fished as much by the inhabitants about its shores and they doubtless did not distinguish the fish from the Common Trout, at least only to the extent of considering it a peculiar form of the latter.

The White Trout is a rich and savory fish for the table, being fat in season, to which its flavor is apparently due. It is caught mainly by "plug fishing" with live bait and cut bait and very occasionally with worms. Not infrequently it is taken by trolling, but with a deep line as a rule. The best bait seems to be the smelt which was introduced into Sunapee Lake, and has always existed in Flood's Pond. It is "still" or "plug" fished for, in about 80 or 90 feet of water in Sunapee Lake, and about 30 to 40 feet in Flood's Pond (in June). The fact that it is a deep-water species would in part account for its being seldom observed by the old inhabitants.

It is said to attain a weight of 10 pounds in Sunapee Lake, but a fish of 5 or 6 pounds in recent years is a monster.

#### WHITE TROUT.

The White Trout of Sunapee Lake, during the warmer months, resides in depths of from 60 to 90 or 100 feet, where the temperature is in the neighborhood of 50° F. or less. In the spring it occurs in shallow water about the shores and is often caught from the wharves and piers. In the early part or middle of October it appears on a shoal near the entrance to Sunapee Harbor, to spawn, and the run continues approximately one month. This seems to be the only spawning place in the lake. At least, in the search that has been made for other grounds none has been found. The shoal consists of coarse gravel and sand thickly interspersed with bowlders of various sizes, and is contiguous to deep water. The water on the shoal varies, of course, with the level of the lake, but it averages from a foot to 6 or 8 feet in depth in place. A phenomenon was noticed on the shoal which may account for the peculiar suitability of the place as a spawning ground of the fish. That is, whenever a light breeze is blowing from any quarter, even from the side most protected from the wind, there is always a perceptible current across the reef, and at times quite strong, in the same general direction as the wind. The temperature of the water at the beginning of the breeding season, is from 40° to 45° and later about 33°.

In the spawning runs males at first predominate. The action of the fish on the ground has not been fully observed, or, if observed, has not been described. Such observations, however, are difficult owing to the fact that the runs occur at night.

In Forest and Stream of December 18, 1890, quoting Commissioner Hodge, Dr. Bean says: "The golden trout have sometimes come on the spawning shoals by the ton at a time. They do not pair to any noticeable extent, and a female is sometimes attended by five or six males. They make no nest, but move around continuously like lake trout. The lake trout voids the eggs by rubbing the belly over the coarse rocks, and the males sometimes lean down on top of the females. At Loon Island shoals the fish have spawned in waters so shallow that their backs were not covered. The usual depth ranges from six inches to four or five feet, but some of the large ones doubtless spawn in deep water."

The following table shows catches by night on "The Reef" during the month of October, 1910, showing the proportion of males to females.

Date.		Total.	Males.	Females.
October	21	7	6	1
"	23	12	11	1
"	24	49	37	12
"	26	40	30	10
"	$\left. \begin{array}{c} 27\\28 \end{array} \right\}$	96	51	45
"	29			
"	30	· 46	6	40
" Novembe	$\left\{ \begin{array}{c} 31 \\ r & 1 \end{array} \right\}$	~ 30	. 2	28
		280	143	137

Up to the 29th females were in the minority but during the latter part of the month greatly predominated. This may be due to the fact that the males running first were nearly all caught.

A female is stated to average about 1200 ova to the pound of fish. From fish-cultural operations it is observable that the eggs are not always deposited at once, more than one and sometimes several strippings being required to get all of the eggs. While this may possibly be due to the abnormal conditions incident to the retention of the fish in live cars, it is probably a natural condition.

It is not known how long the young remain upon the shoal after hatching, but young White Trout of only a few inches in length are taken on the same grounds as the large fish in summer.

The following observations upon young White Trout were made by the present writer in 1910 and 1911.

April 23, 1910. Along the shore of Soo-nipi Park, principally over coarse gravel and over sand beach near the gravel, several young White Trout were seen and four of them caught, each about one inch long. When disturbed they would swim and dart about, hesitating to go far into deep water. But if they went toward shore they would not conceal themselves under the gravel but seemed to depend for protection upon darting and dodging, at which they were quite adept. Apparently becoming tired, however, they swam more slowly and were easily caught. Their stomachs contained larval Diptera (Chironomus) and some minute crustaceans (Entomostraca).

April 28. At the head of Pike Brook deadwater eight specimens from 1 to  $1\frac{7}{16}$  inches long were caught. Their stomachs also contained principally Chironomus larvae.

August 13. Three White Trout from  $5\frac{1}{2}$  to  $7\frac{3}{4}$  inches long were caught at the Hedgehog fishing ground in about 90 feet of water.

# CHARACTERIZATION.

The Blueback advocates would have rejoiced had they foreseen that the Blueback in its native waters would reach the size of an average Sunapee White Trout, as the main argument against the Blueback theory was the small size attained by the Blueback. As a matter of fact, the small size was the chief difference. Dr. Bean mentions one additional character, *viz.*, the difference in the gill-rakers, which in the Blueback were always straight and in the Sunapee fish usually more or less curled and distorted. But this character does not obtain in the small Sunapee fish and in the large Blueback they are frequently as distorted as in the Sunapee fish. Indeed, it is a difficult matter to distinguish a large Blueback from a White Trout after it has been preserved in alcohol for some time and even when fresh.

While it is comparatively easy to distinguish the Common Trout from the Saiblings, it is a rather difficult matter to distinguish the species of the latter. If they were not so closely related

#### WHITE TROUT.

	Sunapee Trout.	Blueback.
1.	Anal III 8.	Anal III 10.
2.	Immature 9 inches in length.	Mature 9 inches in length.
3.	Color of back in young, numerous dark	Back uniform steel blue.
	blotches.	
4.	Embryo with white lines at the upper and	No such white lines.
	lower edges of caudal.	
5.	Spawns in lake on shoals.	Spawns in streams.
6.	Gill-rakers shorter and usually less num-	More numerous and not curled.
	erous and almost always curled.	

The first difference will not serve to distinguish them, as *S. aureolus* sometimes has 10 anal rays, but in general it is of significance especially when taken with other apparent differences that the usual anal fin formula in *S. aureolus* is 9, that of *S. oquassa* is 10 or 11.

The second does not now obtain for mature 9-inch *aureolus* have been observed and *oquassa* is known to reach the size of the average *aureolus*.

The third is of no value as it is comparing an immature or young fish with a mature adult.

The fourth is of little value as it refers to a character that was observed in S. aureolus but its absence in S. oquassa was conjectured.

Fifth, the place of spawning is obviously not a specific distinction.

Sixth, the gill-rakers of the large specimens of S. oquassa do not differ in number, length, or in curling and other distortions, from those of the Sunapee White Trout.

Having weighed and found most of these supposed differences wanting, it remains to point out the differences, if any exist. The most conspicuous external difference is that of color and that is not very pronounced. The spots are more numerous and smaller, and the under side of the pectoral fin has a narrower margin of white, in *oquassa*. While as before stated the *oquassa* occasionally has as few as 9 rays in the anal, it more often has 10 or 11 and *aureolus* never has been found to have 11 and only rarely 10. Comparing two male specimens each of the two species, the *oquassa* apparently has a somewhat longer head and snout. More careful examination of a larger number of specimens each might either reveal more differences or reduce the foregoing to naught. The young even in the fry stage are usually easily distinguished from the Common Trout by fewer parr marks.

#### DESCRIPTIONS.1

Breeding male.— Head about 4.5 in length without caudal; eye 7.9 in head; snout, 3.32; upper jaw, 1.76; lower jaw, 1.4; branchiostegals, 10/10; gill-rakers 7+13 on each side. Body comparatively slender, the depth 3.76 in length without caudal; caudal peduncle slender, 1.22 in the distance from anal to caudal; dorsal somewhat nearer tip of snout than base of caudal; dorsal rays III 9, the longest longer than anal base and 1.84 in head; distance from adipose to base of caudal equal to base of dorsal and somewhat greater than least depth of caudal peduncle; length of pectoral 1.4 in head, the distance of its base from tip of snout about equaling length of head; distance from base of pectoral to ventral 3.28 in length of body without caudal; length of ventral 1.69 in head; distance from base of ventral to base of caudal 1.18 in distance from tip of snout to ventral; anal-rays III 9, the longest 2.12 in head. From a specimen  $16\frac{1}{2}$  inches long taken in Sunapee Lake, N. H., October 24, 1910.

*Coloration.*— Body light grayish olive above, indistinctly and irregularly spotted with darker tones of the same color, becoming paler and showing purplish and rose tints, these passing below the lateral line into a golden yellow which constantly deepens toward the ventral line of the body into golden orange; spots on sides dull orange yellow; dorsal same color as back, fading to dull brownish orange at tips, lightest posteriorly; adipose same color but slightly darker than back; caudal same color as back, darker basally, having three indistinct dusky spots at outer edge of both upper and lower lobes; lower edge shading into orange brown; pectoral, ventral, and anal fins bright crimson with white line on anterior edge; pectoral having blackish line behind the white edge and becoming somewhat dusky basally. Head, color of body, becoming lighter on side, with metallic luster of yellow and light green and mottlings of dusky; lower jaw mottled with dusky, tip of lower jaw and end of snout of duller tones of the orange of the body; iris bright yellow.

Breeding female.— Head.4.90 in length without caudal; eye 6.41 in head; snout, 4.05; upper jaw, 2.08; lower jaw, 1.60; branchiostegals 10/10; gill-rakers 7+13 on each side. Body moderately slender, the depth 4.34 in length without caudal; caudal peduncle slender, its least depth 1.82 in distance from anal to caudal; origin of dorsal nearer tip of snout than base of caudal; dorsal rays III  $10\frac{1}{2}$ ; the longest shorter than anal base and 2.26 in head; distance from adipose to base of caudal less than base of dorsal and nearly one half greater than least depth of caudal peduncle; length of pectoral 1.57 in head, the distance of its base from tip of snout about equaling length of head; distance from base of pectoral to ventral 3.09 in length of body without caudal; length of ventral 1.92 in head; distance from base of ventral to base of caudal

<sup>1</sup>From specimens other than those of the illustrations. Illustrations from a male 18<sup>5</sup>/<sub>8</sub> inches long and a female 19 inches long, respectively.

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a+	a	b/a	m/a	n/a	o/a	p/a	q/a	s/a	t/a	v/a	x/a	y/a	y1/a	z/a	z1/a	c/b	e/b	h/b	k/b	c/g	y/a1	z1/a1	a <sup>1</sup> /z	a/z1	Gr.	Br.	D.	A.	Sex
16	365	.230	.449	.131	.137	.153	.290	.128	.208	.115	.123	.227	.015	.109	.112	.142	.279	.547	.702	.400	2.76	1.36	.750	8.90		?	10	10	57
16 <u>1</u>	365	.235	.450	.120	.117	.161	.304	.134	.205	.109	.106	.246	.019	.123	.126	.127	.325	.555	.720	.366	2.67	1.35	.755	7.93	${7+13}$ 7+13	$\frac{10}{10}$	10	9	S <sup>™</sup>
$16\frac{1}{2}$	375	.221	.453	.114	.120	.157	.304	.130	.218	.096	.104	.232	.032	.114	.129	.126	.301	.566	.710	.365	2.76	1.53	.732	7.73	${7+13}$ 7+13	$\frac{10}{10}$	9	9	57
17	385	.246	.470	.116	.140	.155	.296	.129	.210	.098	.153	.223	.020	.098	.124	.126	.336	.589	.673	.352	2.52	1.41	.894	8.02	${7+14}{7+14}$	$\frac{10}{11}$	11	9	5
16 <u>1</u>	378	.203	.447	.150	.089	.129	.322	.105	.224	.095	.089	.243	.013	.108	.134	.155	.246	.480	.623	.444	3.28	1.82	.682	7.41	${7+13}$ 7+13	$\frac{10}{10}$	10	9	ę
17	380	.215	.481	.110	.102	.144	.334	.110	.231	.092	.097	.252	.021	.096	.126	.170	.280	.512	.646	.351	3.36	1.68	.780	7.91	${7+15}$ 7+15	$\frac{10}{10}$	10	$9\frac{1}{2}$	ę
171	340	.267	.550?		.138	.152	.347	.132	.252	.120	.135	.273	.014	.123	.138	.131	.285	.527	.637	.363	3.00	1.51	.738	7.25	$_{7+12}^{6+12}$	$\frac{10}{11}$	10	9	ę
181	420	.216	.457	.111		.130	.307	.107	.221	.090	.111	.245	.009	.107	.100	.142	.307	.527	.659	.351	3.12	1.27	.733	10.00	${6+12 \\ 6+12}$	$\frac{9}{12}$	10	9	ę
19	430	.211	.467	.113	.118	.146	.332	.125	.239	.090	.111	.220	.019	.146	.111	.153		.538	.681	-	2.79	1.41	.539	8.95	${7+14}{7+14}$	$\frac{10}{10}$	10 <u>1</u>	9 <u>1</u>	ę

Table of Proportional Measurements and other Characters of Salvelinus aureolus from Sunapee Lake, New Hampshire, showing Individual, Size, and Sex Variation.1

Table of Proportional Measurements of Salvelinus aureolus from Averill Ponds, Vermont, showing Individual, Size, and Sex Variation.<sup>1</sup>

<u>_</u> a+	8	b/a	m/a	n/a	o/a	p/a	q/a	s/a	t/a	v/a	x/a	y/a	y1/a	z/a	z1/a	c/b	e/b	h/b	k/b	c/g	y/a1	z1/a1	a1/z	a/z1	Gr.	Br.	D.	A.	Sex
$12\frac{5}{8}$	267	.239	.423	.119	.172	.172	.288	.142	.220	.086	.138	.265	.014	.112	.127	.187	.281	.593	.656	.500	3.38	1.61	.706	7.85		$\frac{11}{10}$	11	9	57
17	390	.228	.458	.117	.141	.158	.317	.128	.210	.112	.117	.251	.015	.107	.105	.140	.325	.617	.752	.416	3.26	1.36	.714	9.51	${7+12} \\ 6+13$	<u>10</u> 9	10	10	0 <sup>71</sup>
15	342	.204	.470	.111	.131	.149	.345	.119	.228	.116	.125	.296	.013	.093	.102	.159	.291	.500	.614	.392	3.17	1.20	.906	9.77	${8+13}$ 9+13	$\frac{10}{10}$	10	10	ę
17	375	.213	.453	.130	.144	.152	.282	.125	.221	.125	.144	.261	.016	.114	.098	.162	.300	.525	.650	.419	3.16	1.19	.720	10.13	${8+13 \\ 9+14}$	$\frac{10}{10}$	10	10	ę

<sup>1</sup> Explanation of symbols used in the tables.— The proportional measurements are expressed by decimal fractions. The parts or structures are indicated by letters and the proportions designated by the letters in the form of algebraic common fractions. Thus: b/a signifies that the proportion is obtained by dividing the measurement of part b by the dimension of a. a+. Total length in inches from tip of snout to tip of tail.

- $h^3$ . Width of supplementary maxillary.
- Length in mm. from tip of snout to end of lateral line. ż.
- $a^1$ . Least depth of caudal peduncle.
- Ъ. Length of head from tip of snout to gill-opening.
- Length of head from tip of snout to nape. b1
- Perpendicular diameter of head through middle of eye. b2.
- Length of eye. C.

a.

- Greatest depth of body. d.
- Distance from tip of snout to front of eye. e. f.
- Distance from tip of snout to posterior edge of preopercle.
- Width of interorbital space. g.
- Distance from tip of snout to posterior extremity of h. maxillary.
- $h^1$ . Width of maxillary.  $h^2$ .
- Length of supplementary maxillary.

- Distance from tip of snout to base of pectoral fin. Distance from tip of snout to ventral fin.
- Length of lower jaw to junction with the quadrate.
- 1. Distance from tip of snout to anal fin.
- m. Distance from tip of snout to origin of dorsal fin.
- Length of base of dorsal fin. n.
- Height of dorsal fin. 0.
- Length of pectoral fin. р.
- Distance from base of pectoral to base of ventral fin. q.
- Length of longest upper caudal ray. T.
- Length of ventral fin. s.
- t. Distance from base of ventral to origin of anal fin.
- u. Length of longest lower caudal ray.
- v. Length of base of anal fin.
- w. Length of middle caudal ray.

- x. Length of longest ray of anal fin.
- Distance from posterior end of dorsal to adipose fin. y.
- $y^1$ . Length of base of adipose fin.
- z. Distance from posterior base of adipose to upper base of tail.
- $z^1$ . Distance from posterior base of anal to lower base of
- tail. Br. Number of branchiostegal rays, upper right, lower
- left side. Gr. Number of gill-rakers on both arms of first branchial
  - arch.
- D. Number of fully developed dorsal rays.
- Number of fully developed anal rays. A.
- 07 Male.
- 9 Female.
- ?. Not determined.

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					00.0	10.8.17	758		131	861.	-821.	£10 <sup>3</sup>	373		.120	352	.132	317		1.38					
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A doic of	1 Toportionai	Measurements and other	Characters of	Salvelinus	aureolus	from	Flood's	Pond.	Maine. showing	Individual	Size	and S.	m Variation	no 1
						Subara Carso		A REAL PROPERTY AND		210000000000000000000000000000000000000	NUAU,	unu Di	a variation	115

a+	8	b/a	m/a	n/a	o/a	p/a	q/a	s/a	t/a	v/a	x/a	y/a	y1/a	z/a	z <sup>1</sup> /a	c/b	e/b	h/b	k/b	c/g	y/a1	z1/a1	a <sup>1</sup> /z	a/z1	Gr.	Br.	D.	A.	Sex
$12\frac{3}{8}$	268	.246	.477	.123	.138	.145	.313	.119	.208	.089	.115	.216	.015	.104	.108	.159	.272	.530	.636	.456	2.76	1.38	.750	9.24	${7+12}\ {8+12}$	?	10	9	
$12\frac{3}{4}$	283	.250	.468	.113	.127	.115	.328	.123	.197	.091	.120	.219	.010	.098	.113	.161	.281	.521	.633	.500	2.81	1.45	.785	8.84	$\begin{cases} 8+12 \\ 8+14 \\ 7+12 \end{cases}$	$\frac{11}{12}$	10	9	07
13	290	.255	.503	.120	.148	.155	.331	.124	.196	.103		.217	.012	.103	.124	.148	.297	.567	.662	.458	2.62	1.50	.800	8.05	${8+12}$ ${7+13}$	$\frac{9}{10}$	10	?	5
131	305	.229	.465	.117	.121	.140	.321	.216?	.196	?	.108	.226	.016	.104	.117	.157	.285	.485	.614	.478	2.33	1.59	.687	8.71	$     \begin{cases}       7+13 \\       8+13     \end{cases}   $	$\frac{9}{10}$	10	9	5
14	310	.251	.480	.122	.129	.151	.306	.129	.206	.096	.109	.203	.016	.100	.109	.153	.282	.576	.679	.461	3.13	1.25	.870	9.11	${8+14 \\ 7+12}$	<u>11</u> 11	10	9	5
123	275	.229	.469	.123	.130	.127	.320	.107	.207	.083	.090	.221	.016	.112	.116	.158	.277	.460	.587	.571	3.05	1.60	.645	8.59	{7+12	9	10	9	
14 <u>3</u>	328	.234	.466	.109	.118	.143	.314	.121	.204	.082	.118	.240	.018	.115	.121	.149	.272	.496	.584			1.60		Section Physics	7+13 9+13 9+13 9+13	1 <u>10</u> 9	10	9	Q Q
16 <u>7</u>	376	.228	.468	.119	.125	.148	.337	.106	.202	.082	.114	.228	.013	.111	.114	.144	.267	.604	.546		3.18		.642	074		$\frac{11}{12}$	10	9	¢
1078	243	.238	.475	.115	.139	.147	.345	.115	.197	.084	.102	.230	.012	.102	.102	.172	.258	.482	.586	.555	2.87	1.28	.780		(7+13		10	9	.7
$10\frac{1}{2}$	234	.239	.478	.115	.141	.149	.311	.115	.198	.087	.119	.217	.021	.102	.115	.178	.267	.482	.589	.357?			.770		7+13 8+12 8+13		10	9	5 5
9 <u>3</u>	212	.226	.464	.115	.132	.136	.311	.113	.198	.089	.108	.235	.016	.103	.116	.187	.260	.447						0.40	8+13 8+13 8+13 8+13		10	9	0
834	189	.243	.481	.116	.124	.148	.312	.121	.206	.084	.106	.226	.010	.100	.116	.195	.260	.478	.565	.642	2.86	1.46	.789	0 00	8+13 8+13 8+13 8+13		11	9	?
778	172	.232	.465	.122	.139	.148	.331	.116	.215	.087	.104	.203	.014	.104	.122	.207	.268	.463	.585	.708	2.69	1.61	.722		8+13		11	9	?
578	129	.248	.496	.116	.147	.155	.333	.120	.201	.089	.108	.217	.011	.108	.104	.218	.234	.421	.531	.777	2.94	1.42	.678	9.55	7+12 7+13		10	9	?

<sup>1</sup> Explanation of symbols used in the tables.— The proportional measurements are expressed by decimal fractions. The parts or structures are indicated by letters and the proportions designated by the letters in the form of algebraic common fractions. Thus: b/a signifies that the proportion is obtained by dividing the measurement of part b by the dimension of a. Width of supplementary maxillary.

- a+. Total length in inches from tip of snout to tip of tail. a. Length in mm. from tip of snout to end of lateral line.

Table of Dury 1' 1 10

- a<sup>1</sup>. Least depth of caudal peduncle.
- Length of head from tip of snout to gill-opening. Ъ.
- Length of head from tip of snout to nape. b1.
- Perpendicular diameter of head through middle of eye.  $b^2$ .
- c. Length of eye.
- d. Greatest depth of body.
- Distance from tip of snout to front of eye. е.
- Distance from tip of snout to posterior edge of pref. opercle.
- Width of interorbital space. g.
- h. Distance from tip of snout to posterior extremity of maxillary.
- h<sup>1</sup>. Width of maxillary.
- $h^2$ . Length of supplementary maxillary.

- Distance from tip of snout to base of pectoral fin. Distance from tip of snout to ventral fin.
- Length of lower jaw to junction with the quadrate. k.
- *l*.
- Distance from tip of snout to anal fin. m.
- Distance from tip of snout to origin of dorsal fin.
- Length of base of dorsal fin. n.
- Height of dorsal fin. 0.

i.

- p.Length of pectoral fin.
- Distance from base of pectoral to base of ventral fin. q.
- Length of longest upper caudal ray. r.
- Length of ventral fin. S.
- Distance from base of ventral to origin of anal fin. t.
- Length of longest lower caudal ray. u.
- Length of base of anal fin. v.
- w. Length of middle caudal ray.

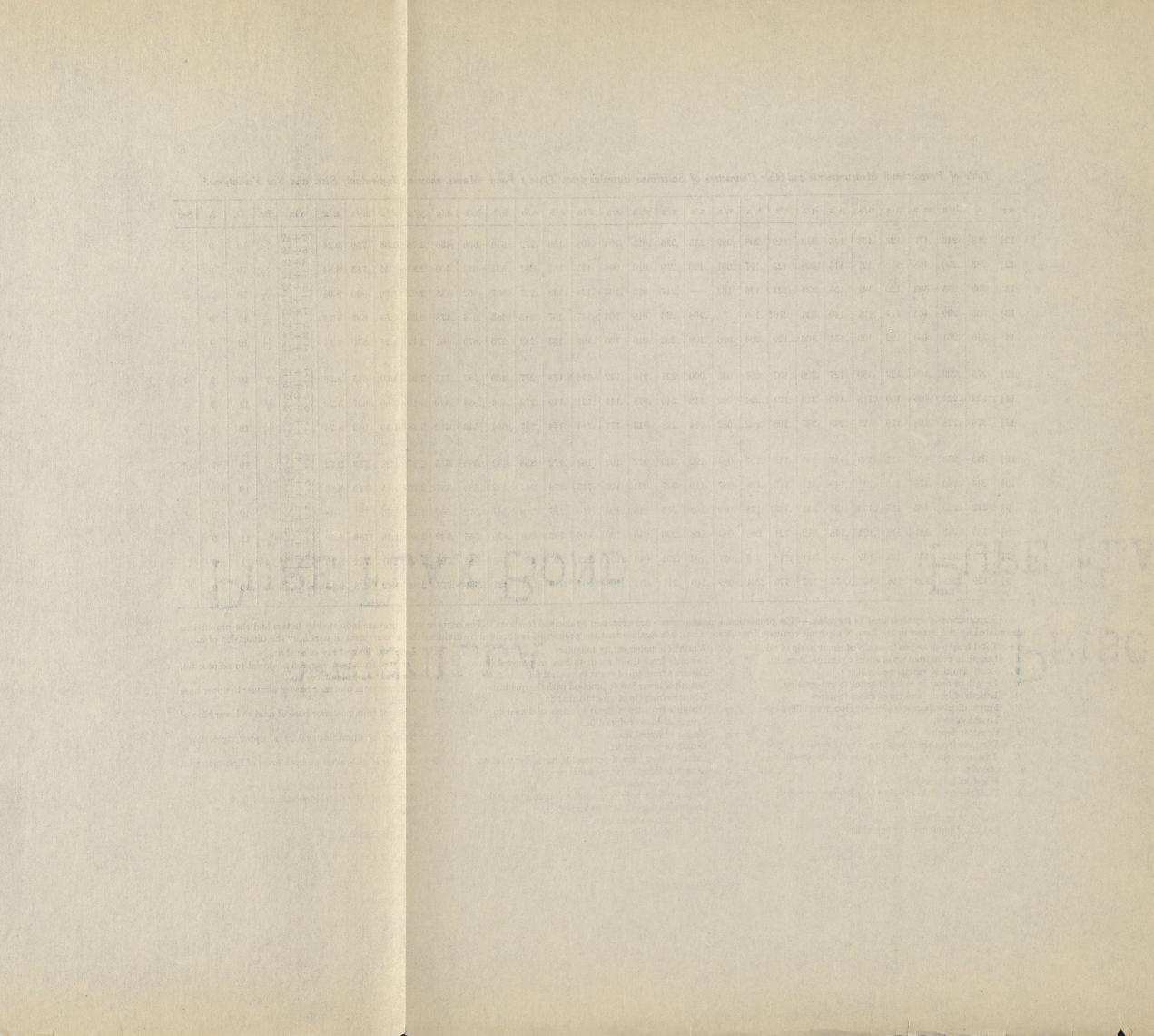
Distance from posterior end of dorsal to adipose fin.  $y^1$ . Length of base of adipose fin.

x. Length of longest ray of anal fin.

- Distance from posterior base of adipose to upper base 2. of tail.
- $z^1$ . Distance from posterior base of anal to lower base of tail.
- Br. Number of branchiostegal rays, upper right, lower left side.
- Gr. Number of gill-rakers on both arms of first branchial arch.
- D. Number of fully developed dorsal rays.
- A. Number of fully developed anal rays.
- o' Male.
- Q Female.

у.

- ?. Not determined.



#### WHITE TROUT.

1.15 in distance from tip of snout to ventral; anal rays III  $9\frac{1}{2}$ , the longest 2.26 in head; vertebrae 64. From a specimen  $16\frac{1}{4}$  inches long taken at Sunapee Lake, N. H., October 30, 1910.

*Coloration.*— As in male but paler and much less brilliant, lower part of body rather more yellow than orange; pectoral, ventral, and anal pinkish orange, growing darker, dusky purplish at tip, white edges anteriorly.

 
 Table of Proportional Measurements and other Characters of Salvelinus aureolus, two Localities compared showing Individual, Size, Sex, and Locality Variations.<sup>1</sup>

									and the second						
Locality.	a+	a	b/a	o/a	p/a	x/a	c/b	e/b	h/b	k/b	Gr.	Br.	D.	A.	Sex
Flood's Pond	7	152	.244	.137	.145	.114	.218	.218	.421	.546	$\left\{\begin{array}{c}6+12\\6+14\end{array}\right.$		11	10	\$?
" "	$7\frac{4}{10}$	167	.251	.131	.140	.101	.202	.214	.440	.559	§ 5+12	$\frac{10}{9}$	11	9	ę
"	8910	182	.258	.120	.142	.104	.191	.223	.446	.531	$\begin{cases} 7+12\\ 8+13 \end{cases}$	$\frac{8}{9}$	10	9	0 <sup>71</sup>
" "	$9\frac{1}{5}$	235	.214	.114	.129	.100	.183	.244	.469	.571	$\left\{\begin{array}{c} 6+12\\ 8+14\end{array}\right.$	$\frac{1}{1}\frac{1}{0}$	10	9	0 <sup>7</sup>
Sunapee Lake	$13\frac{7}{10}$	315	.198				.166	.240	.496	.604	$\begin{cases} 8+14\\ 8+14 \end{cases}$	$\frac{1\ 0}{1\ 0}$	10	9	3?
" "	$14\frac{1}{2}$	330	.230	.142	.162		.144	.289	.578	.690	${10+13 \\ 10+11}$	$\frac{11}{10}$	9	9	d <sup>7</sup>
" "	$14\frac{1}{2}$	331	.223	.132	.158		.135	.270	.527	.641	$\begin{cases} 9+13 \\ 8+14 \end{cases}$	$\frac{9}{9}$	10	9	0 <sup>71</sup>
	$20\frac{2}{5}$	470	.234	.157	.168		.118	.336	.645	.790	$\begin{cases} 7+14\\ 7+12 \end{cases}$	$\frac{9}{11}$	9	9	o <sup>7</sup>
" "	$15\frac{2}{5}$	362	.204	.104	.127		.148	.270	.479	.635	$\begin{cases} 8+13 \\ 8+14 \end{cases}$	$\frac{10}{10}$	9	8	♀?
" "	$19\frac{1}{2}$	450	.210				.126	.275	.529	.671	$\left\{\begin{array}{c}7+15\\8+15\end{array}\right.$		9	8	ę
" "	$20\frac{2}{5}$	468	.221	.106	.141			.229	.531	.623	$\left\{\begin{array}{c}7+13\\7+13\end{array}\right.$	$\frac{9}{10}$	10	9	ę.
" "	$20\frac{3}{5}$	470	.225	.127	.126	-	.127	.273	.518	.650	$ \begin{cases} 10 + 13 \\ 8 + 13 \end{cases} $	$\frac{8}{10}$	9	7	ę

# SYNONYMY.

Salmo fontinalis var. GARMAN, S., "The American Salmon and Trout, including introduced Species," Nineteenth Annual Report of the [Mass.] Commissioners of Inland Fisheries, fig. 16, 1885.

S[alvelinus] agassizii GOODE, G. BROWN, American Fishes, p. 499, 1888, Sunapee Lake, (name and locality only).
Salvelinus aureolus BEAN, TARLETON H., "Description of a supposed new species of charr (Salvelinus aureolus), from Sunapee Lake, New Hampshire," Proc. U. S. Nat. Mus., vol. 10, p. 628, 1887, Sunapee Lake, N. H.; Shooting and Fishing, vol. 5, no. 11, p. 6, fig. 2, January 10, 1889, (adult male and young).—
KENDALL, W. C., "Fauna of New England, List of the Pisces," Occasional Papers Boston Soc. Nat. Hist., vol. 7, no. 8, p. 47, 1908, (Golden Trout, White Trout, Silver Trout).

Salvelinus sunapee QUACKENBOS, JOHN D., Shooting and Fishing, February 28, 1889, p. 7 ("The Fish of Sunapee Lake").

Salvelinus alpinus aureolus JORDAN, DAVID STARR, and EVERMANN, BARTON WARREN, "The Fishes of North and Middle America," Bull. U. S. Nat. Mus., no. 47, part 1, p. 511, 1896, (Sunapee Trout), Sunapee Lake, New Hampshire; Dan Hole Pond, Carroll County, New Hampshire; Flood's Pond, Maine.

<sup>1</sup> For explanation of symbols used see page 53.

# THE SILVER TROUT OF MONADNOCK LAKE.

# Salvelinus agassizii (GARMAN).

# PLATE 6, FIG. 9 (male); FIG. 10 (female).

Attention seems first to have been attracted to the habits of this trout, in that they differed so radically in some respects from those of the Common Trout (S. fontinalis), which this fish was once thought to be.

An early article entitled "Observations on some of the habits of Salmo Fontinalis" by Samuel L. Bigelow, M. D., (Boston Journ. Nat. Hist., vol. 6, p. 49, 1850) follows verbatim. Dr. Bigelow does not definitely name Monadnock Lake but the description and location sufficiently indicate it. The habits of the fish also, as described, agree exactly with the known habits of the Monadnock-Lake Trout.

Dr. Bigelow said: "The following observations on the habits and peculiarities of a species of Salmo, were made in a comparatively short space of time, without any reference to science, but merely as a source of pleasure to myself, and to gratify a natural curiosity.

"The pond in which these trout are found, is situated at the base of the north-east ridge of the Monadnock mountain. It covers an area I should think, of seventy-five or one hundred acres, and is so deep about the centre, that soundings have not been found, though a line has been sunk two hundred feet. It is supplied entirely by springs at the bottom, which is composed of red and white sand and rocks, so far as the depth of the water will permit of an examination. The water is always very cold, and so clear that the bottom may be seen, in a bright day, to the depth of twenty-five or thirty feet; and although there are neither inlets nor outlets, its height is nearly the same at all seasons. Its depth increases from the shore, where it is only a few inches, in some parts gradually, and in others rather abruptly. The form of the pond is quite irregular, and has been fancied by some to correspond very exactly to that of the base of the mountain, which is close beside it. From this circumstance, together with its great central depth, has arisen a legend of its having been once filled by this mass, now a mountain, which was heaved out by some convulsion of nature.

"The south-west shore is more stony, and less exposed than almost any other, and here it is that the trout form their beds and come up to spawn. Another natural advantage which this point possesses over others is, that here the change from shallow to deep water is quite abrupt, affording the trout a better chance for escape in case of fright or danger.

"Their beds, as they are called, are merely small cavities formed by the accidental position of three or four stones, sunk to their upper surface in sand. Their capacity is generally from a pint to a quart, and their forms are various; sometimes conical, with the base upward,

#### SILVER TROUT.

sometimes flat and shallow. They are most numerous within ten feet of the shore, and in not more than ten or twelve inches of water. The trout having selected these little cavities, clean them out with great care, removing the finer particles of dirt by fanning with their tails, and the larger with their mouths; this done, they have a bed which they visit for a successive series of years, which will be longer or shorter, as they are more or less disturbed. An old fisherman pointed out to me abandoned beds, on which he had in former years taken great numbers. They were on the south side of the pond, whence the fish had gradually followed the shore, till year before last, when they came up on the extreme south-west shore, where I found them. They remain in the deep water about the centre of the pond, during the entire year except the spawning season, which commences about the first of October. So precise are they in their time of appearing, that this fisherman has for the last six or eight successive years taken fifty or seventyfive pounds, on the first day of October, when even the day before he could neither see a trout nor get a bite. They failed, however to be thus regular last season. The first four days of October were quite warm and rainy, and with almost constant fishing we caught only ten or fifteen pounds during that time, and those in water of twenty or twenty-five feet in depth. This proximity to the shore, however, showed them to be approaching their beds, and a few cold nights brought them up. The unusual mildness of the season, causing too great a difference in the temperature between the deep water they inhabit and the shallows on the border, may be the cause of their late appearance. But it was no easy matter to make a convert of the old fisherman to this doctrine; he held firmly to his old notion, that 'they had a wonderful sight of almanack learning,' - they had only 'missed their reckoning.' Having reached their beds they lose almost entirely their natural cautiousness and shyness, and seem wholly absorbed in the object of their visit, endeavoring in turn, to reach a bed, which they remain upon till their ova are deposited. If frightened by a sudden or violent motion of one standing on the shore, over them as it were, they reluctantly retire a little distance, but almost immediately return. The males follow the females closely at this time. They are, I should think about in the proportion of one male to four or five females. I was in the habit of disturbing them daily, from sunrise till dark; and prevented them to a great extent from remaining quiet long enough to spawn; so they were compelled to come up in the night, in order to go through with their labor undisturbed. In the females which I took the day before they began to spawn at night, I found the membranes enclosing the mass of ova, ruptured, and a continuous line of single ova extending from the mass, through the passage, and stopping directly within the external organs, which were very red and much swollen. The spawning season lasts, I think, for two or three weeks; after which they retire again to the deep water, where they can be taken only in the winter, through the ice. Generally in spawning-time there is no difficulty in taking them with a baited hook; but last season, perhaps owing to their being late, and pressed to the performance of their functions, they passed all kinds of bait and hook untouched. In the

winter, the only bait used is the minnow; but in October it is various, as the grasshopper, angleworm and artificial fly. These are most used; but I found that when they passed all these, they would often take readily their own spawn, dried a little in the sun. Another means of taking them at this time, is by a slip-noose of strong wire attached to the end of a short pole. This is passed over the tail or head, it matters little which, they are so careless at this time, and carried to the centre of the body; when a strong and sudden pull will bring them to the shore. Another mode of catching them is by means of a large hook attached to a short pole and line. This is carried under the fish, and secured in the body by a sudden jerk, which lands the fish on shore. Four hooks are sometimes used, bound together by the shanks in such a manner that the points are presented at right angles to each other. If these are dropped among a number there is a chance of securing more than one; and if a single fish is the object, his chance of escape is made less. These are both easy methods. At this time they do not seize the bait with the suddenness of the common brook trout; they take it calmly and retire deliberately, like the perch. They vary in size from one quarter of a pound to five pounds; but those taken are seldom less than one quarter or more than three pounds. The larger ones are taken almost exclusively in the deep water, through the ice. The males are of a very brilliant and shining dark brown or olive color on the back. The sides are brilliant and silvery, and are traversed by a longitudinal line, and covered with very bright red and yellow spots. The belly is perfectly white. There are some spots on the fins, but I cannot say on which, nor if all are spotted; nor do I know the precise number of spots. The females are less brilliant than the males; the back is lighter and more dingy, the sides are less silvery, and the spots are fewer and less bright. Several females which I took were of a yellow brown color, darker on the back than on the sides, with a yellowish white belly. They were mottled and looked as if water-soaked. These trout, as a whole, were much more silvery and brilliant, and had more and brighter spots than most brook trout. Their flesh is red, but not so dark as that of the salmon. There is but one other kind of fish found in this pond, viz., the perch. They live in an entirely distinct part from that occupied by the trout, and I think they are never seen or taken together. The perch are only about the north-east shore, which is quite rocky. The trout have been taken in this pond, as far as I could learn, from time immemorial, and formerly in so great numbers, to use the language of the old fisherman, as to 'have been fed by bushels to the hogs.' This is by no means the case at the present day."

The next published reference to this fish consists of the letter of transmittal and Professor S. F. Baird's conclusion regarding some specimens sent to him for identification. In his identification, Professor Baird was misled by the slenderness, forked tail, and general silvery coloration of the fish (see synonymy). As will be seen later some local fishermen regarded it as a "lake trout" and a controversy arose between them and the fishwardens. This communication is quoted in full as follows:

#### SILVER TROUT.

# "Keene, N. H., October 30, 1872.

"Dear Sir: I send you by express to-day a few specimens of the 'silver-trout,' or 'Dublin trout,' as they are called here. They were caught in Center Pond, in Dublin, yesterday, and are fair specimens of the variety found there.

"The pond lies at the foot of Monadnock Mountain, and is sometimes called Monadnock Lake. The shores and bottom are covered with a fine white sand. The water is always much colder than that in the neighboring ponds, as it is fed only by deep springs, there being no stream running into the pond. The water is also very clear. In the pond are a few dace, perch, and eels, which are not in any way peculiar. I believe the flesh of these trout is a fine salmon-color, and they have a great local reputation for the angler and for the table since the settlement of the country. They are caught only in May or June and in October, when they seek their spawning-beds in the shallows of the pond. Great numbers were formerly taken from the spawning-beds, but they are now protected by law at that season. They are thought by our anglers to be a different species from the brook-trout of our New Hampshire streams, and by some are claimed to be 'land-locked salmon.' I hope these specimens may enable you to decide these questions. As the colors will be damaged by the alcohol in which I send them, I give you the notes of the coloring of a female, measuring nine inches in length and weighing four ounces: iris, dark-brown; upper part of head, black; gill-covers, silvery white, with prismatic reflections; lower jaw, white, with a dark line near the mouth; back, light olive-green; sides, light-green to lateral line, and then much lighter, shading rapidly to white of belly, the whole gleaming like silver in the sun-light, even under water; belly, white, tinged with bright vermilion. Sides covered with golden spots, rather faint in color, from one-eighth to threesixteenths of an inch in diameter; lateral line very distinct; the pectoral, ventral, anal, and caudal fins bright vermilion, with the larger rays in each white; the dorsal and adipose fins olive-green, mottled with brown; the scales are small, but very distinct. The male is darker colored, with much more red upon the belly, and has small red spots in many of the yellow spots, resembling much more some of our brook-trout. I may add that no other pond, as far as I have learned, has trout marked like these.

"Hoping these specimens may arrive safely and in a satisfactory condition, I remain, yours, truly, "Thos. E. Hatch,

"Com. on Fisheries for New Hampshire.

"Professor S. F. Baird.

"[These fish proved to belong to the group of lake-trout, probably closely related to what Dr. Prescott called *Salmo symmetrica*.— S. F. B.]"

In Forest and Stream, vol. 10, page 196, April 18, 1878, appeared an article by Dr. D. S. Jordan entitled "Prof. Jordan on Characteristics of Trout," from which the following brief comment on the Silver Trout is extracted:

"By the way, the silver trout of Dublin Pond or Monadnock Lake, New Hampshire, somewhat noted among anglers, seems to be a silver gray variety of common *fontinalis*, not visibly different except in color. The statement in the report of the U. S. Fish Commissioners for 1872–73 (p. 372), that it belongs to the group of lake trout, probably closely related to what Dr. Prescott called *Salmo symmetrica*, is erroneous. The so-called species of lake trout, *namaycush*, *amethystus*, *pallidus*, *confinis*, *adirondacus*, *symmetricus* and *toma*, are, beyond any reasonable doubt, forms or varieties of *Salmo namaycush*, differing in some triffing respects in the different waters."

In 1884, a controversy regarding the identity of this fish and a point of fish-protective law depending upon its identity, arose among the inhabitants and fish wardens in the vicinity of Dublin Pond. A notice regarding the fish and the controversy appeared in the Boston Journal <sup>1</sup> as a published letter which was copied by Forest and Stream, vol. 22, page 130, March 13, 1884, and which is here quoted:

"A peculiar fish.- Concord, N. H., March 5. An exceedingly interesting question has arisen in Dublin, N. H., in relation to the subject of fish protection. It appears that of late persons have been catching a certain kind of trout from Dublin Pond and claiming that it is a peculiar species and is not protected by the state law. The local wardens refrained from making arrests under the circumstances, but caught some of the fish and forwarded them to the State Commissioners, who are Col. George W. Riddle, of Manchester, Hon. Luther Haves, of Milton. and Col. E. B. Hodge, of Plymouth. Those gentlemen sent specimens to Harvard University for examination, and an answer has been received from Prof. F. W. Putnam, Curator of the Peabody Museum. Prof. Putnam, assisted by Prof. Garmon [sic = Garman] head of the Zoological Museum, has made a preliminary inspection of the fish and says the variety is one they do not yet make out. At present they are inclined to believe them a variety of the Salmo fontinalis, or brook trout, but add that further study may change their views. In the meantime the Commissioners have instructed the Dublin wardens to prohibit the catching of the fish under discussion, and to prosecute all persons found taking them. This action is based on the belief that they are a variety of brook trout. They are small in size and fine eating, and their general appearance is such that if few of them were mixed with accepted brook trout it would require an effort to separate them. There is a rumor that Agassiz once stated that he discovered a rare variety of trout in Dublin Pond, such as was found nowhere else in the United States. excepting in a small lake among the Rocky Mountains.- Boston Journal.

"[We have seen the singular trout from Dublin Pond and think it merely a white form of the common brook trout. These silver fish, which are the rule there, occasionally occur in Caledonia Creek, N. Y.]."

The last reference by the Journal to a rumored statement by Agassiz that he had discovered

<sup>1</sup> This is the daily paper and should not be confused with the Journal of the Boston Society of Natural History.

# SILVER TROUT.

a rare variety of trout in Dublin Pond, such as was found nowhere else in the United States, excepting in a small lake among the Rocky Mountains, is doubtless a misquotation regarding the locality. The statement ascribed to Agassiz, even in current tradition at this lake, is to the effect that the fish has its closest relationship with a charr of the mountain lakes of Switzerland.

In its issue of March 22, 1884, the Boston Journal again notices "The Dublin Trout," and publishes an old letter of Agassiz's regarding it:—

"The peculiarities of Dublin trout have caused the speculations of anglers and others, during the last half century at least, and as the subject seems to be revived by the Dublin fish wardens, the following letter from Professor Agassiz, written about twenty-five years ago, will be interesting. After some male specimens were sent, as Professor Agassiz requested, he wrote that the examination of them only confirmed his previous opinion that the trout were specifically distinct, adding that there must be others like them found elsewhere as nature did not make a distinct species for one little locality; this last letter cannot now be found.

"Dear Sir: I duly received the two specimens of trout which you have forwarded to me. They reached Cambridge in a perfect state of preservation, and I was not a little surprised on examining them to find that they belonged to an undescribed species. I have carefully compared them to-day with all the trout occurring in the United States which I have thus far been able to secure, from Lake Superior to Labrador and as far south as they reach, and I find them to differ specifically from all. As the specimens are all three females, I should be much obliged if you would secure some males for me.

"Should so-called lake herring, or whitefish, as they are also called, be found in your waters, which I suppose to be the case, I would be much obliged if you could secure some of them for me.

"Allow me to close by returning my best thanks for the specimens you have sent me, which I have at once put up in my museum.— L. Agassiz.

"Cambridge, Mass., Oct. 12.""

The Forest and Stream of March 27, 1884, page 170, again, under the caption of a "Peculiar Fish," publishes a letter in which the writer indicates that previous identifications of the fish as a Common Brook Trout are erroneous as both forms existed there and were easily distinguished. The editor again appends a note suggesting that the opinion of an ichthyologist was needed to decide the question whether or not it was a distinct species. He was evidently unaware that two of the most eminent and distinguished ichthyologists of the country had decided the question,— one, that it appeared to be one of the Lake Trout forms; the other, that it was quite positively the Brook Trout but for some unaccountable reason was slender and silvery and differed otherwise in coloration from the Brook Trout from other localities.

The letter is of sufficient importance in showing that two different color forms or varieties existed side by side, as it were, to warrant the full quotation, which follows:

"I see in your issue of March 13 a piece headed 'A Peculiar Fish,' and, as there has been much discussion as regards it, I want to add my mite. I have for years lived near and fished these waters, and think the description of the fish far from right. Last fall I obtained permission from the State Commissioners to take fifty of these fish for the purpose of stocking Stone Pond. I caught two distinct varieties of trout; one very light-colored, slim and silvery, the other, to all appearances, was a common brook trout, being dark, with very bright spots, and much the heavier in proportion to the length, the same length of the latter weighing one-third more than the former. There is no stream, however small, flowing into this lake, as it is entirely fed by springs. Only the common brook trout are found in the outlet of the lake. The right to fish this lake is claimed on the ground that it is a lake, and the strange fish is a lake trout for this reason. It is called in the Dublin history Monadnock Lake, and also Monadnock Lake on the county maps. It is called by many here Dublin Pond. The question is, is it a lake or a pond? Last fall both kinds of trout spawned on the same bed, but what I term brook trout were about fourteen days later than the others, and did not come until the others had left.

'Fish Warden.'

# "Marlboro, N. H., March 17.

"[The differences mentioned are not of themselves sufficient to establish two species. Shape and color amount to little or nothing in the salmon family..... We cannot say that the fish in question is not a distinct species, but evidence from an ichthyologist is first needed to prove it.....]"

Pursuant of the advice of the Forest and Stream, an appeal for a decision, accompanied by specimens, was submitted to Professor Baird who referred them to Dr. T. H. Bean, at that time Curator of Fishes in the United States National Museum. Dr. Bean reported to Professor Baird as follows:

"After a careful examination of the individuals received from Mr. Greenwood, I arrived at the conclusion that they are the common brook trout, *Salvelinus fontinalis*, differing in no respects, so far as I can see, from the usual type of the species, excepting in their pale coloration and few vermilion spots — variations which I have frequently observed in trout from widely different localities."

This report was accompanied by a brief enumeration of the anatomical characters and proportions most commonly used in fish descriptions. This description is quoted later in this paper.

In the Report of the Fish and Game Commissioners of New Hampshire for the year 1884, at page 7, the following article on the "Dublin Trout" appears.

"Quite an interest has been taken in this trout, whose home is in Monadnock Lake. They differ somewhat from any other trout in the waters of this state. By some it is claimed that they are a lake trout, and can be taken by single hook and line in the months of January, Feb-

# SILVER TROUT.

ruary and March. Others say they are brook trout, and cannot be taken in the closed season, from the 30th of September to the 30th of April next following.

"So anxious are parties to take the fish that in the months of January, February, March and April they are, in their opinion, 'lake trout.' As the close season begins then on lake trout, the same parties call them brook trout after April 30 to Sept. 30 (open season for brook trout). This is quite an ingenious contrivance for the fishermen, but destructive to the fish. The commissioners, finding such a diversity of local opinion, caused several of this species of trout to be taken and sent to the Agassiz Museum at Cambridge, Mass., for investigation, and they were reported 'as a well-marked variety of brook trout.' Several were also sent to Prof. Baird, U. S. Fish Commissioner, Washington, D. C., and were pronounced by him to be a 'variety of brook trout.' Hereafter there will be no mistake in regard to the variety, as that question has been settled, and they will not be taken as lake trout without encountering trouble with the local fish wardens and commissioners.''

Although at a late date, it remained for Mr. Samuel Garman, of the Museum of Comparative Zoology, in 1885, to concur with Agassiz regarding the fish and he accordingly described it as new to science, under the name of *Salmo agassizii* (see synonymy). After giving it this specific name and describing it technically, Garman adds: "A variety of the brook trout; apparently restricted to the small lakes in the neighborhood of Dublin, New Hampshire. Compared with those of *S. fontinalis*, the young are rather more slender, the caudal notch slightly deeper, and the sides more silvery. The young are much darker colored than the adults; on both the red spots of the flanks are large and numerous. On the adult figured, fig. 18, the brown color has become so much bleached that the specimen is nearly uniform silvery; very faint indications of the red spots remain. The differences between the young of *S. fontinalis* and those of this variety are even more marked than those between adults; side by side, the clouded parr-marks or bands at once distinguish the young of *S. agassizii*. Apparently it is later in attaining sexual development, and has the appearance of a deep water species.... Dublin Pond; Lake Monadnock, Keene, N. H.; Center Pond."

The localities mentioned by Garman indicate three separate places, one of which, at least, is supposed to be in Keene. As a matter of fact, the three names are synonymous and the lake is in Dublin, somewhat remote from Keene. Garman apparently hastily inferred from Baird's mention of the locality that Center Pond was different from Dublin Pond and for some other reason that the latter was different from Monadnock Lake.

Garman's description of the fish appears later in the present paper, together with other descriptive matter.

The next published reference to the fish appears to be that by David S. Jordan as "Note on Mr. Garman's Paper on 'The American Salmon and Trout'" in the Proceedings of the United States National Museum for 1885 (see synonymy).

In this note Dr. Jordan briefly but quite positively reiterates his former conclusion that the fish is a mere color variety of *S. fontinalis*.

"9. Salmo agassizi. The trout of Dublin Pond has been known to me for many years. It is obviously a local color-variation of S. fontinalis. It may be called, in current nomenclature, Salvelinus fontinalis agassizi."

Regarding the fish, nothing further appears to have been printed until 1889, when an article or supplement on "The Red Trout of New England," by Dr. Bean was published in Shooting and Fishing, and later in the New Hampshire Fish and Game Commission Report (see synonymy). In this article he recognizes it, by name at least, as a distinct species. This was the first recognition of it after Garman described it and even Garman himself stated that it was a variety of the Common Brook Trout.

Dr. Bean's decision, however, seems to have left no impression on the minds of ichthyologists subsequently referring to or cataloguing the fish. It continued to be considered a variety or subspecies of *Salvelinus fontinalis* until Jordan and Evermann accepted it as a distinct species in their Food and Game Fishes of North America.

# DESCRIPTIONS.

1849.— Bigelow (l. c.): The description is evidently, at least partly, from memory, but, although in some respects vague, it applies in general to this species. It has already been quoted and need not be repeated here.

1872.— Hatch: The color description already quoted is very exact in most respects.

1884.— Bean (l. c.): "It is a Salvelinus without hyoid teeth. The gill-rakers are fifteen to sixteen in number; there are about 115 tubes in the lateral line, the number of rows of scales, of course, being much greater. The eye equals the snout in length, and is contained four and one-half times in the length of the head. The maxilla reaches a little beyond the vertical from the posterior margin of the orbit, and is nearly one-half as long as the head. The origin of the dorsal is nearly midway between the tip of the snout and the root of the upper caudal lobe. The length of the pectoral is one-sixth of the total without caudal. Dorsal ten; anal ten. Coloration silvery-gray on the upper parts, whitish below; pectorals, ventrals, and anal, largely vermilion; vermilion spots on the sides few in number."

In this description there is little given besides color to distinguish the fish from the Common Trout. The first statement, that it is a Salvelinus "without hyoid teeth" would seem to establish it as *S. fontinalis*, so far as that character is concerned.

1885.—Garman (l. c.): "B., 11 to 13; D., 12 to 13; A., 10 to 12; V., 8 to 9; P., 14 to 15; pores, 109 to 119; scales, 38 to 42, 217 to 237, 38 to 42; second dorsal to lateral line, 28.

"Snout longer than eye; maxillary extending behind orbit; in young (fig. 17) the diameter

# SILVER TROUT.

of the eye equals the length of the snout, and the length of the head is one-fourth of the total, without caudal; the length of the head of a twelve and a half inch specimen (fig. 18) equals the depth of the body, and is contained four and three-fourths times in the length of the body and head."

This is the original description but conveys practically nothing distinctive. The principal characteristic differences noted by Garman have already been quoted.

1889.— Bean (l. c.): "This handsome little trout is found in some small lakes of New Hampshire. Garman, who was the first to describe it, considers it a variety of the brook trout. In coloration it has considerable resemblance to this species in its banded back fin and tail fin, but it never has vermiculations, or mottlings, on the back. The tail is forked and there are teeth on the root of the tongue. The stomach is stout and the number of appendages at its pyloric end in some examples is forty-nine. The scales are about as large as in the brook trout and the shape is similar in specimens of equal size of the two kinds. Garman observed that the young are more slender, with deeper fork of the tail and the sides more silvery than in the brook trout, and ornamented with clouded parr marks. Fresh specimens seen in the national collection in 1884 were silvery gray on the upper parts, whitish below. The fins on the breast, belly and behind the vent were chiefly vermilion. A few vermilion spots on the sides.

"The Dublin pond trout is generally designated as a light-colored, slim, and silvery fish. It is said to spawn on the same bed but about two weeks earlier than the brook trout, the latter not making its appearance until the smaller and more graceful relative has disappeared to its reputed abode in deep water. Garman's largest individuals were about a foot long."

In this general, rather than in his technical discussion, Bean gives some of the essential diagnostic characteristics. Here the former assertion that it is a Salvelinus "without hyoid teeth" is modified by the statement that there are "teeth on the root of the tongue." He refers also to the distinctive coloration, which is one of the marked peculiarities of the species.

In Forest and Stream, March 10, 1900, p. 191, A. N. Cheney referred to the Dublin Pond Trout as observed by him at the Sportsman's Show. Contrasting it with the Brook Trout, he described it as follows: "There are no vermiculations on the back, which is a solid greenish color, with silvery glints in certain lights; caudal fins more forward; fins paler, general pinkish hue; the black stripes in fins fainter, and the white border a dirty white; spots lemon color, no halo. Fish generally more slender than the brook trout.

"While looking at the Dublin Pond trout I was fortunate enough to meet Mrs. Dwight and her daughter, of Boston, who reside in summer at Dublin Pond, and they very graciously went back to the tanks to give me such information as they could. When the fish were netted from the water, Miss Dwight was very enthusiastic about the fish, and said they were very fair types of the trout as she knew them at the pond, but there she had observed that the spots were orange rather than lemon, but the colors fade quickly."

In Salmon and Trout, by Dean Sage and others, published in 1902, William C. Harris wrote that the Dublin Pond Trout of New England waters ("Salvelinus fontinalis agassizii") is similar in structure to the Brook Trout ("fontinalis") but differs in coloration, being pale grayish and almost without red spots, thus resembling the Lake Trout or togue. It is found mainly in Dublin and Center Ponds in New Hampshire. He further stated that Mr. A. H. Thayer, a resident angler, writes that the young fish are "as beautiful as a bar of mother-ofpearl. The adult fish living in deep water are much darker with more brilliant red spots."

During the last part of October, 1912, the present writer made a visit to Monadnock Lake. Mr. James DeRocher, of the Nashua Fisheries Station was detailed to assist in the effort to secure specimens of the trout and Mr. Walter H. Rich accompanied the party in order to make a colored drawing of the fish from life should any be secured. Expectations were not very high, however, owing to the lateness of the season, the stated spawning time being about October 20.

Mr. DeRocher was supplied with two gill-nets, each 100 feet long, of different-sized mesh, the larger perhaps two inches and the smaller of one inch, stretched. On the night of the 29th, these nets were set on "the reef," said to be the spawning grounds of the fish, and in about two to four feet of water. Previous to setting the net some small fish were observed close to shore which from their shape were thought to be trout. In the small-meshed net ten small trout were caught, one and two at a time at intervals, and in the large-meshed net which permitted the small fish to pass through one large trout was taken. These were kept in an extemporized live car until the next morning when Mr. Rich made color sketches of the large specimen and two of the smaller ones. During the fishing the party was favored by some visitors, one of whom was Mrs. Grenville Clark, formerly Miss Dwight, to whom in the foregoing quotation Mr. A. Nelson Cheney referred as one very familiar with the trout of this lake. The present writer is also indebted to Mrs. Clark for much interesting and valuable information concerning the trout. Mr. A. D. Mason, of Dublin, who from boyhood has had an intimate acquaintance with the trout and its habits and possesses a traditional knowledge of the lake and its early conditions, furnished much valuable information.

The descriptions immediately following are from specimens secured at the time of this visit to Monadnock Lake.

#### Descriptions of Recent Specimens of Salvelinus agassizii.

*Male.*— Head, 4.13 in length without caudal; eye, 7 in head; snout, 3.25; upper jaw, 1.54; lower jaw, 1.30, somewhat hooked; branchiostegals, 11/11; gill-rakers 5+8 and 5+9; no branchiostegal teeth. Body moderately deep, the greatest depth 3.52 in length without caudal; caudal peduncle slender, as in *S. aureolus;* dorsal slightly nearer tip of snout than base of caudal; dorsal rays II, 10, the longest 1.15 in its base and 2.27 in head; distance from adipose to base of

#### SILVER TROUT.

caudal a little more than two fifths greater than the least depth of the caudal peduncle; length of pectoral about 1.65 in head, the distance of its base from tip of snout equaling length of head; distance from base of pectoral to base of ventral slightly over 3 in length of body without caudal; the ventral length about 2 in head; distance from base of ventral to base of caudal about 1.24 in distance from tip of snout to base of ventral; anal rays II, 8, the longest about 1.9 in head.

Coloration.— Dark grayish green on upper part of back, becoming lighter and yellowish toward the lateral line; below decidedly yellow, paling into pearl gray, and suffused with light Saturn-red, deepening toward the abdomen, where from the ventral fins forward the color stops abruptly against the clear white of the abdomen and throat; light red appearing more or less along the lower edge of the body behind the ventrals, excepting on a sharply defined clear white patch in front of and at the base of the anal fin. Dull orange-yellow spots scattered over middle of body and five ocelli of pale lilac with crimson centers.

Head, color of body on top, fading to the lighter greens and numerous metallic colors of rose, pearl, yellow, purple and reddish; lower jaw whitish, mottled with dusky, the tip slightly tinged with flesh color or dull orange. Iris, straw yellow; dorsal, dull yellow, crossed by several irregular dusky bars, the dark color mainly between the rays; a small dusky spot on body at the base of each ray; adipose dull purplish, somewhat lighter on upper edge, with a narrow submarginal dusky line; pectoral, ventral, and anal fins pale purplish pink, deepening basally, anterior edges white with black line behind, the pectorals growing somewhat dusky basally; caudal, dull purplish pink becoming somewhat orange centrally and dusky basally, with purplish black band at tip and several incomplete and somewhat indistinct dusky bars across it; the upper edge dull orange yellow, the lower white and both with irregular narrow line of dusky behind the light color.

Description from a specimen 16.5 inches long taken on the night of October 29, 1912.

Female.— Head 4.47 in length without caudal; eye, 4 in head; snout, 4; upper jaw, 1.80; lower jaw, 1.50; branchiostegals, 11/11; gill-rakers, III-4+9 and II-5+8 (three rudiments, a space and 4 developed and 9 fully developed, and 2 rudiments, a space and 5 fully developed and 8 fully developed). Body slender, the greatest depth 5.19 in length without caudal; caudal peduncle slender, 1.53 in the distance from anal to base of caudal; dorsal origin nearer tip of snout than base of caudal; dorsal rays, i, 10; the longest ray longer than base of fin and 1.56 in head; distance from adipose to base of caudal about one fourth greater than least depth of caudal peduncle; length of pectoral about 1.63 in head, the distance of its base from tip of snout equaling head; distance from base of pectoral to ventral slightly over 3 in length of body without caudal; the ventral length about 1.89 in length of head; distance from base of ventral to base of caudal 1.23 in distance from tip of snout to base of ventral; anal rays, i, 8, the longest about 1.63 in head.

The colors are generally olive green above shading into the silvery opalescent of the side and white of the belly; the dorsal is somewhat barred but the caudal shows scarcely any bars but merely dark marginal shades. The spots of the side are fewer than in the large specimen, usually wholly absent or only one or two present.

Compared with S. fontinalis of about the same size, aside from the coloration and the more slender form, the diagnostic differences are few. The vertical fins are lower and the base of the dorsal somewhat shorter; the eye is considerably larger and the maxillary longer. The gill-rakers are degenerated to a greater degree than in S. oquassa, in which the same tendency has been observed.

Description drawn from a specimen  $7\frac{3}{16}$  inches long taken on the night of October 29, 1912. Diagnosis.— Head shorter than in S. fontinalis, longer than in S. aureolus, much like S. oquassa but somewhat longer.

Dorsal lower than in S. fontinalis, higher than in S. aureolus, close to S. oquassa.

Pectoral much shorter than in S. fontinalis, a little shorter than in S. aureolus, close to S. oquassa.

Ventral much shorter than in S. fontinalis, shorter than in S. aureolus, close to S. oquassa.

Longest anal ray much shorter than in S. fontinalis, longer than in S. aureolus, close to S. oquassa.

Distance from adipose fin to base of caudal greater than in S. fontinalis, exactly as in S. aureolus, little greater than in S. oquassa.

Distance from anal fin to caudal much greater than in S. fontinalis, less than in S. aureolus, ittle greater than in S. oquassa.

Eye compared with head about the same as in S. fontinalis, larger than in S. aureolus, somewhat larger but near S. oquassa.

Snout a little shorter than in S. fontinalis, close to S. aureolus, longer than in S. oquassa.

Length of maxillary close to S. fontinalis, longer than in S. aureolus, and much longer than in S. oquassa.

Mandible shorter than in S. fontinalis, somewhat longer than in S. aureolus and much longer than in S. oquassa.

Dark markings on dorsal and caudal much like *S. fontinalis*, ocellated red spots on sides much like *S. fontinalis* but very much fewer. Rest of coloration much like *S. aureolus* but lighter.

Notwithstanding the absence of prominent structural differences, it is a question if it is not well to recognize as specific slight differences of that kind in connection with size, shape, color, and habits, at least locally constant and fixed. In this case there are no intergrading forms and while it shows relationship to *S. fontinalis* its most pronounced affinities seem to be with the Saibling group otherwise than in the apparent absence of basibranchial teeth.

Table of Proportional Measurements and other Characters of	Salvelinus agassizii from Monadnock La	ke, N. H., showing Size, Sex, and Ind	ividual Variation. <sup>1</sup>
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Ja	a+	- b/s	m/a	n/a	o/a	p/a	q/a	s/a	t/a	v/a	x/a	y/a	y1/a	z/a	z <sup>1</sup> /a	c/b	e/b	h/b	k/b	c/g	$z/a^1$	$z^1/a^1$	Gr.	Br.	D	Α	Sex
$16\frac{1}{2}$	376	6 .24	.478	.122	.130	.146	.321	.119	.207	.087	.127	.226	.045	.114	.119	.142	.307	.648	.769	-	1.10	1.43	${8+5 \\ 8+7}$	$\frac{11}{11}$	10	8	oī
$7\frac{1}{4}$	165	3 .24	5.441	.116	.153	.153	.319	.134	.227	.092	.141	.220	.036	.104	.110	.225	.250	.550	.675	-	1.21	1.28	${9+6 \ 9+6}$	$\frac{11}{13}$	10	8	d
71	2 16:	1 .24	.472	.111	.155	.158	.322	.124	.217	.087	.142	.204	.043	.105	.111	.237	.250	.600	.725	1. 1. 1. 1. 1.	1.25	1.33	$\begin{cases} 4+9\\ 4+9 \end{cases}$	$\frac{11}{11}$	10	8	o₹
71	L 158	8 .25	3.462	.107	.151	.158	.310	.132	.215	.088	.132	.221	.031	.094	.132	.210	.250	.575	.650	_	1.07	1.50	$\begin{cases} 4+9\\ 4+9 \end{cases}$	$\frac{11}{12}$	9	8	o
$6\frac{3}{4}$	154	4 .25	3.474	.110	.142	.123	.311	.129	.214	.090	.129	.224	.035	.084	.116	.230	.256	.564	.666	-	1.00	1.38	$     \begin{cases}       5+9 \\       5+9     \end{cases} $	$\frac{11}{11}$	10	8	o <sup>7</sup>
$6\frac{1}{1}$	$\frac{5}{6}$ 15	5 .33	.458	.103	.135	.135	.290	.116	.219	.090	.129	.219	.029	.106	.116	.250	.250	.541	.666	_	1.26	1.38	${7+10}{6+10}$	11	10	8	ę
71	3 <u>6</u> 16	1 .22	3 .453	.118	.142	.136	.322	.118	.229	.086	.136	.236	.031	.099	.124	.250	.250	.555	.666	_	1.23	1.55	${7+8}{7+8}$	<del>11</del> 11	10	8	ę

<sup>1</sup> Explanation of symbols used in the tables.— The proportional measurements are expressed by decimal fractions. The parts or structures are indicated by letters and the proportions designated by the letters in the form of algebraic common fractions. Thus: b/a signifies that the proportion is obtained by dividing the measurement of part b by the dimension of a.

- a+. Total length in inches from tip of snout to tip of tail.  $h^3$ .
- a. Length in mm. from tip of snout to end of lateral line. *i*.
- a<sup>1</sup>. Least depth of caudal peduncle.
- b. Length of head from tip of snout to gill-opening.
- $b^1$ . Length of head from tip of snout to nape.
- $b^2$ . Perpendicular diameter of head through middle of eye.
- c. Length of eye.
- d. Greatest depth of body.
- e. Distance from tip of snout to front of eye.
- f. Distance from tip of snout to posterior edge of preopercle.
- g. Width of interorbital space.
- h. Distance from tip of snout to posterior extremity of maxillary.
- $h^1$ . Width of maxillary.
- $h^2$ . Length of supplementary maxillary.

- . Width of supplementary maxillary.
- *i*. Distance from tip of snout to base of pectoral fin.
- j. Distance from tip of snout to ventral fin.
- k. Length of lower jaw to junction with the quadrate.
- *l*. Distance from tip of snout to anal fin.
- m. Distance from tip of snout to origin of dorsal fin.
- n. Length of base of dorsal fin.
- o. Height of dorsal fin.
- p. Length of pectoral fin.
- q. Distance from base of pectoral to base of ventral fin.
- r. Length of longest upper caudal ray.
- s. Length of ventral fin.
- t. Distance from base of ventral to origin of anal fin.
- u. Length of longest lower caudal ray.
- v. Length of base of anal fin.
- w. Length of middle caudal ray.

- x. Length of longest ray of anal fin.
- y. Distance from posterior end of dorsal to adipose fin.
- $y^1$ . Length of base of adipose fin.
- z. Distance from posterior base of adipose to upper base of tail.
- $z^1$ . Distance from posterior base of anal to lower base of tail.
- Br. Number of branchiostegal rays, upper right, lower left side.
- Gr. Number of gill-rakers on both arms of first branchial arch.
- D. Number of fully developed dorsal rays.
- A. Number of fully developed anal rays.
- o<sup>7</sup> Male.
- 9 Female.
- ?. Not determined.

SILVER

TROUT.

# h of longest ray once from posterio

#### HABITAT.

Garman (1885) said it had the appearance of a deep-water species, and such it proved to be.

Bigelow stated that they remain in deep water about the center of the pond during the entire year except in spawning season. Miss Dwight informed Mr. Cheney (l. c.) that when the ice left the lake the trout were caught in water from 80 to 100 feet deep, but two or three weeks after the ice goes out the trout come to the surface.

Mr. Thayer told Mr. Harris (l. c.) that they came to the surface and into shallow water from May 20 to June 10. "This early summer rise to the surface," Mr. Harris wrote, "and their sudden disappearance on or about the tenth day of June is strikingly similar to the habit shown by the cisco, or lake herring, which is also one of the salmonoids."

In a letter to Dr. B. W. Evermann, of the Bureau of Fisheries, Mr. W. O. Robinson wrote, under recent date, that for a period of about ten days in the spring, generally commencing with the 10th of May, the trout leave the deep water and come to the surface, rising freely in the morning till nine o'clock and again from five o'clock till dark. In the fall of 1912, and in a recent letter to the present writer, Mr. A. D. Mason, of Dublin, N. H., of many years' familiarity with the trout, said that they evidently frequented deep water most of the time except in the month of May when they rise to the surface for the little black fly. At this time, early in the morning and toward night they are jumping all the time. But after warm weather comes on and the black flies depart the fish retire to deep water.

# BREEDING HABITS.

Bigelow stated (l. c.) that the breeding time, which lasted about two or three weeks, began about the first of October when the fish congregated on shoals, formerly on the south but at the time of his visit, on the southwest shore, where they spawned at night. Having reached the beds, he said, they lose their natural shyness and seem wholly absorbed in the object of their visit. If frightened they did not go far away and soon returned. The males followed the females very closely in about the proportion of one male to four females.

Mr. Hatch (l. c.) stated that they sought the shoals for spawning in October. In Forest and Stream, (l. c.) a person signing himself "Fishwarden" wrote that both kinds of trout spawned on the same beds, but that the Brook Trout were about fourteen days later than the others, and did not come until the others had left.

Mr. Robinson wrote (l. c.) that they gather on the spawning bed at the same time as the other trout.

#### FOOD.

There are no early notes regarding the food excepting that implied in the mention of baits used in catching the trout.

Miss Dwight told Mr. Cheney (l. c.) that she had observed that the fish generally were growing deeper in the body since the introduction of the freshwater shrimp, and that the fish then caught were found to be filled with the introduced food.

Mr. Robinson's letter to Dr. Evermann stated that the stomachs contained two kinds of food; one was a shrimp about one inch long and the other apparently a dark greenish-brown vegetable material. He said, however, that in the spring they appeared to be feeding upon larval mosquitoes or some other dipterous insect. Mr. Mason (l. c.) stated that they were feeding upon "the small black flies."

#### ABUNDANCE.

Mr. Mason said (l. c.) that some eighty years ago persons living on the lake used to send their boys out to catch a pailful for their hogs, which could be done in a very short time. Within thirty years there were large numbers caught through the ice, but this was prohibited later on. He said that up to perhaps thirty years ago he had seen cartloads on the "spawning bed," where trout were taken in large numbers and of good size; in recent years, however, they had decreased greatly in numbers and that former State Commissioners had advanced the opinion that the small perch which abounded there were destroying the trout.

#### SIZE.

Bigelow stated that they varied in size from one quarter of a pound to five pounds, but those taken were seldom less than one quarter or over three pounds. The two specimens figured by Garman were, respectively, "young"  $7\frac{1}{2}$ , adult  $12\frac{1}{2}$  inches long. The fish on exhibition at a sportsmen's show previously referred to were stated by Mr. Cheney to have been from two to four ounces in weight, but he was informed that fish netted for spawning purposes have weighed between two and three pounds each, and once one was taken weighing seven pounds.

Mr. Robinson informed Dr. Evermann (l. c.) that the fish caught in 1912 averaged a little over 9 inches in length, the largest being 11 and 12 inches, and there was one caught which he did not see that was reported to weigh one and a quarter pounds; also that larger specimens had been seen on the spawning grounds.

Mr. Mason says that the size at present is much smaller than it was years ago, and it is seldom that one is caught weighing over one and one half pounds. The average is from one

eighth to one quarter of a pound, and they seem to grow smaller each year, but it is certain that there are larger ones in the lake for the skeleton of a large one was washed up on the shore. Mrs. Clark told the present writer that only a few years ago she had caught fish of one and a half, and even two pounds, as they were making their way on to the spawning grounds, but in late years no large fish had been seen and that the fish were growing smaller and scarcer.

# FISHING SEASON AND METHOD OF CAPTURE.

Bigelow stated that in deep water they could be taken only in winter through the ice but generally in spawning time they could be taken on baited hook. In winter the only bait used was said to be minnows but in October they were caught with grasshoppers, angleworms, and artificial flies, and when those failed they would often take their own spawn, dried a little in the sun. Another means mentioned by Bigelow was by snare or grapple, methods now prohibited.

Mr. Cheney stated (l. c.) that Miss Dwight informed him that in the spring only deep-water fishing was possible, until about two or three weeks after the ice left the lake, when they could be taken on very small flies, with drawn gut leaders.

Mr. Robinson wrote Dr. Evermann (l. c.) that for only about ten days, usually beginning about May 10th, they could be caught and that the only successful bait was the angleworm. He stated that he never heard of their taking the fly.

Mr. Mason wrote (l. c.) that the present open season was from May 20th to the 1st of August and added that if the season opened a month earlier he had no doubt but that more trout would be caught. He stated that worms are the most usual bait but some use flies and others shiners. Mrs. Clark said that she used to catch the larger fish on flies.

Mr. Mason said that after the fish had departed to deep water, following the advent of warm weather and the departure of the black flies, one could fish from that time on to the beginning of close season with no catch at all.

#### ORIGIN.

In the American Angler, July 30, 1887, J. D. Q. (Dr. John D. Quackenbos) writing of the possible origin of the "white trout" of Sunapee Lake said: "Dr. Bean has recently advanced other theories of its origin, which may be interesting to your readers. The one is that the so-called *Oquassa* may prove to be the same as the little Dublin Pond Trout, which, perhaps, is more widely distributed than has been supposed; but the Dublin Pond Trout, like the Blueback in Maine, always remains *little*, and the arguments that are adverse to the one theory of origin must be equally antagonistic to the other."

## SILVER TROUT.

In reference to the theory mentioned in the foregoing quotation, Dr. Bean wrote (American Angler, February 4, 1888): "It seemed to me at one time that the Dublin Pond trout of New Hampshire might be identical with the new Sunapee species. The fine specimens secured through the instrumentality of Dr. Quackenbos enabled me to explode this fallacy very quickly. The Dublin Pond (Lake Monadnock) form is more nearly allied to *fontinalis*, the common brook trout, than to the Sunapee species; it is the *Salvelinus agassizi* of Garman, a trout with mottled fins, a forked tail and hyoid teeth."

The first impression given by a large fresh specimen is that it might be a cross between S. fontinalis and S. aureolus. But such disposal of it is forbidden by the facts presented by its structure and its habitat. If it were a cross of these two species it could come about only by the later advent of one or the other. From present conditions it is obvious that S. aureolus would have had to be the original Monadnock-Lake Trout, and subsequent hybridization effected by S. fontinalis gaining access to the pond. Some of the oldest inhabitants at present state that S. fontinalis has always co-existed with the fish in the lake but that there had been introductions of the Common Trout in recent years. Some, both permanent and summer residents of long acquaintance with the fish and who are intensely interested in it, believe that it is a hybrid between the original inhabitant and the Brook Trout of the outlet and that the present apparent deterioration in size is due to the fact that the outlet trout are now occluded. But other S. fontinalis have been introduced. The hybrid, if such it is admitted to be, has been a hybrid of the same appearance within the longest memory. The original fish has long ago disappeared. Therefore, according to natural laws, the alleged hybrid should become less and less like the original inhabitant and finally disappear. Even if it were possible for successive generations of a hybrid fish to perpetuate itself for a time without reversion, when there has been subsequent adulteration, if one or the other factor of the hybridization mingles with it the hybrid would naturally tend to revert to that new form. The continued access of the outlet trout or the introduction of other *fontinalis* would then be likely to absorb, as it were, such hybrid as has been hypothetically discussed. But the "peculiar trout" still possesses all its peculiarities, even in the face of several introductions of S. fontinalis and the fact that they are sometimes found together on the same spawning beds and are always distinguishable sufficiently indicates the specific distinctness of the particular fish under discussion.

When Agassiz stated that this fish was more closely related to Swiss charrs than to any other American species, he had probably seen no specimens of *S. oquassa*, and *S. aureolus* and *S. marstoni* had not been discovered. But his prediction that the Monadnock species would be found in other waters, as nature did not make a distinct species for one little locality, was in a way fulfilled in the later discovery of *S. aureolus* in Sunapee Lake. *Salvelinus agassizii* is more closely related to *S. aureolus* than to *S. fontinalis*. The only resemblance to the latter is in the mottling of the dorsal and caudal and the red spots on some individuals. In other

respects, its general shape, coloration, and habits are very close to S. aureolus. This is particularly noticeable in the larger specimens.

# Salvelinus agassizii var.? The TROUT OF CRISTINE LAKE.

Under date of April 8, 1884, (Bull. U. S. Fish Comm., 1884, p. 294), Tarleton H. Bean writes: "I have examined the trout recently received from Cristine Lake, New Hampshire, whence they were sent by Mr. S. M. Crawford, and found them to be *Salvelinus fontinalis* (Mitch.) Gill and Jordan.

"The proportions and other specific characters are the same as in the Monadnock Lake trout recently reported upon, but the coloration is different. The ground color of the sides and upper parts is a rich purple, the sides are profusely ornamented with crimson spots, and the pectorals, ventrals and caudal, even now, are largely suffused with vermilion. Another peculiarity of these trout is their elegant shape."

While studying the Monadnock-Lake Trout, the present writer tried to find the specimens referred to by Dr. Bean but they could not be located in the National Museum collection. It was then thought that some specimens might be secured from Cristine Lake. Difficulty was encountered in locating the lake as it was not named in the list of lakes and ponds given in the New Hampshire Fish and Game Commission Reports. An inquiry of Mr. A. D. Mason, of Dublin, N. H., elicited the information that it was in the northern part of the State and that further information might be obtained from Merrill Shurtleff, Esq., of Lancaster. Mr. Shurtleff was written to and he kindly furnished some of the desired information and referred the writer to Mr. Alvah Cole, of Percy, suggesting that he might be able to secure and send some of the trout. Regarding the lake, Mr. Cole imparted essentially the same information as Mr. Shurtleff to the effect that it is 1194 feet above sea level and is surrounded by mountains, and is about one and a quarter miles long by half a mile wide, with very clear water. Its greatest depth is about 65 feet and the bottom is sandy. The shores are rocky and sandy. There are two small inlets but the lake is mostly fed by springs. The outlet, having a fall of 220 feet in the first half mile, empties into the Ammonoosuc River, a tributary of the Connecticut.

Salmon were introduced about 35 years ago but they are practically extinct now. Some eels and shiners are present. Mr. Cole said that the Common Trout had been introduced into the lake for many years from all parts of the State and that it was very seldom that any of the old stock were caught.

Dr. Bean's description and the foregoing information sufficiently indicates that the original trout of Cristine Lake is or was distinct from *Salvelinus fontinalis*. It is therefore provisionally included here as a variety of *S. agassizii*, although an examination of specimens might reveal that it is entitled to a specific name.

# SYNONYMY.

Salmo agassizii GARMAN, S., Nineteenth Annual Report of the [Mass.] Commissioners of Inland Fisheries, p. 78, figs. 17, 18 (young; adult; outlines), 1885.

Salvelinus agassizii JORDAN, D. S., and EVERMANN, B. W., American Food and Game Fishes, p. 210, 1902.— KENDALL, W. C., "Fauna of New England, List of the Pisces," Occasional Papers Boston Soc. Nat. Hist., vol. 7, no. 8, p. 46, 1908.

Salvelinus agassizi BEAN, T. H., Shooting and Fishing, vol. 5, no. 11, p. 7, fig. 3, Jan. 10, 1889, and Report Fish and Game Comm. New Hampshire, appendix, p. 32, fig., 1889.

Salvelinus fontinalis agassizi JORDAN, D. S., Proc. U. S. Nat. Mus., vol. 8, p. 82, 1885.— JORDAN, D. S., and EVERMANN, B. W., Report U. S. Commissioner of Fish and Fisheries for 1895, p. 293, 1896 (Check List); and Bull. U. S. Nat. Mus., no. 47, part 1, p. 507, 1896.

Salmo fontinalis BIGELOW, S. L., Boston Journ. Nat. Hist., vol. 6, p. 49, 1850.

(Salmo?) fontinalis, var., JORDAN, D. S., Forest and Stream, vol. 10, p. 196, April 18, 1878.

Salvelinus fontinalis BEAN, T. H., Forest and Stream, vol. 12, p. 229, April 17, 1884; Bull. U. S. Fish Comm., vol. 4, p. 293, 1884.

Salmo symmetrica, var., BAIRD, S. F., Report U. S. Commissioner of Fish and Fisheries for 1872 and 1873, p. 372, 1874.

# BROOK TROUT.

Salvelinus fontinalis (MITCHILL).

## PLATE 7, FIG. 11.

This charr is peculiar to eastern North America. Its northern limit is indefinitely known. It occurs in many Canadian streams flowing into the Great Lakes and St. Lawrence River and Gulf and as far north, at least, as Hamilton Inlet on the Labrador coast. The Hudson Bay records may be a mistake from confusion with another species. The Atlantic Ocean restricts it on the east and it extends southward in the Alleghanies to the headwaters of streams in the mountains of Georgia and Alabama.

Aboriginally it was common throughout the New England States, especially in the northern sections, and in Maine there was scarcely a stream from the merest rivulet to the mightiest river, from the smallest pond to the largest lake, that did not abound with trout, from adult pigmies of an ounce or two to fish of ten pounds or more of weight, according to the waters.

In general the trout is by nature a denizen of cool waters but not infrequently it occurs in unfavorable places such as warm, muddy ponds. But in such instances there is usually, perhaps always, some "spring hole" or cool inflowing spring brook to which it resorts during the summer months. From such places it first disappears and there are many waters in New England that once contained trout but are now exhausted. In fact such depletion is not confined

to naturally unfavorable waters but many natural trout waters have been made uninhabitable for trout through artificial modifications, and from them the trout have gone or become very scarce, and in some instances both trout and waters have vanished before the "advance of civilization."

Its distribution is governed mainly by the temperature of the water, and in its natural habitat it seems not to endure a temperature of over 60° or 65° F. In many of the long settled portions of the country where the woods have been cut from the banks of the streams and surrounding country, the trout has practically disappeared. In the words of Dr. Henshall, which are a graphical expression of a well known fact: "The altered conditions of its aboriginal environment, owing to changes brought about by the progress of civilization, have resulted in its total extinction in some waters and sad diminution in others. In many instances the trout brooks of our childhood will know them no more. The lumberman has gotten in his work,— the forests have disappeared,— the tiny brooks have vanished.

"The lower waters still remain, but are robbed of their pristine pureness by the contamination due to various manufacturing industries. In such streams the supply of trout is only maintained through efforts of the federal and state fish commissions. It is hoped by this means the beautiful brook trout, the loveliest and liveliest of fish of all the finny world, may be preserved and spared to us for yet a little while" (James A. Henshall in Favorite Fish and Fishing, 1908).

This article, as indeed most of popular trout articles, pertains to the trout as a "brook trout." The trout, while naturally a permanent resident of many brooks and streams is also a resident of ponds and lakes, in some of which it attains a large size, even more than ten pounds in weight. The "progress of civilization" has also had its effect on the lacustrine trout. As the trout, whenever possible, ascends streams from ponds and lakes to spawn, the lumbering operations, by destroying the spawning places, have been fully as effective in the diminution of lake and pond trout as of the brook trout, especially in such ponds or lakes as have no suitable spawning grounds in them.

But lumbering operations are not alone to blame for the disappearance of trout or their decrease in numbers. Excessive and untimely fishing are most destructive, particularly the catching of fish on their spawning beds and through the ice in the winter. Dr. Henshall, in the foregoing passage, expressed the hope that through fish culture this fish might be spared "for yet a little while." It doubtless has in many streams and lakes, but fish culture is also responsible for its diminution in numbers, if not complete extinction, in some waters for the introduction of more powerful and more voracious fishes has resulted in the great diminution of the native trout and which, together with or added to the ill effects of excessive and untimely fishing, has in some instances, at least, notwithstanding the efforts to maintain the stock by artificial propagation, almost completely exterminated the trout.

Anatomically, the trout differs from all other charrs in possessing no teeth on the basibranchials <sup>1</sup> or bones at the "root of the tongue." Its chief distinctive characteristics are, however, its generally less slender form and particularly its coloration. These, however, have not proved infallible, for even by distinguished authorities other species of charrs have been mistaken for the Common Trout. A color mark, however, that is constant in freshwater individuals of this species is the "worm-shaped" markings or rivulations on the back, which no other known species possesses. Among themselves, also, the trout differ greatly in shape and color; not only those from different waters but often those of the same body of water or different localities in the same lake or stream. The breeding season also changes the coloration and often, to some extent, the form. Such differences have on occasions caused the fish to be regarded as distinct species and they have been described as such. For instance, *Salmo nigrescens* of Rafinesque was described from a dark-colored individual and the name *Salmo erythrogaster* was, by DeKay, applied to a red-bellied breeding male of the present species.

The ichthyologist is not alone in making such errors, however. Often trout of different waters or even of the same waters have been regarded by the inhabitants as distinct species, although only local names of their own coining and not Latin expressions were applied.

In Square Lake, of Aroostook County, Maine, a deep, oval, short and chunky fish, very different from the common run of trout of the region, is locally known as Snowshoe Trout, from its fancied resemblance in outline to a snowshoe.

In the Rangeley Lakes region all of the foregoing differences of form obtain among the trout as well as differences of color and they have been suspected to be, if not actually regarded as, distinct species by those most familiar with them. If the scientist has been deceived by these things, who shall blame the layman?

In Forest and Stream, April, 1883, Mr. J. G. Rich, of Bethel, Maine, a man of many years' acquaintance with the trout of Rangeley Lakes, contributed an article on "The Trout of Rangeley Lake." In this article he seems to be inclined to believe that there are more than one species in those waters. The following is extracted from that article: "The vermilion and yellow spots are said to be universal on all *Salvelinus fontinalis*, but other distinctive marks prevail among them, especially in Rangeley waters. So that one is often puzzled and half inclined to believe there are more than one species of trout in our lakes; indeed the only general distinction is the red spots." And he says the question arises whether or no the location of the feeding ground influences the color and shape as scientists state. He was inclined to disbelieve it as he could not understand why the same species of fish in the same waters, in the same conditions and environment, should present such marked differences in "organization and habits." He then

<sup>1</sup>A few teeth have been found on these bones usually but erroneously called "hyoid" in some Labrador and New England "trout," perhaps through mistake supposed to be this species, and they are occasionally absent from individuals of the other forms.

describes two or three varieties, the most contrastively striking of which was his "Cedar Tree" Trout, receiving its name from Cedar Tree point, near which it spawned. This was considered more different from the common run of trout than the Landlocked Salmon is from the Penobscot Salmon, and he suggested that ultimately it would be considered a distinct species. Mr. Rich later stated that he sent one, together with his opinion regarding it, to Professor Agassiz, who pronounced it nothing else than a "simon pure *Salmo fontinalis*." It was stated to be a thin, flat, short fish with very highly colored sides, which, when red, were very red, and when black, white or brown, intensely so; this appearance giving the deceptive impression of a greater than the actual weight.

Contrasted with the Cedar-Tree Trout was the "long, round, light-colored, almost silvery, trout, with white flesh, in deep and large waters." Another of this type of about three fourths of a pound in weight, with yellow flesh, would be found during the last of August and first of September congregated at the mouths of certain brooks. Still another of the same form but very plump and with red flesh is found at some other places. In the spawning season, October and November, in Beama Stream, Metallic Brook, and the inlet of Richardson Ponds, generally far up in the small headwaters in the dense woods, was said to be still another highly colored variety, with a stripe of white on each fin, which often betrayed the presence of the fish in the black moss of running stony brooks. These ran from about three ounces to a pound in weight and were of the most beautiful of all in appearance, but no better, if as good, for the table. Among these, he said, were found both white- and red-meated fish. He went on to say that in many years of winter fishing very few of this kind of trout were caught in the lakes and ponds and were seldom taken except on their spawning grounds, and therefore concluded that they did not mix with the long, round kind but probably had some special location of their own.

Continued residence of trout in one locality modifies the appearance of the fish according to the conditions obtaining in the locality. A trout of a clear, running, sandy stream is likely to be slenderer, lighter colored, and more silvery than one of a sluggish, muddy stream. The same, as previously stated, may be said of ponds and lakes, or different portions or branches of the same stream or different localities in the same lake. The shape and color also often vary with the age and size of the individual.

But most of the "distinctive" color and form characters of the "Cedar Tree" Trout and the upper-water Brook Trout just mentioned were obviously due to breeding season, which accounts for their seldom being caught at any other time. Now and then a trout retains the appearance of the breeding fish long after the season is over, not having regained his former strength and vigor, and, as is stated in connection with spawning habits, there are instances of fish being found in breeding condition out of season.

The cause of the "red" color of the flesh of salmon and trout has long been a mooted question and ascribed to many things which, upon due consideration, have been found to be incon-

sistent with the facts. It has been thought to be caused from the fish subsisting upon certain kinds of food pigmented with red. This seems to be defective for other fishes feeding as extensively upon the same kinds of food always have white flesh. After taking everything into consideration, it seems probable that the food has no more to do with it than to fatten the fish and it is the intrinsic fat or oil in the fish which produces the red flesh and delicious flavor of the red-meated trout. The oil or fat is naturally red, as that of some other animal is naturally white or some other color, and it is the amount present in the fish that gives it its intensity. Young, rapidly growing fish, or fish with comparatively scarce food supply, are usually whitemeated. The meat of well fed growing trout gradually becomes yellow and then "red" with increasing age and, inversely, the meat of breeding fish gradually, sometimes irregularly, becomes white with the advance of the season.

# Food.

The trout is carnivorous and almost omnivorous within carnous limits, levying upon nearly every class of animals,— worms, mollusks, crustaceans, insects, batrachians, fishes, birds, and mammals. A list of the insects and other things that have been found in trouts' stomachs would "fill a book."

The trout of brooks and young trout feed mainly upon the aquatic larvae of numerous species of insects, particularly caddis fly, May fly, Chironomus and dragon fly, also upon insects that fall upon the water or hover over the water while depositing their eggs. All brooks contain more or less of this kind of food.

The food of trout of larger streams, ponds, and lakes consists of the particular kinds that the water affords, often differing materially. In general, however, it may be said that in these places, too, there is usually a supply of such insects as were just enumerated, also varying with the time of the year. In the lakes, however, the general dependence is upon some kind or kinds of fishes, although at times the diet is varied with insects and such more or less accidental animal life as may become available. The regular food supply of the trout of the Rangeley Lakes, aside from the insects and such other accidental or incidental animals, was formerly, without much doubt, the small fishes living there, to some extent including its own young and eggs. The Blueback Trout was believed by the late Commissioner Stanley to have been the main dependence of the large trout, regarding which the commissioners said in one of their reports, it was to the trout of Rangeley Lakes what the myriads of smelt were to some other waters. The subsequent introduction of smelts afforded the trout an unlimited and unexcelled food supply.

In Forest and Stream, November 24, 1900, J. Parker Whitney wrote: "The saltwater smelt introduced a few years ago has increased extensively and extended to all the lakes of the range. This fish seems to readily habituate itself to most all freshwater lakes, and has increased

to a large extent in the Rangeley waters, although confined to a small size of 3 or 4 inches in length. Although large numbers are observed dead floating upon the surface of the water in the spring time, the increase seems hardly to be affected. The fish is apparently an admirable food for the salmon and trout, and in spring would seem to be the principal food, as their stomachs seem to be crowded with them, and I have repeatedly observed from fifty to seventy in a single trout of large size. I consider without question the smelt to be the most valuable fish for food-stocking of freshwater ponds and lakes."

He also stated that in December and January there is a notable scarcity of live bait and in February and March it is very difficult to find, yet the trout are seldom empty of small fry or chubs, and it is quite likely that the trout root them out of the mud. This is indicated by earth and often lumps of clay found in their stomachs. He stated that he had caught large trout often with a small handful of clay balls in their stomachs. In the winter the contents of their stomachs are quite miscellaneous,— glutinous ground feed, chubs, varieties of small fry, rarely Bluebacks, suckers, and in a few instances I have found whole clams in shells up to three inches in length.

Feeding time.— The trout does not feed at all times of the year or the day. Its habits are influenced by both internal physiological and external physical condition. The postnuptial wasted condition of the fish would naturally impel it to recuperate by feeding, but at that time food is scarce. This is, however, compensated for by the cold water making the fish more or less sluggish and dormant, when there is little metabolism and little or no food required. But these two forces are contending, as it were, and the fish, therefore, will eat when there is anything to eat, but can get along without it. The warming of the water and other physical changes stimulate them to activity and food.

It is probable, however, as indicated by their behavior toward anglers, that in warm bodies of water they do not feed very much, if at all, during the summer. The principal feeding in such cases is done during the night and on cool, overcast or rainy days. But even during the recognized fishing season there are often days when the fish will not take bait or fly, and during the day when feeding the time is usually early in the morning or in the cool of the evening. Although many of the habits of trout are fairly well known, their apparent caprices or idiosyncrasies are little understood. In this respect the trout is too much individualized to permit of much generalization.

It is a matter of common remark that on some days trout will bite ravenously and on the following day or for days they will not bite at all. Also that at times the fish will rise to a fly freely for some time and then suddenly cease to rise, although there are many fish still there. There are several things that may be assigned as the causes of such phenomena. It has been noticed that when feeding the fish will fill itself to repletion and then periods of varying length ensue when the fish will not take food at all. Apparently having become surfeited, they put

in the rest of the time in utilizing what they have acquired. Changes of temperature and barometric pressure and other meteorological conditions are also assignable explanations and there may be more truth than poetry in the old rhyme relating to the direction of the winds.

Illustrative of the foregoing, an incident related by E. D. T. Chambers is of interest: "Observations convinced me long ago, and subsequent experience has justified the conviction, that there are times when trout, no matter how plentiful they may be, will not take a line at all, being entirely off their feed. A case in point occurred to me only a few weeks ago. At the mouth of a large lake where I was fishing is a disused dam. In the outlet immediately below it is a clear pool containing hundreds of brook trout of various sizes, from three-quarters of a pound down to fingerlings. The pool is too far from civilization to be much fished. Not half a dozen people visit it in the course of the year. I fished it three evenings in succession. On both the first and the third evenings I had wonderful sport. No matter what fly was offered, the fish took it freely, and after returning to the water nearly two dozen small trout on each occasion, I took back to camp, for supper and breakfast, over a dozen good fish. The water was so clear on both occasions that the fish could always be seen rising to the fly. Nor were they at all shy, but would rise almost at my very feet. On the second evening there were apparently as many fish in the pool as on both the preceding and succeeding evenings. The weather was apparently as favorable for fishing as on either of the other two nights. The fish were wonderfully active, but apparently in no way frightened. They were simply playful, swimming gayly about the pool, rising to the surface and then descending, without apparently sucking in any surface food, but just stirring a ripple upon the water. Never a fly would they take, however. I changed the cast nearly a dozen times, but all to no avail. Generally they took no notice of the flies at all. I tried bait, but it was of no avail. One little fellow, which was returned to the water, took it and that was all. It was impossible to account for such a failure. The fish were there, but apparently they were not hungry and would not feed. I took no more precautions in approaching the pool upon the two nights when I was so successful than I did upon the blank evening. Had the fish appeared frightened, I should have come to the conclusion at once that the pool had been recently disturbed by some trout-eating animal or bird; but on the contrary the fish appeared perfectly at their ease. It was a puzzle that must remain so, I suppose, but it is by no means the first one of its kind that has occurred to me. Very often the fish would rise all around the flies without touching them."

After commenting on Mr. Chambers' experience as one of common occurrence amongst anglers, Mr. E. A. Samuels wrote: "All of us have had blank days in trout fishing for which we could not account, for all proper conditions, such as light, breeze, ripple, etc., were present; we knew the trout were there, and in goodly numbers, too; they simply would not rise.

"I have let my boat quietly drift over the pool on such an occasion, and, peering down into the water, have discovered the fish lying closely together at the bottom, almost without moving

a fin. In late years I have come to the conclusion that the fish are influenced in their movements by barometric changes, and it has seemed to me that when a storm is approaching the trout settle down, as if awaiting its advent."

Another man wrote regarding September fishing on the Rangeley Lakes: "For ten successive days I cast steadily, whipping every nook and corner of the Upper Dam, without a solitary rise, yet I could see the big fellows breaking water every little while; but they carefully eluded the fly. On September 15, I made an early start, taking a lunch, and pulling my boat to the narrows, and fished 'Cedar Tree,' 'Minters' Favorite' and Metallic Brook, returning in the evening. Last year at Metallic Brook I had splendid luck. This year during the entire trip I did not get a single rise, and this after pulling my boat some fourteen miles. I tried Brandy Point, Sandy Cove and Trout Cove in the big lake with the same result. The fish were there — I saw dozens break water — but they would not take the fly. Some friends of mine at the Middle Dam reported the same state of affairs in that vicinity, and Parmacheenee — always good fishing ground — afforded but poor sport, while the 'affidavits' were all the same — the fish were there. They could be seen, but they would not bite."

Another correspondent of a sportsmen's paper, who is frequently quoted in this article, wrote regarding the celebrated Marble-Morse fish referred to in another place: "I remember well the large trout, the 11-pounder which for several years in the autumn came to the same place in a moderate swirl of water above the dam, where in his mighty solitude, for he seemed to be quite alone, he would signify his presence occasionally by an uplifting on the surface which would make the angler's heart quake. He became the target of many ambitious efforts, both of fly casters and bait dabblers, but maintained a dignified and conservative indifference. In a quiet surface and with the sun's rays in a favorable quarter he was often observed either in quiet meditation or slowly taking his constitutional promenade. In vain were flies sunk down for his convenience and equally vain were tidy worms and natty grasshoppers trolled before his majestic presence. Some vowed he was 3 feet long, that his mouth was large enough to take in a black duck, and that he must weigh 15 lbs. Well, he was taken one day by an old guide, who would have scorned to have taken him in any other way than fairly. But most curiously he was taken while everybody was at dinner, and according to his account, he had allowed his worm-baited hook to rest on the bottom for a while, from which it was seized by the old patriarch and in natural sequence completed his foraging adventures and soon he lay gasping on the green grass. He did not prove to be 15 lbs. in weight, or 3 ft. long. In fact he was a very short trout for his weight, measuring exactly  $27\frac{1}{2}$  inches in length and of magnificent color."

Speaking of the pool below the former stone dam he said: "Some days one might whip the pool for hours without a rise, although gigantic breaks might occasionally be observed, but the favorable hours in the right season was sure to reward the seeker. Once I caught the pool on a day of high carnival, a day of exultant joy, of moving and commotion of trout, which on

some days and occasions exhibit an eager recklessness, and all fearless and bent on destruction. It was a cold, blustering, gusty day, with occasional sleet, late in September, when I had to go back frequently to a fire on the shore to thaw out my benumbed hands. At intervals the water boiled about me with swirling breaks, and visible currents of pursuing fish. My first cast, a short one, scarcely 10 feet away, responded with a 5-pounder in an instant, and I begrudged the time it required to bring him to net. Another and another rose in succession to my fly, which scarcely flecked the very ripple caps ere it was taken. No under surface draw seemed required for my first few fish, and I screamed with delight at each strike. My third was an  $8\frac{3}{4}$  pounder, and the largest of the day, and the smallest was 3 lbs., and my total catch, 10 fish, which weighed 57 lbs."

# HABITAT.

In the spring of the year the trout begin to scatter and often may be found at almost any point in the lake, their location being controlled by their food supply to a great extent. But as the hot weather approaches they become more and more restricted in their movements until finally they resort to cool waters of "deep" holes or cold in-flowing brooks. Again in the fall they congregate on shoals, or at the mouths of streams which they ascend to spawn. After spawning they gradually work back into the lake and are found about the mouths of streams or wherever food may be found. It is this latter rundown fish that has been mentioned previously by a correspondent as constituting one of his supposed distinct races.

In an article published in Forest and Stream, November 24, 1900, Mr. J. P. Whitney said that in December and early January the trout are comparatively plentiful in a few feet of water below the ice, and that afterwards they are mostly in from 15 to 40 feet.

Brooks possessing suitable conditions are occupied throughout the year and sometimes year after year, at least in some portions of it. While streams tributary to lakes afford nurseries from which the lake receives an annual supply, many trout, continuing small, reach maturity and pass their whole existence in the brooks.

# MIGRATORY MOVEMENTS.

Trout are not subject to extended migrations and in the far inland waters, excepting their movements for breeding or seasonal accommodation, they are rather localized in their habits. Near the coast, however, when possible, they often enter the sea and in certain localities there seems to be a race of almost permanent marine trout, entering fresh water at more or less regular periods. In New England such fish are locally known as "salters."

One of the previously mentioned Rangeley Lake observers, in a communication to a sportsmen's journal, wrote: "Trout are not migratory in their habits, although in exceptional in-

stances when disappointed in love affairs and driven away by successful rivals, and physical disturbances, will roam about, and oftentimes, in such cases, will take extended departures. Otherwise they will frequent the same feeding grounds, although taking their spring and autumnal outings. We all know of the particular fellows which are found year after year in the same deep pools and by the steep rocks, which so long bid defiance to human art, but which finally yielded up their liberties and lives to their unconquerable taste for the insidious fly." And he further states that if a trout was carried away from his accustomed home and placed in the water he would return forthwith, citing an instance of a trout, which was known by a hook left in its mouth, which was caught again the next day in its original place, having traveled a distance of three miles during a dark night beneath thirty inches of ice and snow.

Mr. Rich wrote in the American Angler of April 14, 1883: "I once met a school of trout several acres in extent making their way from the head of the lake [Rangeley] down toward the inlet. They were swimming near the surface and the water appeared to be alive with them. I could seen them plainly from the boat and they appeared to be all sizes, and among them very large ones. Some of them would break water occasionally."

The population of tributary waters is mainly brought about by the wanderings of young fish which tend to move up stream and into smaller streams after they begin to feed; although, while in pursuit of food, adult trout doubtless gradually make their way into neighboring waters.

# SPAWNING TIME.

The trout spawns in autumn during the falling of the water temperature, the season varying somewhat with the latitude, also with the local temperature of the water. In general, including all localities and conditions, it may be said to extend from in September into December. The duration is about two months for the trout of any body of water. In the Rangeley Lakes the height of the season is about the middle of October to November, depending somewhat on the condition and weather. The season may be delayed or interrupted by weather conditions.

The sexes differ much in appearance at the breeding time, especially in large fish. The head of the male is longer (Text-figs. A, B), the lower jaw somewhat hooked, the mouth and teeth larger, and the coloration more brilliant, the belly and some of the fins being a brilliant red, and the white margin of the pectorals and ventrals more distinct. The body of the male also becomes flat or slab-sided and has a thick coat of mucus, almost or quite obscuring the scales.

The age of maturity varies somewhat. The male is usually more precocious in that respect than the female. Artificially reared trout have been found mature at one year of age. A colored picture of a female in spawning condition,  $7\frac{5}{3}$  inches long, 14 months old, still bearing parr marks, is shown in the Manual of Fish Culture issued by the United States Fish Commis-

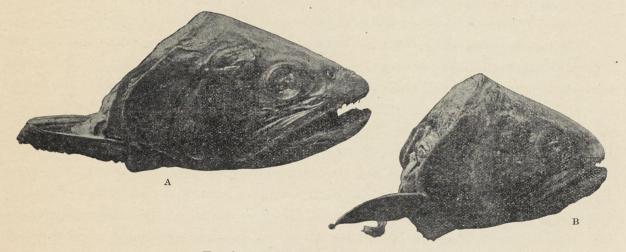
sion in 1900. The usual age of maturity under natural conditions is doubtless somewhat more advanced. As shown in another place, the size of the fish does not indicate its age, therefore breeding brook residents only two or three inches long, are not necessarily young fish although possessing parr marks.

According to Livingston Stone, all two-year-old trout spawn; some yearlings do and some do not; and the main dependence of the trout breeder for eggs is on trout upwards of two years old.

The duration of fertility is also variable, but has not been ascertained. But very large fish, although present on the spawning grounds, are often found to be old and practically sterile.

The eggs vary in size, but are usually one-sixth of an inch in diameter. The number yielded by one fish depends on its size and age, yearlings usually producing from 150 to 250, two-year-old, 350 to 500, and older fish, 500 to 2,500 (Manual of Fish Culture).

Livingston Stone states: "The number of eggs to a fish is given as one thousand to the



Text-fig. A.— Head of male Brook Trout. Text-fig. B.— Head of female Brook Trout.

pound, but it is often more than this, and varies much with the size of the eggs, those having small eggs yielding the most in number. I have taken eighteen hundred eggs from a pound trout, and once took over sixty eggs from a trout that weighed just half an ounce immediately after being stripped."

Regarding the size of the eggs Stone says: "The eggs of the trout are large compared with those of most fish, except the salmon. They average about three sixteenths of an inch in diameter, varying very considerably in size, the very largest containing probably twice the bulk of the very smallest.

"They are sometimes colorless, sometimes orange-hued, and sometimes have a rich red tint. The cause of the variation in the color of the eggs is not positively known. It has been

thought to be hereditary.<sup>1</sup> It has also been attributed to the color of the flesh of its parent, and to the nature of the parent's food.<sup>2</sup> A correspondent of Mr. Buckland says that the tints cannot depend on the color of the parent's flesh, because all grayling's eggs have similar tints, and all graylings are white-fleshed."

Usually there are established breeding places to which the fish resort year after year unless changes of physical conditions occur. The Rangeley Lakes are extremely liable to such changes, which affect both streams and shoals as spawning resorts. Offtimes lowering of the water exposes the bars that most streams form in the still water at their mouths, thus preventing the entrance of trout, and of course shoals in the lake will be laid bare by the same means. In Forest and Stream of October 15, 1891, it was stated by a correspondent that in the Rangeley region the trout had begun to seek their spawning grounds as usual, "but," using his words, "the spawning grounds are not found where they should be. On the contrary the water has far receded from them and they are only flats of dry gravel, in some instances many rods from water sufficient for trout to spawn in."

In the same paper of January 12, 1888, Captain F. C. Barker, a lifelong resident and observer of the Rangeley region wrote: "For years before the Union Water Power Company tripped up Nature and made the Mooselucmaguntic Lake over to suit themselves, one of the largest spawning beds to be found anywhere in the Rangeley region was off the Bemis bar in this lake [Mooselucmaguntic] and in not less than 8 feet of water, 40 rods from shore. Year after year they came there and did their spawning, but when the water was raised only 2 feet higher over their beds they abandoned it altogether. This fact shows that they are particular about the depth of water even over their deep water beds, and by their maneuvering the last few years since the Power Company has been constantly changing the depth of water in the lakes, it is evident that Nature has not slighted them in an endowment of instinct and reason, and although they have been considerably disturbed for the last few seasons on their lake spawning grounds, they will at no distant day get settled right again, whether it be in stream or lake."

The trout begin to assemble on the shoals or in the streams, as a rule, during September, usually in the latter part of the month in the Rangeley region, but they are not at this time quite ripe. The run then continues well into October, sometimes later. The fish appear to go in schools and there seems to be a consensus of statements that the early runs are composed entirely of males. In his article regarding his observations in Kennebago Stream, Mr. J. G. Rich stated that the males came first, cleaning off the stones until they fairly shone in the sunlight. Then they seemed to leave all at once for a day or two, afterward returning with the females, but a curious fact was observed that while before the arrival of the females the beds were covered with males, afterwards there were but few of them. In his former article, he stated that there are always more males than females, sometimes three to one.

<sup>1</sup> Mass. Fisheries Report, 1868, p. 31. <sup>2</sup> Buc

<sup>2</sup> Buckland, Fish Hatching, pp. 19, 20.

In the Rangeley Lakes region doubtless the trout spawn on every suitable shoal and ascend every suitable stream when possible. The most famous spawning places are Rangeley, Kennebago and Cupsuptic Streams and the outlet of Mooselucmaguntic Lake below Upper Dam. Mosquito, Saw Mill, and Metallic Brooks are also of importance as well as Beama and Bemis Streams. Kennebago Stream is stated, sometimes, to be ascended as far as Kennebago Falls, which present insurmountable obstruction, but Captain Barker states that the seven miles between its mouth and the "Ash Tree" is the usual resort and probably furnishes Mooselucmaguntic and Cupsuptic Lakes seventy-five percent of their trout, but another writer in Forest and Stream of November 3, 1894, was of the opinion that nine tenths of the Rangeley trout spawn in still waters where the water was affected by springs.

With the trout frequenting different shoals or streams there are frequently differences of size of the fish composing the "runs." One locality may comprise small fish, another large ones, the individuals being of more or less uniform size. Regarding this fact, after speaking of the anglers catching out big fish from those coming on to the spawning grounds, Mr. Rich says: "I am now referring to the largest brook trout which run together in masses, all nearly the same size, or at least of two pounds weight and upward. One-pound trout, as a rule, spawn in entirely different localities and by themselves, and commonly earlier in the season by some weeks. This is not, however, exclusively so, for many one-pound trout are often mixed with larger ones on the spawning grounds."

Mr. Rich graphically describes the first run of trout in Kennebago River, in 1884, as follows: "We were encamped on the banks of the Kennebago, way up among the trout beds, where, from the last of September to the freezing of the river in November, the speckled beauties resort to deposit their spawn. Our business was to protect the trout from poachers, and prepare suitable pens or places on the side of the river to confine the fish when taken until they were ripe, or in other words until 'their spawn would run,' as it was the intention of the fish commissioners to secure trout eggs to the full capacity of the Rangeley hatching house.

"The 22nd day of September, about noon, we were startled by the splashing of the water in front and above our camp, making a noise like a drove of moose wading the river. I caught my rifle and ran to the banks of the river to see not a drove of moose but the surface of the water literally covered with trout, many of them of the largest size, jumping out of the water and going through various maneuvers making slowly up the river.

"This was the first I had seen of trout near these beds, but after this the beds were covered with them, mostly males, up and down river. They seemed to come in large schools, and as many stopped on each system of beds as could work to advantage, and the remainder continued on up river until the places were stocked or the school exhausted. We found the next day plenty of trout on the beds and in the pools farther up.

"The quantity of trout coming up the river to spawn cannot be estimated, and only a

guess can be made in comparison. In front of our camp, a space of say five rods up and down the river, we secured five hundred trout from the 1st to the 12th of October, and confined them in pens immediately in front of the beds. This is not a solitary spawning place for there are many more above and below, but perhaps not so convenient to seine; and considering the great eddy and all intermediate suitable localities we shall come to the conclusion that they are as the sands of the sea — innumerable."

By flapping away the sand and dirt the trout form shallow hollows in the gravel which serve as nests in which the eggs are deposited and covered with gravel or pebbles.

Mr. Rich states that the "beds" are made of small round pebbles piled up in heaps, three or four feet across. These pebbles are carried in the fishes' mouths, sometimes quite a distance. The beds accumulate sediment and "river muss" during the year, and when the time for spawning draws near the male trout congregate near the spawning grounds in great numbers and clean the beds and make them as bright as if they had been polished. The fish then retire, and in some ten days or two weeks return with the female trout in large schools, and lie around in the vicinity of the beds until their time of deposit arrives.

While most of this statement is doubtless correct, Mr. Rich has evidently mistaken old chub nests for those of the trout, due perhaps to having observed the trout utilizing them. He must have guessed that the trout carried the pebbles to the heaps in their mouths. In another article regarding nests in Kennebago stream he states that his observations there afforded no reason for changing his views of the manner of trout spawning except that the beds there appeared to be flat, formed of small cobbles.

The spawning process is thus described by Mr. Rich: "The female drops some spawn, then with a dexterous movement of her under fin, turns a pebble over it, whirls back and forth around the bed a minute, and then goes through the same operation again; the male occasionally sidling up to the female, and both touching bellies together for an instant, then the male leaves her and looks after the spawn, and if he finds it he gobbles it up. The above operation is continued for many days, until the female has deposited all her ova."

The eggs are not all emitted at one time, but a female trout, usually attended by one and the same male, occupies the nest for several days. Mr. Rich says (l. c.) that if the female is taken from the bed the male will leave, but if the male is removed the female will remain and ere long a second male will take the place of the other.

The time necessary for the development of the eggs is dependent on the temperature of the water, varying from about 125 days in water at 37° F. to about 50 days in water at 50° F.

Trout are not infrequently observed with ripe spawn out of season, during almost any month of the year. A writer in a sportsmen's journal in 1894 stated that in the Rangeley region, well into January, he had observed, through the ice, trout spawning, and that he had not long before caught, in August, a pregnant seven-pound fish from which spawn was dripping. The

fish was said to be caught by slow trolling with worm bait in about thirty feet of water. The present writer once caught a two-pound trout in early June that contained ripe spawn.

Livingston Stone says: "It is at all events true that in the spawning season the trout are very much influenced in their spawning by the character of the day. An experienced breeder can tell in the morning, by the wind, the sky, and the state of the air, how his trout are going to spawn that day. Indeed, a person sensitive to the changes in the weather can tell by his feelings, with his eyes shut, whether it is going to be a good day for spawning. A warm rain is the most favorable condition for spawning. A sharp frosty night, followed by a warm, bright, sunny afternoon is the next best. A warm rain, particularly, brings up the fish upon the beds in swarms. This is partly owing to the increased volume of the water, for a freshet always calls out the instinct in trout and salmon to rush up to higher waters; but it is not wholly this, for the action of the pattering rain on the water hastens irresistibly their time of parturition, and they would spawn more in a warm rain if the volume of water were not increased any. On these favorable days it is noticeable that the milt of the males is also much better ripened, as well as the eggs of the female. A raw, chilly November day, when the air feels disagreeable, is the worst kind of weather for spawning, and in some of these days they will hardly come up at all. An increased current and volume of water have an effect upon the spawning fish similar to a rain, perhaps from the same cause, namely, increase of friction in the water. At any rate, the trout come up better when the stream rises. This instinct the breeder can often turn to his own convenience. For instance, if he must be absent a day, he can keep the spawners back by turning off the water as far as is safe; or if he wants to hasten the spawning on any particular day, he can do so by turning on a powerful current. The afternoon especially, whether rainy or sunny, I have always found to be the best part of the day for taking spawn."

The eggs are hatched in the spring, the time being determined by the temperature of the water. Warm water hastens and cold water retards the hatching. After they are hatched the young trout lie concealed amongst the gravel until the yolk sack is absorbed and it is capable of feeding. Then it gets into shoal water along the stream's margin or on the ripples, and whenever possible into rivulets and other small waterways. They ascend such places for considerable distances.

#### GROWTH AND AGE.

A correspondent of Forest and Stream of June 23, 1887, asked the questions: "What causes the *Salmo fontinalis* to grow to such a size in the Androscoggin waters? Why are not the trout as large in Moosehead and other Maine lakes?" Then he proceeds to answer the questions himself: "Cut open the maw of one of the great trout and the question is answered. There you will find minnows in several stages of digestion, from the one just gulped down to

only the backbone of the first one eaten. It is the feed. Millions of the chubs, Cyprinidae, are there for trout to eat. It is probable that these numerous Cyprinidae are increasing faster than the trout."

The explanation to the effect that the food is the main cause of the size attained is doubtless true, but his inference that it was the abundance of food in the Rangeley Lakes that resulted in larger fish than elsewhere in Maine was not well founded. In some other Maine waters, Moosehead for instance, such food as he mentioned is fully as abundant, with some additional species. Still other lakes are even better supplied. The probabilities are, too, that trout fully as large as those of Rangeley are taken or at least occur in other Maine waters, although the Rangeleys still hold the cup for the record fish. In Square Lake not many years ago a trout of ten pounds was caught and the present writer has personal knowledge of one of over 11 pounds taken not long ago in Belgrade Lake.

The fact is that the Rangeleys have been before the public for a longer time and the records of big fish have been advertised. Less famous waters have doubtless afforded local fishermen at least as large fish as ever were authentically recorded from the Rangeleys but public attention was not called to them.

However, it is, as the correspondent said, due in great part to the food. But combined with plenty of available food must be room in which to grow. For some reason or other there seems to be a necessity for range,— a trout will not attain a very large size in restricted quarters no matter how much food he has.

The large size attained by the Rangeley trout naturally aroused interest regarding the age of the large fish and there is a tradition that when Professor Agassiz was asked how old the big Rangeley trout probably were, he replied that no man living could tell, they might be 10 or 200 years old.

The Forest and Stream of November 1, 1877, describes an experiment undertaken by George Shepard Page, president of the Oquossoc Club, directed toward learning something of the rate of growth of trout in Rangeley Lakes. Platinum wire was cut into one and one-half inch lengths, flattened at one end, and various numbers stamped thereon from  $\frac{1}{2}$  to 4, also the numbers 70, 71, 72, etc., to denote the year. As trout were captured they were weighed, one of these tags passed through the skin just under the adipose fin, securely twisted, then the fish liberated. In the course of two or three of the years named a large number of these trout were labeled. In June, 1873, one of them was reported; a trout weighing  $2\frac{1}{4}$  lbs. was caught and found to bear a tag marked " $\frac{1}{2}$ -71," showing that this particular fish had gained  $1\frac{3}{4}$  pounds in two years. No further notice of the results of this tagging appears to have been published.

As previously stated, trout grow faster and larger in the larger bodies of water where food is plentiful than in smaller or more circumscribed places. Given plenty of room and

plenty of food it is a question to what size a trout might not attain. There are at least two natural conditions aside from those of environment just mentioned that probably affect trout. There is doubtless a natural size limit beyond which the trout could not go if it lived to be "200 years old." But even if there were no size limit the species doubtless has a more or less definite life tenure which would in any case limit its growth.

The comparatively recent developments in the study of fish scales have shown that rarely, if ever, is a greater age than 10 years attained by the Atlantic salmon and probably not that; — the lake trout of Scandinavia probably not over 12 years. Allowing then an average growth of one pound a year as suggested by Mr. Page's experiment the record fish would be only  $12\frac{1}{2}$  years old. It is quite probable that no trout lives over 12 or 15 years.

In the American Angler, vol. 3, page 312, May 16, 1885, Seth Green had the following to say regarding the growth of Brook Trout: "There are many questions concerning the growth of brook trout which I am frequently called upon to answer. I am well aware of the fact that it is very difficult to answer these questions with any degree of positiveness, for the reason that these fish differ in size and growth in nearly every locality and then again the speckled trout which inhabit lakes are known to attain a larger growth than the speckled trout of the streams. Taking these two features into consideration a correct general reply would be impossible.

"From careful measurements of brook trout from Caledonia Spring Creek I am enabled to give the following dimensions:

"A brook or speckled trout when first hatched is nine-sixteenths of an inch long, at six months old two inches long, at one year old four and one-half inches long, at two years old six and one-half inches long, at three years old eight inches long, at four years old nine inches long, at five years old ten inches long, and at six years twelve inches long. After they have reached the age of six years their increase in length is usually very slow, but they are like old men, they increase in breadth and thickness. These measurements are a fair average, but fish are like people and animals; some grow faster than others under the same conditions and frequently a two-year-old trout will be as large as a three-year-old.

"Some waters are much better supplied with food than others and this regulates their growth more than any other one thing, but there is no question about there being large and small families of trout the same as there are large and small families of horses and cattle, and no matter how well supplied with food or how favorable the conditions were the small family would never equal the large in point of size.

"As a rule trout are found to grow in proportion to the size of the stream in which they are found. I have known of streams in which trout exceeding a half pound are very rarely caught and they would be considered as large for that stream as a pound trout would for another. Brook trout sent from this locality to Long Island waters will far outstrip those of the same brood remaining here. I attribute it to the food found there and also to the salt they get.

It is my opinion that fish crave salt the same as a deer and a little given them occasionally is of great benefit.

"The largest speckled trout I ever saw which was caught in a brook weighed four pounds and two ounces and measured eighteen inches in length. The largest speckled trout I ever heard of was caught in the Rangeley Lake, Maine, which, if my memory serves me correctly, weighed ten and one-quarter pounds."

In Forest and Stream of June 30, 1887, page 495, someone writing under the pseudonym of "Percival" gave a formula for trout weight: "Apropos of the discussion in late numbers of the size and weight of trout, particularly that in your last issue by Mr. Page, the following may be of interest.

"The weight of a trout if of normal shape, and by this I mean not excessively short and chunky, extremely so, in fact, may be approximated with great closeness by the following formula:

$$W = \frac{L G^3}{1,000},$$

in which W equals weight, L equals length from eye to root of tail (not total length), and G equals girth, which, as the formula shows, should be cubed. The result is the weight in ounces. In fish up to say 5 lbs. this is extremely close, in larger fish it, of course, is liable to slight differences, increasing as the fish departs from normal form.

"Applying this now to some of the fish whose measurements and weights are given by Mr. Page, say for example his own trout, which was 30 x 18, and subtract a reasonable amount for nose to eye and tail (for the length was of course total) we find the weight  $10\frac{1}{2}$  lbs. which is close to Mr. Page's figures. Applying it to Mr. Grote's we find it about  $8\frac{1}{2}$  lbs., which is what the fish must have weighed."

Large trout.— The size which the trout might attain was for a long time a subject of disputatious and argumentative discussion. Hallock mentioned one from the Nepigon River which was said to have weighed 17 pounds. In newspapers and sportsmen's journals even greater weights have been reported from other localities, some of which were in Maine. The largest trout reported from the Rangeley Lakes was one of 24 pounds, said to have been taken in 1872 by a boy who had left his hook baited with a minnow in the water over night. In connection with the account of this fish others of 17, 15, and 12 were alleged to have been subsequently caught. Such records were undoubtedly based upon mistaken identification or misinformation.

In American Fishes, G. Brown Goode stated that the Brook Trout seldom exceeded two or three pounds and a five-pounder was thought a monster. He referred to the Rangeley Lakes as a famous locality for large fish and mentioned one obtained by Professor Agassiz in 1860, which weighed 11 pounds.

In 1905, in answer to an inquiry by "Maine Woods," State Fish Commissioner H. O. Stanley stated that the largest trout he had ever seen taken in Rangeley waters and weighed, was caught by Luman Sargent, an Upton guide, which tipped the scales at  $11\frac{1}{2}$  pounds. The next largest was one that he himself had caught which weighed  $10\frac{1}{2}$  pounds. Mr. Stanley said that this was the famous fish that George Shepard Page took to New Jersey. Mr. Stanley continued that in his boyhood days "more than 60 years ago" he had seen larger fish which his father used to bring home from those famous waters in the fall. The fish were not weighed, having been dressed and salted when they were brought home. But as he recalled them they looked more like codfish than trout. He said that he had no doubt but that larger fish than the first two mentioned had been caught but he had never seen one weighed.

The records and data referred to in the following pages were compiled from Forest and Stream, the American Angler, and Maine Woods. Back numbers of the last, previous to 1903, were not available but they supplement the other two which about that time ceased to publish regular accounts. This information is probably far from complete except perhaps that relating to the very large fish. Probably all fish above nine pounds of weight that have been caught since the first issues of the Forest and Stream have been recorded and probably most of those of nine and eight pounds taken by anglers. In other words, those that were large enough to attract attention in a region noted for large trout.

Aside from the fabulous monsters previously mentioned, no record of a Rangeley trout above 13 pounds appears, and this by subsequent reduction to fact could not possibly have weighed over 9 or  $9\frac{1}{2}$  pounds.

There are four records of Rangeley Lakes trout weighing from 12 to  $12\frac{1}{2}$  pounds, of which two are authentic, the others being more or less uncertain estimates. All but one of these were taken on the spawning beds and the exception is the  $9\frac{1}{2}$  pounder just referred to and which is discussed later.

The first was the one caught by Mr. Stanley with which George Shepard Page's name has been associated. Concerning this fish Mr. Page wrote in Forest and Stream of June, 1883, that in 1867 he carried alive to his private pond in New Jersey a female trout weighing  $8\frac{3}{8}$  pounds and a male that weighed exactly 10 pounds. They were weighed after they had been three weeks in captivity, during which time they had eaten nothing. In Mr. Page's words, "They had endured the discomforts of nine miles across Rangeley Lake in a fish car which contained forty-three brook trout averaging 5 lbs. each; thirty-five miles by wagon ride, four hundred miles by railroad; across Boston and New York by express wagon; and two miles by wagon in New Jersey. Describing this experience on one occasion to the late Prof. Agassiz, I inquired what they probably lost in weight. He replied, 'The male trout at least two and one-half pounds and the female one and one-half pounds.'" This would make them twelve and one-half and nine and seven-eighths pounds respectively. The male trout was thirty inches in length and eighteen inches in circumference and eleven inches in diameter. In Forest and Stream

he later stated that the male fish weighed after death 10 pounds, 1 ounce, and that according to Stanley and Atkins it would weigh approximately 12 pounds.

This weight was not equaled until eleven years later when two men dipping Blueback Trout in October, 1878, caught two trout one of which, a female, according to Commissioner Stanley, weighed 12 pounds, and a male which weighed  $10\frac{1}{2}$  pounds. Both were returned to the water. This is possibly the record referred to by Captain Barker in a letter to Forest and Stream under date of March 28, 1886, in which he says: "As far as I know the large trout taken near Rangeley Dam a few years ago, by the men fishing for breeding purposes, still stands at the head of the list of our large trout. I did not see the fish weighed but a man who did told me this afternoon that the weight was an honest twelve pounds two ounces."

In September, 1879, another large trout was heralded in the papers as weighing 12 pounds, caught by a Mr. Marble and his guide, Steve Morse, of Upton, at Upper Dam, September 30. A correspondent of Forest and Stream, who saw the fish weighed, stated that its actual weight, taken sometime after the fish was caught, was  $11\frac{3}{4}$  pounds. He wrote: "It was a most ungainly fish, a male with a wonderfully prominent hooked jaw. I saw the fish a few moments after its capture and had seen him several times on the spawning bed which the trout had made at that time a few feet above the dam, owing to the low water. The trout, evidently an old one, was thin and flat, but very wide, with a crooked back. The numerous pictures on the covers of guide books, and on the advertisements of the Maine Central Railroad, do him justice only in point of ugliness. Still he had the bright spots and the vermilion sides of the perfect Salmo fontinalis at breeding time."

The Forest and Stream of July 8, 1886, published the following: "The Biggest Brook Trout.— We have to record the capture of a brook trout weighing  $12\frac{1}{2}$  lbs., by Mr. J. Frederic Grote, of 114 East Fourteenth Street, New York City, in Mooselucmaguntic Lake, Maine, on June 11. The fish was a female and Mr. Grote kept it in a car for one week when it died. It was weighed several times at the Mooselucmaguntic House, in the presence of Mr. John Schultz, of Philadelphia, and the proprietors, Messrs. Crosby and Twombley. It was  $26\frac{1}{2}$ inches long,  $17\frac{3}{4}$  inches girth,  $7\frac{3}{4}$  inches deep, and was 4 inches thick through the back. The guide was Jerry Ellis....We believe this to be the largest brook trout yet recorded."

In Forest and Stream of June 23, 1887, George Shepard Page wrote in comment that C. T. Richardson informed him that the trout was one that Jerry Ellis, Mr. Grote's guide, called an 8-pound trout, but did not weigh it. After the entrails were removed, after having been in the car four days, it weighed  $8\frac{1}{2}$  pounds. Commissioner H. O. Stanley estimated the weight as  $8\frac{1}{2}$  or  $9\frac{1}{2}$  pounds, basing his estimate on the known weight of one of the same dimensions.

Of trout weighing 11 pounds and over, but below 12, the one previously referred to,  $11\frac{3}{4}$  pounds, caught by Steve Morse, guide to Mr. Marble, was taken September 29, 1879, and reported as a 12-pound fish. Doubtless  $11\frac{3}{4}$  is authentic.

On June 7, 1887, Dr. S. J. Mixter, of Boston, caught, by deep trolling with minnow bait,

three trout of the respective weights of  $11\frac{3}{4}$ ,  $9\frac{1}{2}$ , and 6 pounds. In answer to an inquiry by Wm. C. Harris, publisher of the American Angler, regarding the largest fish, C. T. Richardson stated that he saw the trout weighed after nearly one pint of spawn had run out of her and the stated weight was absolutely correct. This record is almost entitled to enter the 12-pound class. As it is, however, it is the largest fish caught on a hook and line by an angler during the fishing season in the Rangeley Lakes. Its length was  $27\frac{1}{2}$  inches, depth  $8\frac{1}{2}$  inches, thickness 4 inches, girth  $20\frac{1}{2}$  inches.

Of trout weighing from 10 pounds, inclusive, up to 11, there were 15, of which two of 10 and  $10\frac{1}{2}$ , respectively, were taken on the spawning grounds in 1867; one of 10, also a spawner, taken in 1873; two of 10 each, also spawners, in 1878; one of  $10\frac{1}{4}$  and one of  $10\frac{9}{16}$  taken in September, 1885, the latter caught by Mr. John Prentice near Brandy Point. Regarding it the editor of Forest and Stream stated that it was the third largest. One that weighed  $10\frac{5}{8}$  pounds nine hours after it was caught was taken in June, 1886, by Dr. Charles Haddock, of Beverly, Mass. It was said to be a "clean cut perfectly symmetrical fish  $28\frac{1}{2}$  inches long and  $16\frac{1}{2}$  inches girth." This fish was again reported in Forest and Stream of July 27, 1895, with exactly the same data, as having been caught that year. In 1888 one of  $10\frac{1}{2}$  pounds was taken in August, and another of  $10\frac{1}{2}$  in May, 1890. One of  $10\frac{1}{2}$  was taken in June, 1897; one of 10 in May, 1898; one of 10 in May, 1903; one of  $10\frac{3}{16}$  July 30, 1907, by Capt. S. Z. H. Slocum, U. S. A.; and one of 10 in May, 1908.

Of fish ranging from 9 pounds upward but not including 10 pounds, there are records of about 30, of which the largest was  $9\frac{3}{4}$ , caught in May, 1901. Two others almost as large,  $9\frac{11}{16}$ each, were caught in September, 1897, and June, 1906, respectively. Nine of  $9\frac{1}{2}$  pounds each are mentioned as having been caught October, 1877, for fish culture; October, 1878, for the same purpose; August, 1883; June, 1884; September, 1885; June, 1887; September, 1897; May, 1911; and July, 1910. Five of  $9\frac{1}{4}$  each were taken, respectively, in October, 1873, for fish culture; September, 1884; September, 1885; April, 1896; and September, 1897. One stated to weigh over 9 pounds was recorded for May, 1890, taken on a fly at Upper Dam. One of  $9\frac{1}{8}$  pounds was taken for fish culture in October, 1878, and one of the same weight caught September, 1892. Eleven or more of 9 pounds, each of which was taken at spawning time, have been recorded.

Over sixty weighing 8 pounds and over and less than 9 are authentically recorded, of which not more than a dozen were fish-cultural records.

#### TROUT AS A GAME FISH.

By many anglers, the trout has always been regarded as the paragon of game fishes. It is, however, due to an *ensemble* of attributes rather than to any particular quality. In certain points it is far surpassed by other fishes. The black bass in some ways requires more concen-

trated attention to effect its capture. In point of activity, there are several northern fishes that equal or excel the trout. The freshwater salmon will arouse more excitement by its evolutions and tactics, and the white-fish, pound for pound, surpasses them all in every way. The bass, the salmon, and the white-fish are all leapers; they leap when first hooked and they usually continue to leap until free or wearied by excess of energy. The trout seldom leaps from the water except when rising to a fly, and never more than once when hooked and not often that once. Sometimes when first hooked in trolling the fish will go into the air, then its action is one of dogged pulling and shaking. The present writer has heard of but a few instances of trout leaping after being hooked. Once he, himself, caught a two-pound trout on a small combination of spoon and fly and when the trout struck and was hooked it went out of the water. In one of the sportsmen's journals someone described the catching of a seven-pound trout in the Rangeley Lakes. It was stated that the fish jumped full length in the air. At the time there were one hundred feet of line out and it took almost an hour to land the fish. It was stated of the 9<sup>1</sup>/<sub>4</sub>-pound trout caught September 1 by Thomas Barbour that it was taken on a whitetipped Montreal No. 2 fly with a  $4\frac{1}{2}$ -ounce rod and that "Mr. Barbour worked  $1\frac{1}{2}$  hours from strike to finish before he had the big fellow reduced to possession."

There is, then, an inexpressible something in the trout besides activity or those things that are usually regarded as gameness that makes it such a general favorite.

### DESCRIPTIONS.

# Description of Large Salvelinus fontinalis from Rangeley Stream, Maine.

*Male.*— Head 3.45 in length without caudal; eye 6.58 in head; snout, 3.11; upper jaw, 1.44; lower jaw, curved up over end of snout, 1.45 in head; branchiostegals 12 and 11; gill-rakers 7 + 10 on each side. Body stout and deep, the depth 4.07 in length without caudal; least depth of caudal peduncle greater than distance from adipose to caudal and slightly greater than distance from anal to caudal, 2.86 in head; dorsal rays 11, the longest 1.86 in head; distance from anal to lower base of caudal 2.94 in head; anal rays 8, the longest 2.87 in head.

*Coloration.*— Top of head and back dark olive, finely vermiculated with black. Side of head iridescent bluish, greenish, and reddish; blue of back blending into yellowish green and bluish on sides, and below lateral line becoming purplish to red on sides of belly, having a blueblack shaded area between the red and the soiled white ventral line. Sides thickly spotted with yellow and with blue areolated crimson dots; dorsal fin lighter olive than back with coarser black vermiculations. Adipose yellowish with black markings; caudal dark olive with wavy dark crossbars most intense on the upper and lower lobes, faint on the middle rays; blackish terminal margin, and lower ray white; pectoral crimson with dusky shadings; outer ray white

margined behind with black; ventral similar to pectoral but not so dusky; anal crimson, anterior ray white margined with black behind. Specimen  $17\frac{1}{2}$  inches long.

*Female.*— Head, 4.1 in length without caudal; eye 7 + in head; snout, 3.65; upper jaw, 1.72; lower jaw, 1.41; branchiostegals 12 and 11; gill-rakers 7 + 11 and 8 + 11. Body deep, symmetrical, the depth 3.86 in its length without caudal; caudal peduncle deep, its least depth equal to distance from adipose to upper base of caudal; dorsal rays 9, the longest 2.11 in head; distance from anal to lower base of caudal less than least depth of caudal peduncle, 2.43 in head; anal rays 9, the longest 1.66 in head.

Coloration.— Top of head and back dark olive green finely vermiculated with lighter olive and yellowish. Sides of body greenish olive with bright purple and bluish iridescent reflections, thickly spotted with yellow, and crimson spots with blue aureola; belly from line of upper base of pectoral grayish blue. Head dark olive with iridescence. Mandible bluish, tipped with olive; branchiostegals bluish. Dorsal color of back with similar rivulations, the anterior margin pale blue marked with dusky, extending as a narrow upper margin; adipose olive, vermiculated; caudal above similar to dorsal and vermiculated, shading into reddish, middle rays becoming a dull brick red on the lower third with faint fine irregular cross-markings. Terminal margin of tail black except at about upper one fifth; lower margin white with a line of black within. Pectoral, ventral, and anal dull brick red with bluish posterior angles; white anterior rays with black inner line; base of anal bluish. Specimen  $17\frac{1}{4}$  inches long.

# Description of a Typical "Brook Trout."

Length, 6.66 inches. Head, 4.42 in length without caudal; depth, 3.42; eye, 5.25 in head; snout, 4.20; maxillary bone, 1.9; branchiostegals 10 on right side and 11 on left; gill-rakers very short and rather stout, 6+10 on each side; dorsal 9; anal 8; scales about 225. Head bluntly conic, mouth rather large, distance from tip of snout to posterior extremity of maxillary 1.61 in head; mandible, 1.44; eye moderate, distance between the eyes rather broad, 3.23 in head; body rather slender, slightly compressed; lateral line with about 118 pores; caudal peduncle rather deep and compressed; dorsal moderate, when depressed the tips of first rays not nearly reaching tips of last, 2.25 in head; base 2.1; anal falcate, the first rays longest 1.6 in head; when depressed reaching far beyond the tip of last rays, base 2.62 in head; pectoral moderate, 1.68 in head; ventral 1.9.

Head and body to some distance below lateral line brownish olive; vermiculated on top of head and back with yellowish markings; sides iridescent, bluish and green, with large yellow spots and some smaller red spots surrounded with pale blue aureola; lower jaw creamy white; throat and branchiostegals dusky; belly much punctulated with dusky, causing an irregular clouding, conforming somewhat to the dark parr marks, seven of which cross the sides; lower three fourths of dorsal with large black spots arranged in irregular rows, sometimes coalescing,

- most trout - lila My fini Solveling, 3 widen - selm brock - lale - all near Sont, - Mitavill. Long 53 only speadsphal to stream life Brook Thout really brook char "t' char Corchard geners Salvelines . Absense . + black spots (St1:1. Lock of teeth in shaft of vomen (not moth) - - break me differring for, other species of genus ( lake trait, Arctic cham, Dolly usudar, etc.) by wary manicing (dermiculation) on back and on corvel ofic a tail, and pronounces to white borders for lower fins . bréddt. ful for palie to \_\_\_\_\_\_ brêddt. ful for palie to \_\_\_\_\_\_ - first propagatel 1857. original vange - . introduced. ell ver - Kergelen fr. ~ more colds preference Then RB or brown sers tolerout solvern a - gone most of notice very East - but prot. more abondant the ever - dominant fish in 1000's miles of hostuster, she is Roch Mr. Corcode , Sierres, - where repleted notive cutthrost. - Subsp.? - southern - 'salter' -agassie' - There mines 'salter' ana dromous pr -feeding - 20 RB bu - but more benthic -less surter - esp. when coexisting - Rangely LK- - Spawn-foll - streams 5-6 in It - Rangely LK- - Spawn-foll - streams 5-6 in It - Die The Scole, 14/216.-Dr. J. W. Cook. 14/216. - 1916 Nipigen - record size Dr Coll 1914 - age-grewty - stunt: !-. \*Bunny C. - 24 You - 109-1070 14'2 16 - larger ? -' - Nipison R. - Le Super sterile Ernod. ut - Mgt. - intrasp. diverst Direct webster -old ye - predector. - Splake Temiscomie (best) - Con. Halm Bay Mich. Hangil. - Adirendoar Legue Club Assigned hybrids - Brondon Park Rev. Myrun Read - phophecy - don't write it and \* Plant breeden genetic & went ; . all our rup of sp- 2 evol. , dit seld fed. - temps, se thed was about the ... - China K

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Kirtland 1838 - speckled that in Ohio in only 2 strooms -2 small creek in Ashtabola Co. and branch of Chagrin R. Gezula Co. - , hesduster, Alleghenny R., Penn. - why 1868 --Garlick 1853-L. Monodrock (Dublin Poud) S. 2925Siziz. silver troot of Mensdusck L. - early history, - described in . Kendell 1802 - Velden extrus Jallwoh similer to relief Howard Museum has specimen 1930 and Jan 1939 Outdoor Life -N.H. 1939 somey - extinut Reg Howe . cought 25-30 - most 7216. - Dr. Samuel Bigeloc - Boston J. Not. Hist. 1800 - first mention lir. remain deep water except on spanning in fect. to show a There is but one other fish in this pond - The perch = formedy much more abundant. "fed by bushels to hogs" - local snagged, shared, -quarters + ident - Interest pergisted - "Jishwarden sent to smithemson for identy in 1872 (Spencen Brind) - in paul sue Sen perch, doce reels. Dublin - who identified Then as form of Iske Thour. 1878 D.S. Jordon - "silver-gray voriety of common fontinalis" N.1+ .. 1854 - contravery supre - Beighte claim "2 peculiar up. not protected by law" - W. H. Fish Commissioners sent speciments Horvord. Forestisthern 1884 - not brook Trout because both forms occur there and are easily distinguished. - IEEU letter "Fish worker" - cought a distinct types - brock Trot & silver that . 50 for stocking in Stone Pond. brook that spown shout 14 days later Than silver Tout. conly brook thout in outlet stheom. - 1884- speciment from Greenwood" zgzin sent to USNM-Tit. Bean examines - found no dif fr. brook thart-1885 - Som Gorman = S, agassizii - "a vaniety of brook that" - more silvery, none stender, more forked tail

Auvors trout 5, f. timpsmiensis note 3 small lobs headwater Menthod Re (1914) - chon moregon Kendall - Oct 1912 - obtained by gill wets - painting Fontinglis - Bl/while fins, metted D'stail, a 60 wet, & pelus engr - lew roker. - Kendell thought nestpines 1884 - Mr. Crowford sent cristine L, speciment to Bean -who found them to be S fontinalis ( Commenter tris). - \$2 Cell, USNM = 39327, 39328 S. H. Kimball Nor 335355 4. STONA NEY ·34710 - N=5 . W.S. Greenbood . Apr. 2, 1824 Rangely LKs - 12/216. 1930 Kendell letter to J.A. Hallinon With, 7×9, -"Later caught Cristin L. Atout - probably distinct

from Dublin Pard mont and positivily distinct from Townshow 1929 beleeved Dublin & Cristine materie trout -extinct -- 5 spec. typical brook trout in Dublin Pond - mather pale - 4 of 5 ate smelt.

typical brook stort in Dublin Pond - matter pale - 4 of 5 ate smelt. The mas Series glacial lakes · Conn. R. - L. Hitchcock - Conn. 150 mi yester into M.H. U.t.

Biol. Survey Com, Watershed - N.H. 725. Dept. 1959. Cristine L. Stark - 192 2000- 67 ff- acp "clear, cold, well oxygenated. - S. 29255izii in Iske until 1926. brook, brown, R& stocked. Dublin Pond (Monadnock L.) Dublin, - 113 ft. deg - stud-lake trout, smelt,

liti salmon

- Typical Solmo type evoli to fill nide- E. N. An. 14-17 F3 speciment USNM . ## 'IS-16 roken - [17-20] brun many rudimentary knobs of rech - like pike rokan. Bof 13 up baribn. Teeth S7-60(59) vent, US. 25-50 erecs - 43,49,55,58

Predation - Specializ 5 Fryer, Greenbord, Jackson 1965 Proc. Zool. Soz. London 144(pt. 3): 301-322. N.E. area of Recent Glaciation : limited found but "sibling" sp. > Glacial Fronts- advances a retreats & correlation w, distribution of alpinus A. golden (aureolus). Sanapee, aveill Flood Me. K. blueback (oquassa) - Rangely Lh. +? - Ore all aureolus & oquassa populations of common price? common origin institute surcours - various opinions C. marstoni p. typical coastal alpinus Backus (54)

giving, with the lighter ground color, a vermiculated appearance to the latter; upper margin of fin straw with indistinct spots; pectoral, ventral, anal orange, with first ray white, bordered by black within; adipose dusky, tipped with yellow; caudal orange and olive, finely barred with wavy marking.

The small trout (Plate 7) serving as the subject of the illustration of *S. fontinalis* in this paper was an artificially reared fish from a small private pond at Falmouth Foreside, Maine. The stock of this pond originated in a highly colored trout occurring in a small private lake in Buxton (?), Maine. The trout of this lake are frequently of a rich rose madder to carmine on their ventral regions. The offspring of this stock in the Falmouth Foreside pond show none of the red hues but are of bright yellow tints. This is a good illustration of change of color with change of environment.

This trout is described as follows: head, 4.6 in length without caudal; eye, 5.62 in head; snout, 3.46; upper jaw, 1.8; lower jaw, 1.73. Body not very robust, the depth 4.81 in length without caudal; caudal peduncle comparatively stout, its least depth 1.47 in the distance from anal to caudal; dorsal inserted somewhat nearer tip of snout than base of caudal; dorsal rays 10, the longest equal in length to the length of the dorsal base, considerably longer than anal base, and 1.15 in head; distance from adipose to base of caudal considerably greater than base of dorsal and not much greater than the least depth of the caudal peduncle; pectoral 1.21 in head; the distance of its base from tip of snout slightly greater than length of head; distance from base of pectoral to ventral 3.5 in length of body without caudal; distance from tip of snout to ventral slightly less than from base of ventral to lower base of caudal; length of ventral, 1.5 in head; anal rays 8.

*Coloration.*— Body dark olive green with lighter vermiculations, the dark color fading into brownish olive, then golden brown, then flesh color toward ventral line where it is narrowly white. Spots of orange brown, ocelli pale lilac with crimson center; dorsal, color of body, paler toward tip, becoming faintly orange yellow, crossed by several irregular dusky wavy bars; adipose like back, mottled with lighter dull orange; caudal, color of back along its upper edge, mostly deep purplish pink, with black crossbars; lower edge narrowly white, bordered anteriorly by a narrow irregular black line; pectoral, anal, and ventral deep pinkish crimson, edged with white, with black line between white and crimson. Head, color of back with reflections of bronze, gold and green on olive base; iris greenish yellow.

Specimen 9 inches long.

## SYNONYMY.

Salmo fontinalis MITCHILL, SAMUEL L., Report in Part of Samuel L. Mitchill, M. D., Professor of Natural History, etc., on the Fishes of New York, p. 12, 1814 (New York Trout).— STORER, D. HUMPHREYS, Fishes of Massachusetts, in Report on the Fishes, Reptiles and Birds of Massachusetts, p. 106, 1839 (The Common Brook Trout), "Sandwich" (Salmon Trout); Memoirs Amer. Acad. Arts and Sci., vol. 6, p. 322, pl. 25, fig. 3, 1858; A History of the Fishes of Massachusetts, p. 144, pl. 25, fig. 3, 1867 (The Common

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	Locality		a+	a	b/a	o/a	p/a	s/a	x/a	z/a	z <sup>1</sup> /a	c/b	e/b	h/b	k/b	c/g	a¹/z	a/z <sup>1</sup>	Gr.	Br.	D	A	Sex
Rangeley	Stream, <sup>2</sup>	Maine	18 <u>1</u>	415	.228	.125	.146	.110	.127	.104	.124	.126	.263	.578	.652	_	1.01	8.05	{7+11 8+11	$\frac{12}{11}$	11	9	ę
"	"	"	$17\frac{1}{4}$	390	.243	.115	.151	.123	.130	.107	.100	.142	.293	.578	.705	.415	-	10.0	$     \begin{cases}       7+11 \\       8+11     \end{cases} $	-	9	9	ę
"	"	"	17	390	.238	.135	.145	.117	.123	.105	.102	.129	.301	.645	.763	.333	-	9.75	$     \begin{cases}       8+11 \\       7+13     \end{cases} $	-	9	8	ę
"	66	"	$17\frac{1}{2}$	387	.289	.155	.180	.155	.167	.090	.098	.151	.321	.705	.857	.535	-	10.18	${7+10}{7+10}$	$\frac{12}{11}$	11	8	৵
"	"	"	$15\frac{3}{8}$	350	.285	.134	.165	.140	.142	.088	.088	.140	.340	.720	.830	.470	-	11.29	${7+10}{7+10}$	—	10	8	37
"	"	"	$14\frac{3}{4}$	335	.307	.161	.173	.134	.152	.095	.104	.139	.301	.655	.752	.569	-	9.56	${6+10 \\ 6+11}$	$\frac{9}{10}$	9	7	ਾ
Rainbow	Lake, Ma	ine	129	293	.249	-	.143	—	.156	—	—	.178	.246	.561	.671	_		-	${7+9}{7+10}$	$\frac{10}{11}$	9	8	Ŷ
"		"	$10\frac{1}{3}$	230	.247	.139	.152	_	.148	_	—	.201	.263	.561	.666	_	-	-	{8+10 {8+10	$\frac{10}{11}$	9	8	\$
"	cc (	"	101	260	.241	.148	.157	-	.144	_	—	.181	.254	.527	.618		—		5+9 (6+11)	$\frac{11}{12}$	9	8	ę
"		"	97	224	.232	.147	.151	-	.142	_	-	.211	.250	.557	.634	-	-	-	$     \begin{cases}       6+9 \\       6+9     \end{cases} $	9 12	9	8	ę
"		"	9 <del>1</del>	210	.238	.145	.157	-	.145	_	-	.200	.280	.540	.620	_	_	-	${}^{\{4+10\}_{6+8}$	$\frac{10}{11}$	9	8	ę
"	"	"	88	200	.235	.135	.150	-	.135	-	-	.212	.255	.553	.659	-,	-	-	5+11 (6+10)	$\frac{12}{12}$	9	8	Ŷ
"		"	81/2	190	.236	.152	.163	-	.142	-		.200	.266	.533	.644	-	_	_	$\begin{cases} 4+7 \\ 4+7 \end{cases}$	$\frac{10}{12}$	9	8	ę
"	"	"	102/3	243	.255	.156	.160	-	.131	-	-	.185	.306	.629	.725	-	-	-	${6+7 \\ 5+9}$	11	9	9	ð
"	"	"	103	238	.235	.130	.155	-	.134	_	-	.196	.232	.561	.660	-	-	-	$   \begin{cases}     5+11 \\     4+12   \end{cases} $	10 11	9	8	or
"	"	"	98	230	.269	.147	.160		.147	-	-	.177	.241	.564	.661	-	-	-	${4+7}{4+7}$	10 11	9	8	5
"	"	"	97	216	.259	.166	.152	-	.143	-	_	.178	.285	.589	.696	-	-	-	5+10 5+10 5+10	$\frac{11}{12}$	9	8	3
**	"	"	81/3	188	.244	.132	.143	-	.138	-	-	.206	.282	.554	.652	-	-	-	$5+11 \\ 5+11 \\ 5+11$	$\frac{11}{12}$	10	9	0 <sup>71</sup>
Caspian	Lake, Vt.		9	206	.223	.145	.155	.121	.135	-	-	.173	.282	.565	.652		-	-			9	8	?
			81/2	207	.229	.140	.152	.115	.135	-	-	.168	.294	.568	.631	-	-	-		-	11	10	?
"			835	193	.227	.145	.145	.116	.134	-	-	.204	.295	.590	.659	-	-	-		-	10	10	?
Freepor	t, <sup>3</sup> Maine		858	192	.245	.165	.156	.135	.145	.083	.098	.191	.255	.595	.680	.600	1.18	10.10	${7+10}{7+10}$	$\frac{10}{10}$	10	9	?
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Proportional Measurements and other Characteristics of Salvelinus fontinalis from different Localities showing Size, Sex, and Individual Variations.1

<sup>1</sup> Explanation of symbols used in the tables.— The proportional measurements are expressed by decimal fractions. The parts or structures are indicated by letters and the proportions designated by the letters in the form of algebraic common fractions. Thus: b/a signifies that the proportion is obtained by dividing the measurement of part b by the dimension of a.

us.	the mound of part of part of the second seco				
a+	. Total length in inches from tip of snout to tip	h <sup>3</sup> .	Width of supplementary maxillary.	v.	Length of base of anal fin.
	of tail.	i.	Distance from tip of snout to base of pectoral	w.	Length of middle caudal ray.
a.	Length in mm. from tip of snout to end of		fin.	x.	Length of longest ray of anal fin.
	lateral line.	<i>j</i> .	Distance from tip of snout to ventral fin.	y.	Distance from posterior end of dorsal to adi-
$a^1$ .	Least depth of caudal peduncle.	k.	Length of lower jaw to junction with the quad-		pose fin.
b.	Length of head from tip of snout to gill-opening.		rate.	$y^1$ .	Length of base of adipose fin.
$b^1$ .	Length of head from tip of snout to nape.	1.	Distance from tip of snout to anal fin.	z.	Distance from posterior base of adipose to
$b^{2}$ .	Perpendicular diameter of head through middle	m.	Distance from tip of snout to origin of dorsal		upper base of tail.
0	of eye.		fin.	$z^1$ .	Distance from posterior base of anal to lower
	Length of eye.	n.	Length of base of dorsal fin.		base of tail.
с.	Greatest depth of body.	0.	Height of dorsal fin.	Br.	Number of branchiostegal rays, upper right,
d.		р.	Length of pectoral fin.		lower left side.
e.	Distance from tip of snout to front of eye.	1200 - 200	Distance from base of pectoral to base of ven-	Gr	Number of gill-rakers on both arms of first
f.	Distance from tip of snout to posteric edge of preopercle.	q.	tral fin.	u	branchial arch.
g.	Width of interorbital space.	r.	Length of longest upper caudal ray.	D.	Number of fully developed dorsal rays.
9. h.	Distance from tip of snout to posterior ex-	8.	Length of ventral fin.	<i>A</i> .	Number of fully developed anal rays.
16.	tremity of maxillary.	t.	Distance from base of ventral to origin of anal	5	Male.
h <sup>1</sup> .		14 di	fin.	ę	Female.
		и.	Length of longest caudal ray.	?.	Not determined.
$h^2$ .	Length of supplementary maxillary.				(C) 11 12
	<sup>2</sup> All breeding fish.		<sup>3</sup> Taken 1	in tide	water = "Salters."

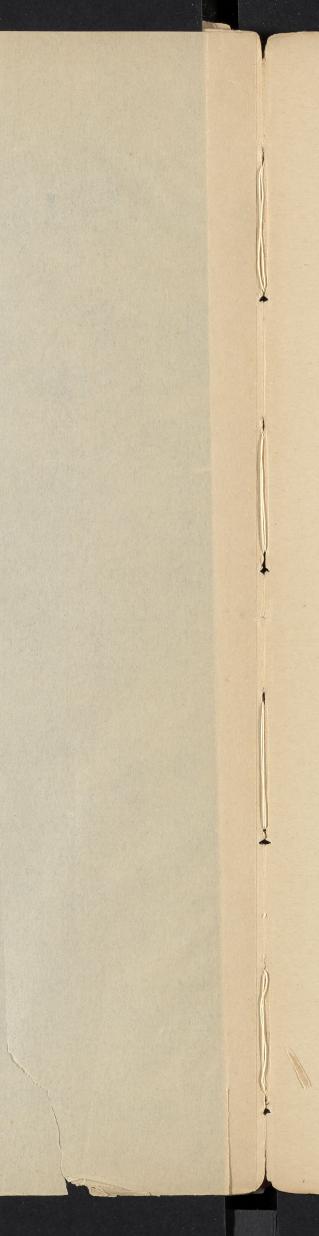
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Brook Trout), "Sandwich." — THOMPSON, ZADOCK, in History of Vermont, Natural, Civil and Statistical, part 1, chapter 5, p. 141, 1842, "Fishes of Vermont" (The Brook Trout), "More generally diffused than any other fish," Tinmouth; *ibid.*, 1853.— LINSLEY, JAMES H., "Catalogue of the Fishes of Connecticut," Amer. Journ. Sci. and Arts, vol. 47, p. 69, 1844, (Brook Trout), "Common."— FORSYTH, J. B., "On the Habits of *Salmo fontinalis*. From a Letter addressed to Dr. Storer," Boston Journ. Nat. Hist., vol. 5, p. 412, 1847, "Sandwich."— HOLMES, EZEKIEL, "Catalogue or Synopsis of a Part of the Fishes of Maine, arranged according to Prof. Gill's Classification," Dr. Holmes' Report on the Fishes of Maine, part 2, Second Annual Report on the Natural History and Geology of Maine, p. 32, 1862, (Brook Trout).— GARMAN, S., "The American Salmon and Trout, including introduced Species," Nineteenth Annual Report of the [Mass.] Commissioners of Inland Fisheries, p. 76, figs. 14, male; 15, female, 1885, (Brook Trout),

"Great Lakes, their tributaries, the region eastward to the Atlantic and southward to Alabama." Salmo tructa (in part) BELKNAP, JEREMY, The History of New Hampshire, vol. 3, p. 179, 1792 (Salmon Trout),

"All streams which flow from the mountains, and very near their summits."

Tracta WILLIAMS, SAMUEL, The Natural and Civil History of Vermont, p. 121, 1794 (Trout).

Salmo erythrogaster LINSLEY, J. H., Amer. Journ. Sci. and Arts, vol. 47, p. 69, 1844 (Red-bellied Trout), "Housatonic." — Holmes, E., Catalogue or Synopsis, Part 2, Second Annual Report on the Natural History and Geology of Maine, 1862.

Fario fontinalis HOLMES, E., Synopsis, Part 1, ibid., p. 32, 1862 (Brook Trout).

Fario erythrogaster (?) HOLMES, E., ibid., Part 1, p. 32, 1862.

Salvelinus fontinalis BEAN, TARLETON H., "The Red-spotted Trout of New England," Shooting and Fishing, January 10, 1889, p. 7, fig. (Brook Trout), "Woods Hole, Cristine Lake, N. H. (?)".- KENDALL, W. C.. "Notes on the Fresh-water Fishes of Washington County, Maine," Bull. U. S. Fish Comm., vol. 14, pp. 50, 53, 54, 1895, (Trout, Brook Trout, Speckled Trout), "Dennys River, Grand Lake Stream." - EVERMANN, B. W., and KENDALL, W. C., "An Annotated List of the Fishes known from the State of Vermont," Report U. S. Commissioner of Fish and Fisheries for 1894, p. 592, 1896 (Common Eastern Brook Trout), "Sleeper River at St. Johnsbury .... small stream on the east side of Lake Memphremagog." - SMITH, HUGH M., "Fishes found in the Vicinity of Woods Hole," Bull. U. S. Fish Comm., vol. 17, p. 92, 1898 (Brook Trout, Speckled Trout), "Abounds in the fresh waters of the region and in fall, where communication exists, regularly enters the salt water, remaining through the winter .... Great Harbor and Little Harbor." ---KENDALL, W. C., and GOLDSBOROUGH, E. L., "The Fishes of the Connecticut Lakes and Neighboring Waters," Bureau of Fisheries Document, no. 633, p. 52, pl. 12, 1908, (Trout), "Connecticut Lakes, Perry and Indian Streams."- KENDALL, WILLIAM C., "Fauna of New England, List of the Pisces," Occasional Papers Boston Soc. Nat. Hist., vol. 7, no. 8, p. 46, 1908, (Trout, Brown Trout, Redspot, Squaretail), "Almost everywhere in brooks, rivers, ponds and lakes." - TRACY, HENRY C., "Annotated List of Fishes known to inhabit the Waters of Rhode Island," Fortieth Annual Report of the Commission on the Inland Fisheries of Rhode Island, p. 83, 1910, (and reprint), (Brook Trout, Speckled Trout), "Common in fresh-water streams throughout the State. Reported from brooks and small streams in Foster, Scituate, Glocester (Moosquitohawk and Huntinghouse brooks), North Smithfield, Burrillville (Sucker and Brandy brooks), Coventry, West Greenwich, Exeter, and North Kingstown."-SUMNER, FRANCIS B., OSBURN, RAYMOND C., and COLE, LEON J., "A Catalogue of the Marine Fauna of Woods Hole," Section 3, "A Biological Survey of the Waters of Woods Hole and Vicinity," Bull. U. S. Bureau of Fisheries, vol. 31, p. 743, 1913, (after Smith).

#### KENDALL: NEW ENGLAND CHARRS.

#### ADDENDUM.

Since the present Memoir went to press, C. Tate Regan, M. A., of the British Museum, has published "The Systematic Arrangement of the Fishes of the Family Salmonidae."<sup>1</sup>

The classification of the Salmonidae, according to Regan's interpretation of skeletal characters, consists of the two subfamilies, *Salmoninae* and *Coregoninae*, as in the present Memoir.

According to Regan's arrangement Salmoninae includes the genera Salmo, Salvelinus, Hucho, and Brachymystax, the latter being closely related to Hucho. Coregoninae comprises Stenodus, Coregonus, Phylogephyra, and Thymallus.

It is to be noted that Plecoglossus is omitted from the classification and Brachymystax is included in *Salmoninae*. Oncorhynchus is relegated to Salmo and Thymallus, which Gill considers as constituting a distinct family (Thymallidae), is included without stated reasons in *Coregoninae*. Regan's disposition of Oncorhynchus seems to be based solely upon a few anal fin rays of "*Salmo (Oncorhynchus) masou.*"

The distinguishing characteristics of *Salmoninae* and *Coregoninae* are stated to consist mainly of the arrangement of the parietals which he says *do not meet in the middle* line in the former and *do* so meet in the latter.

According to Regan the genus Salvelinus comprises three groups essentially conforming to the arrangement in the present Memoir, thus:

"1. S. alpinus group.— Head of vomer with posterior process but little developed. Basi-branchial teeth uniserial. No dark spots or markings. Circumpolar.

"2. S. fontinalis group.— Head of vomer with a well-developed posterior process. Basi-branchial teeth absent." Blackish or dark olivaceous spots or markings on back, dorsal, and caudal fins. N. America.

"3. S. namaycush group.— Head of vomer with a long posterior process. Basi-branchial teeth in a long patch. N. America."

After giving diagrams showing the arrangement of the vomerine teeth in Salvelinus perisii, S. fontinalis, and S. namaycush, it is stated that S. fontinalis is so exactly intermediate between the typical charr and S. namaycush in the form and dentition of the vomer that it is thought best to give up the genus Cristivomer.

Attention should be called to the fact that in the *S. alpinus* group the basi-branchial teeth are not invariably uniserial, but vary from elongate patches to few or no teeth at all. This seems to be individual variation rather than a group or specific character.

<sup>1</sup> Ann. Mag. Nat. Hist., ser. 8, vol. 13, p. 405–408, April, 1914.

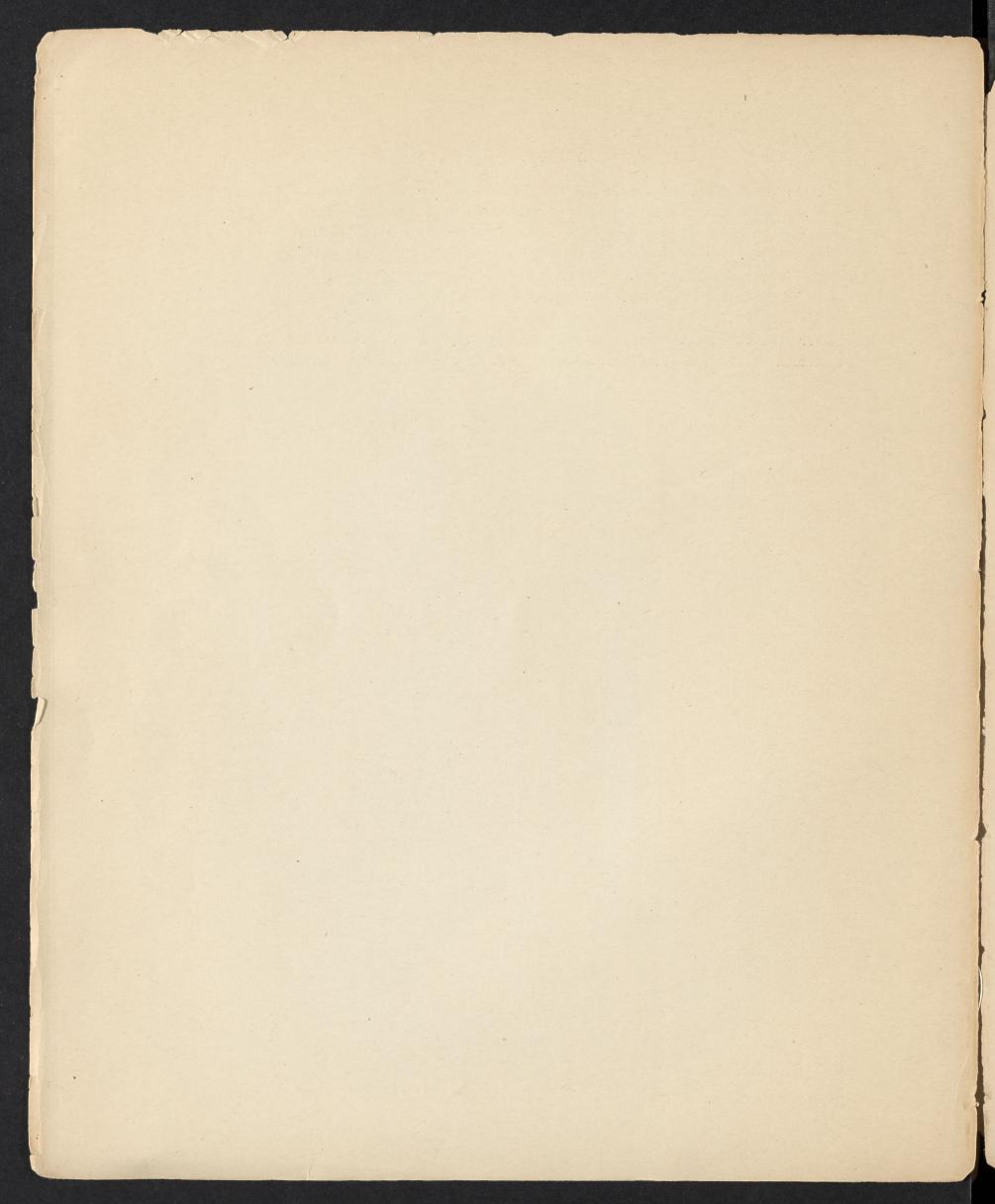
102

### ADDENDUM.

From an examination of vomers of many specimens of Arctic and New England charrs of the S. alpinus group as well as of S. fontinalis and S. namaycush, the author of the present Memoir concluded, as has already been seen, that the S. alpinus group rather than S. fontinalis is intermediate. However, re-examination of the same vomers and Regan's statement and diagrams suggest that neither the S. alpinus group nor the S. fontinalis group is intermediate, but that both vary considerably and each intergrades independently with S. namaycush.

This conclusion is in conformity with the suggestion previously expressed in the present Memoir regarding the origin of the charrs, to the effect that S. namaycush is an older derivative of a common parent stock and that the S. alpinus group and S. fontinalis are later divergents.

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# EXPLANATION OF PLATES.

# PLATE 1.

Fig. 1. Lake Trout, Salvelinus namaycush (Walbaum). Male, from Thompson Pond, Maine.

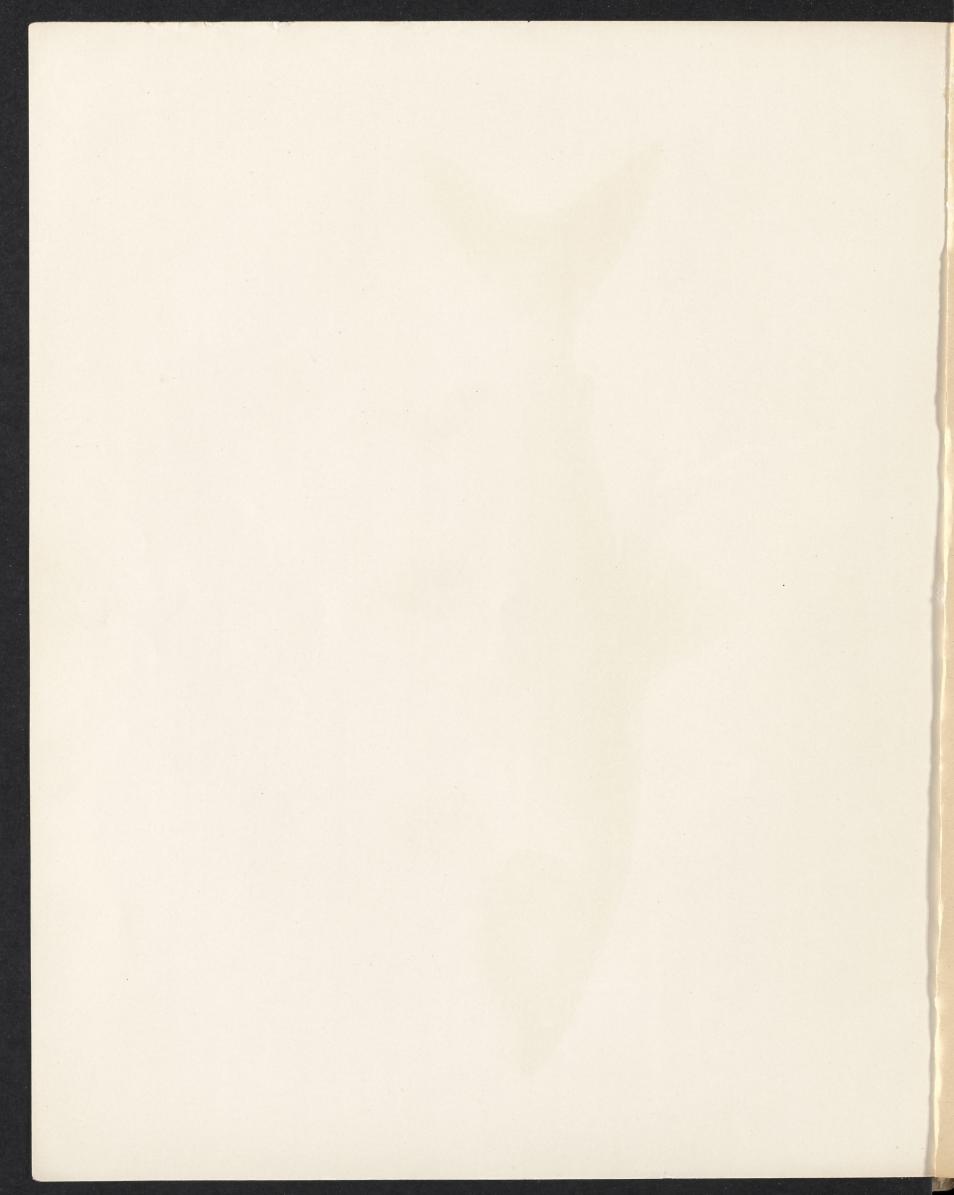
MEMOIRS BOSTON Soc. NAT. HIST. VOL. 8.

PLATE 1.

KENDALL ON NEW ENGLAND CHARRS.

1

Werner u.Winter, Frankfurt<sup>a</sup>/M.



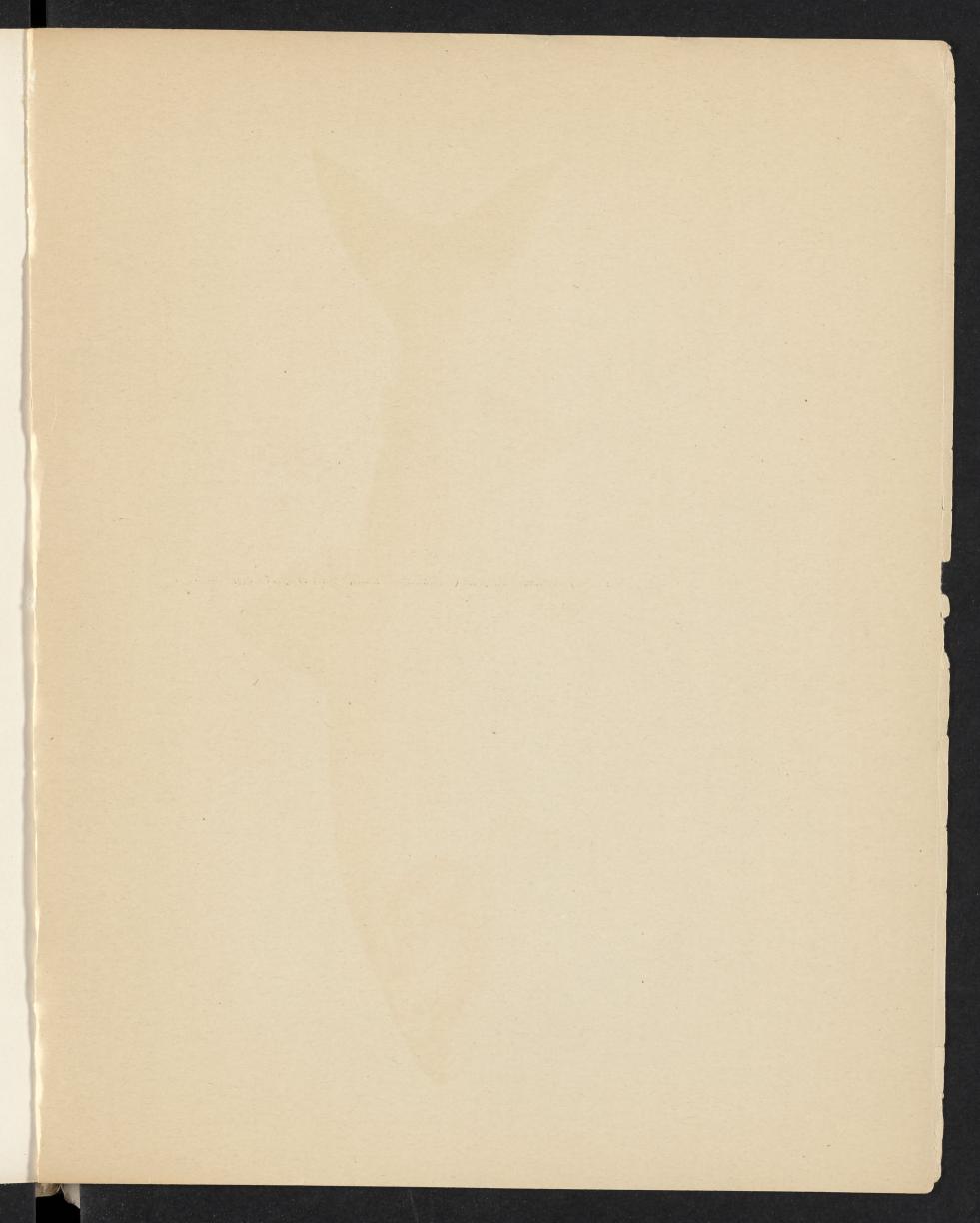


PLATE 2.

Fig. 2. Lake Trout, Salvelinus namaycush (Walbaum). Female, from Thompson Pond, Maine.

MEMOIRS BOSTON SOC. NAT. HIST. VOL. 8.

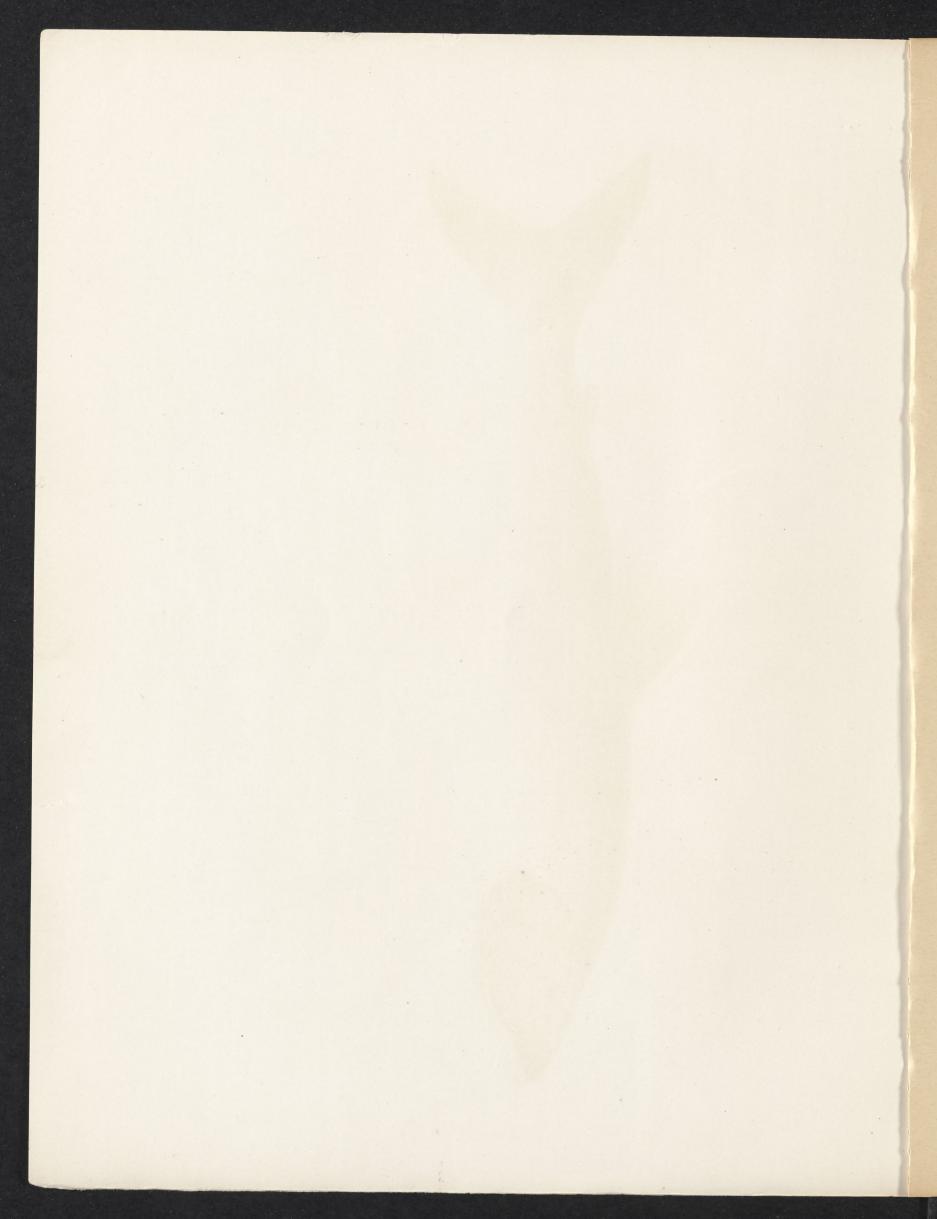
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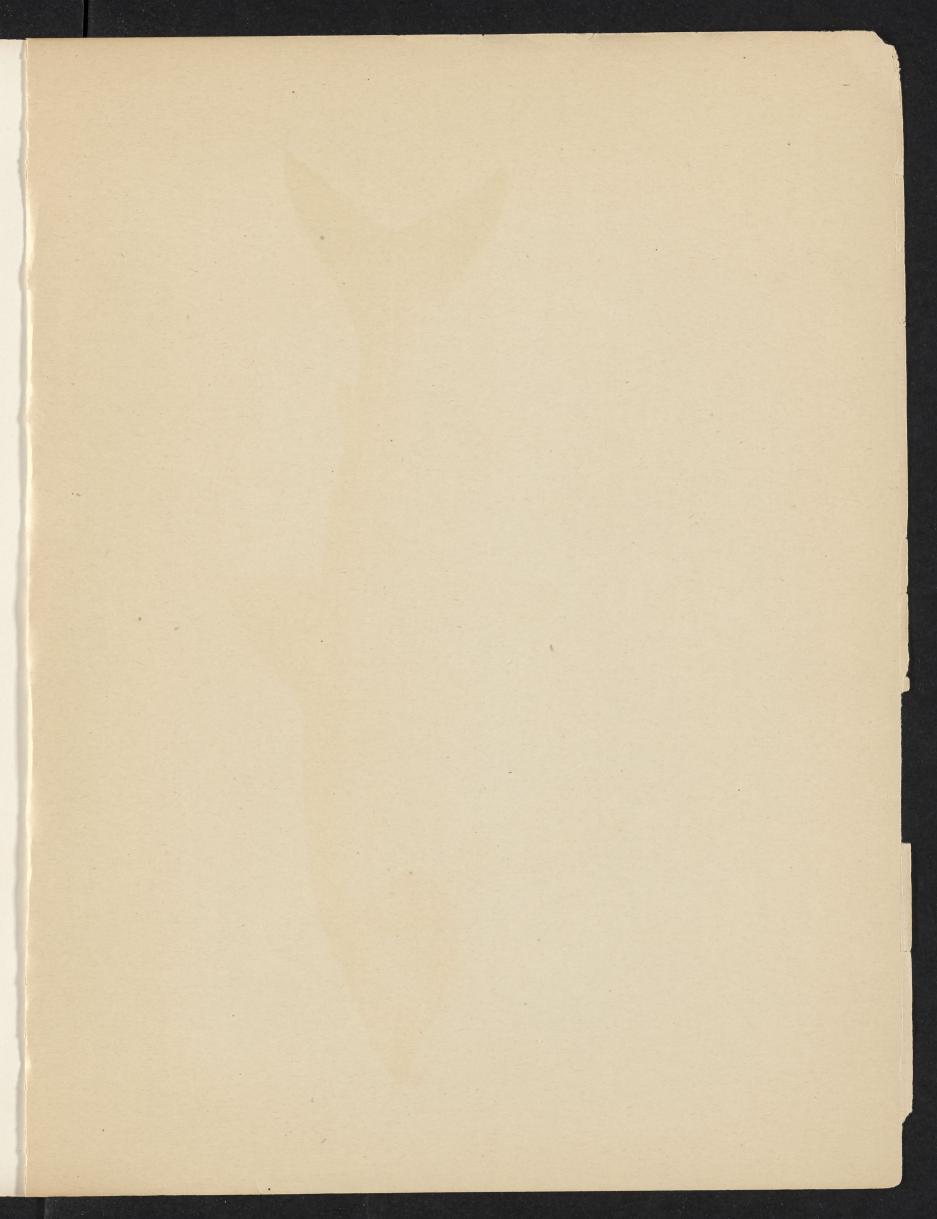
PLATE 2.

Kendall on New England Charrs.

2

Werner u.Winter, Frankfurt<sup>a</sup>/M.





## PLATE 3.

Fig. 3.Blueback Trout, Salvelinus oquassa (Girard), var.?Male, from Rainbow Lake, Maine.Fig. 4.Blueback Trout, Salvelinus oquassa (Girard), var.?Female, from Rainbow Lake, Maine.

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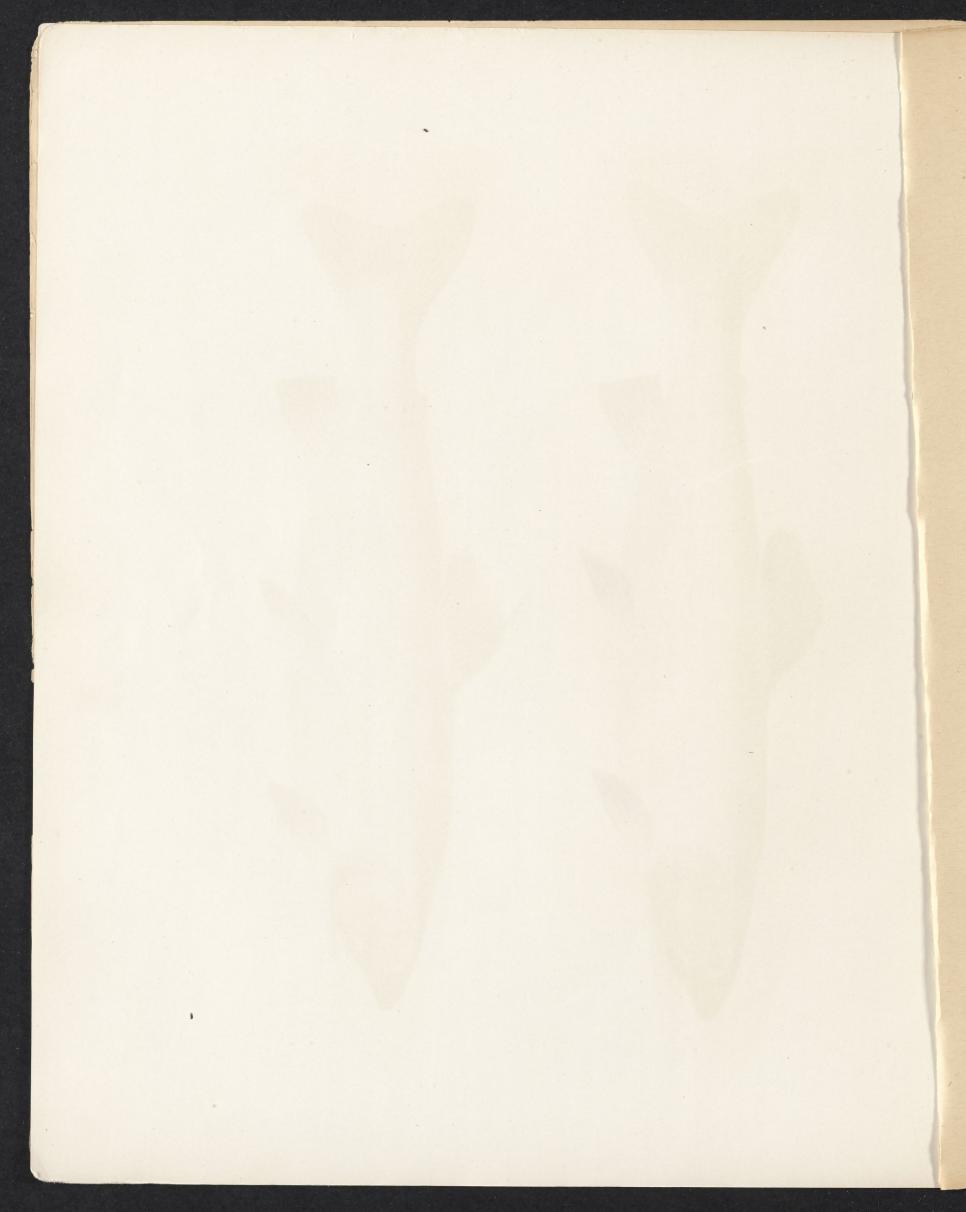
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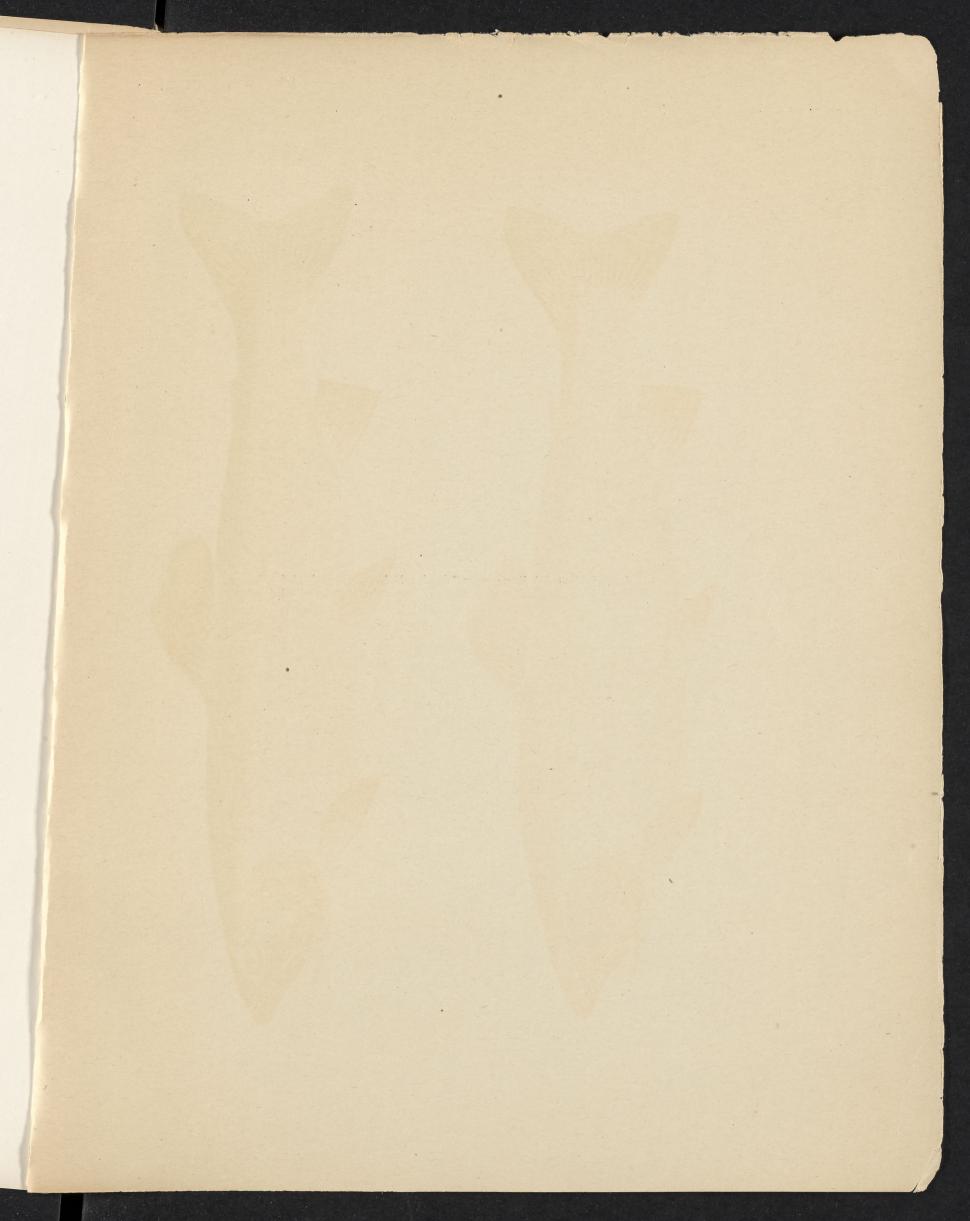
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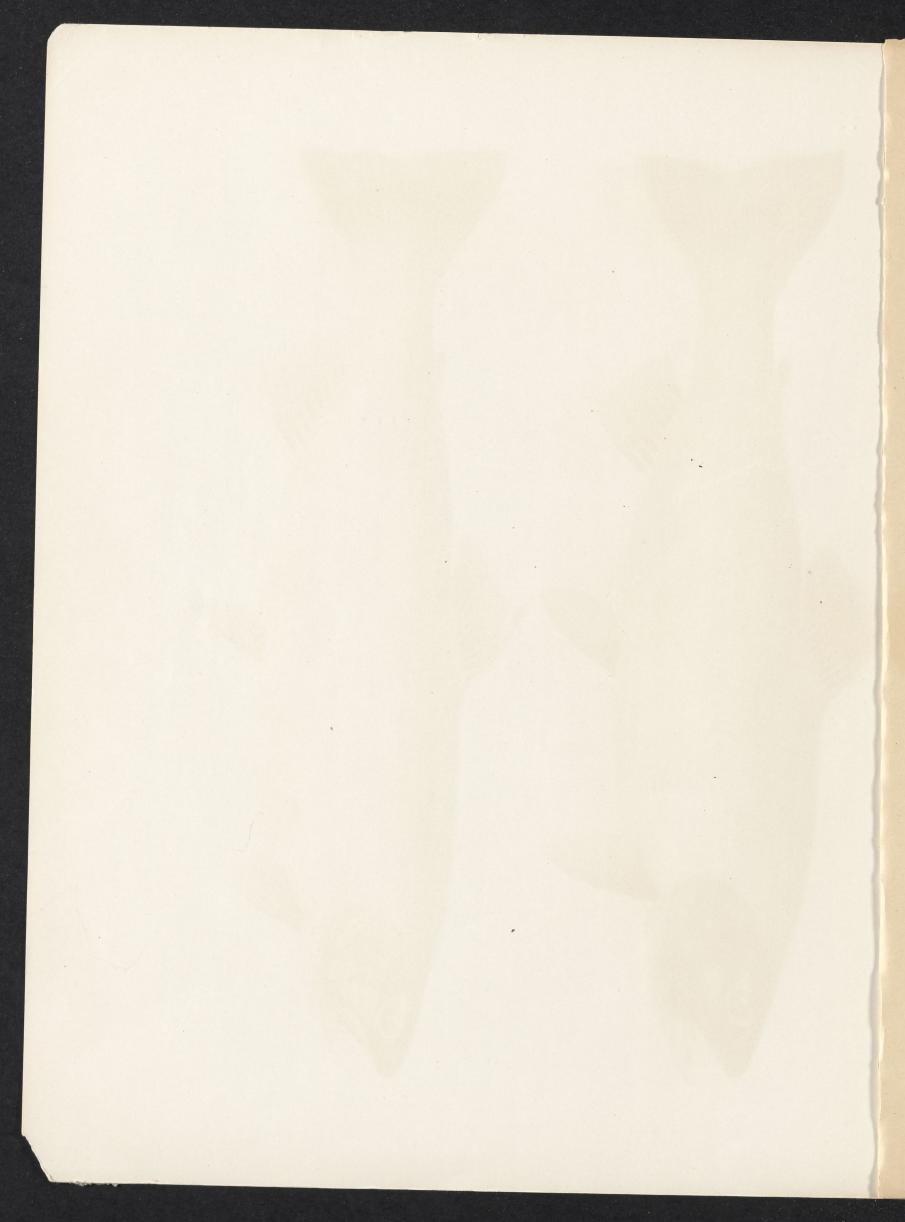


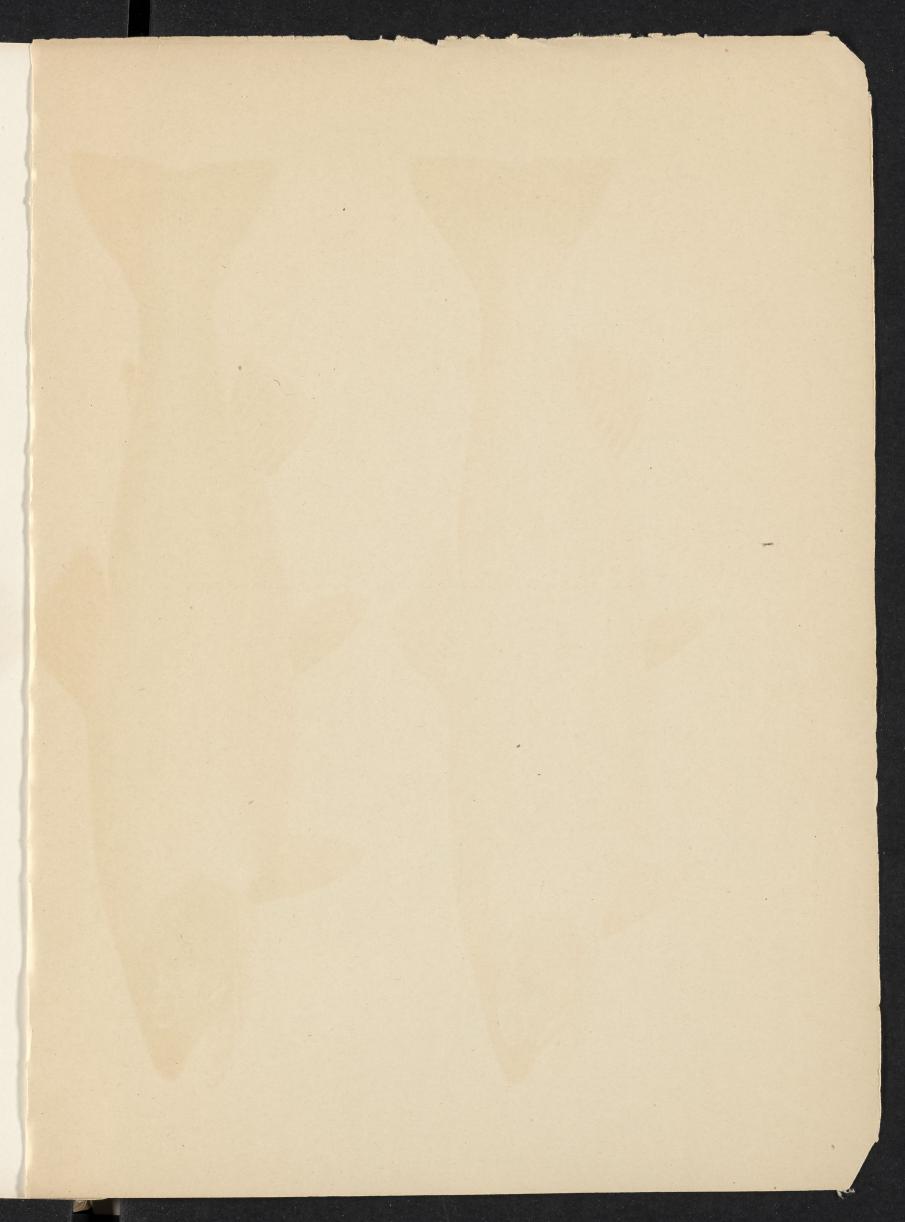
## PLATE 4.

Fig. 5. Blueback Trout, Salvelinus oquassa (Girard). Male, from Rangeley Lakes, Maine.Fig. 6. Blueback Trout, Salvelinus oquassa (Girard). Female, from Rangeley Lakes, Maine.

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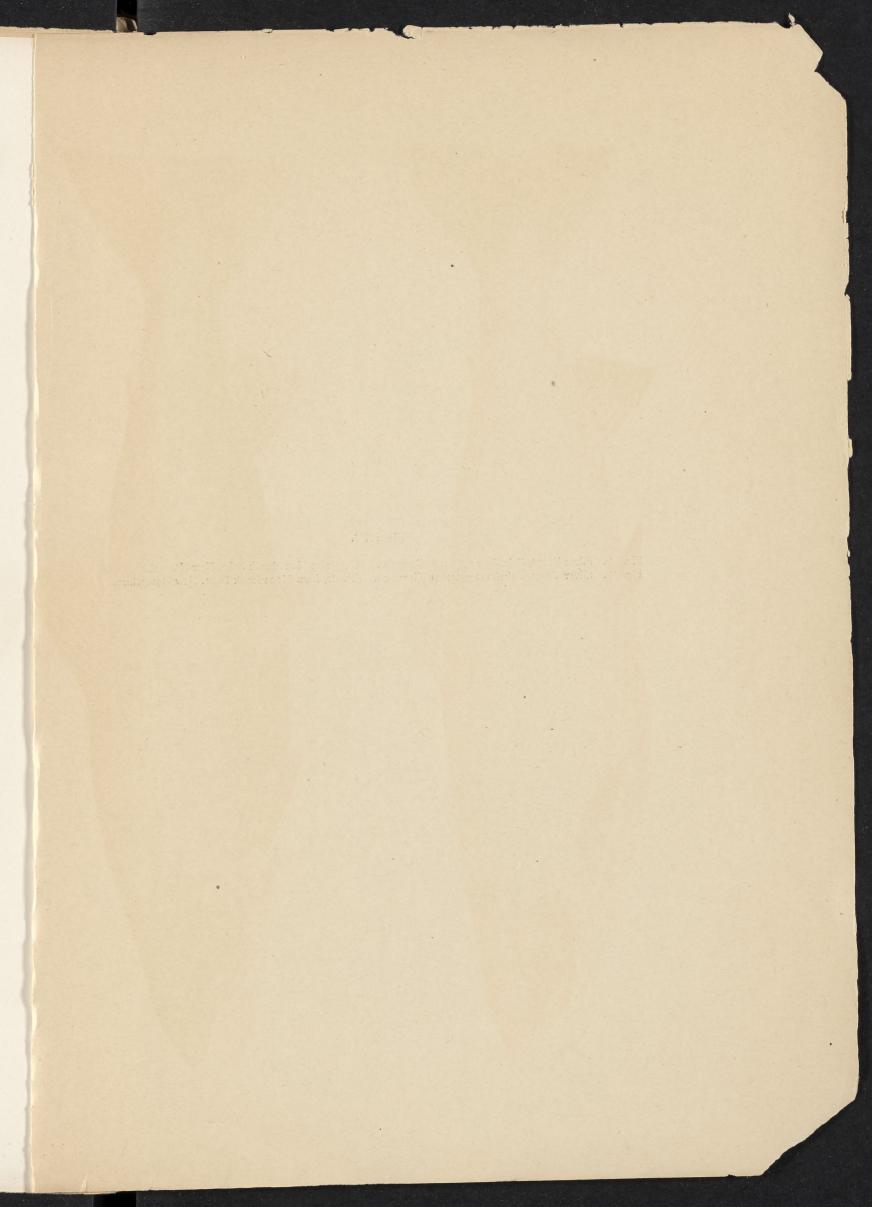


## PLATE 5.

Fig. 7. White Trout, Salvelinus aureolus Bean. Male, from Sunapee Lake, New Hampshire.Fig. 8. White Trout, Salvelinus aureolus Bean. Female, from Sunapee Lake, New Hampshire.



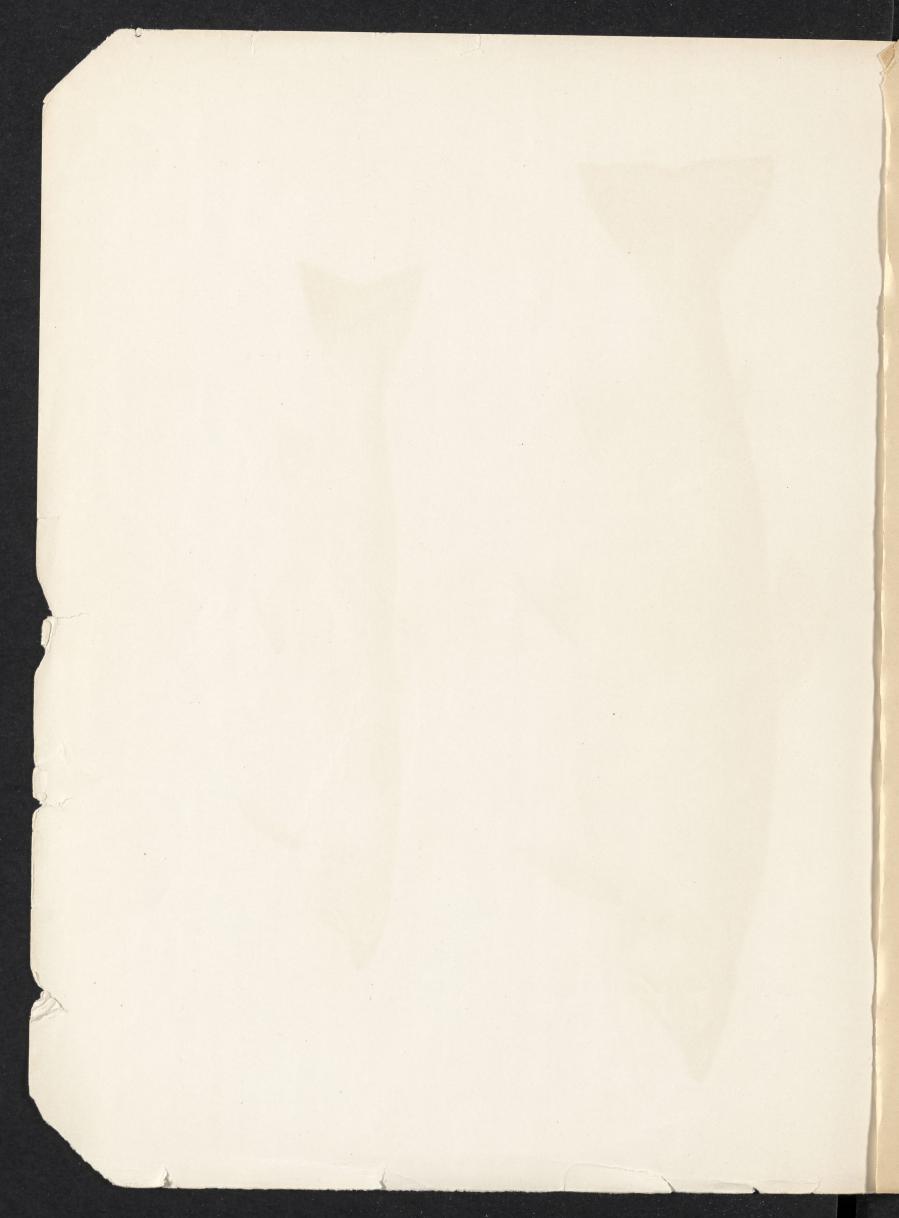




## PLATE 6.

Fig. 9. Silver Trout, Salvelinus agassizii (Garman). Male, from Monadnock Lake, New Hampshire.
Fig. 10. Silver Trout, Salvelinus agassizii (Garman). Female, from Monadnock Lake, New Hampshire.





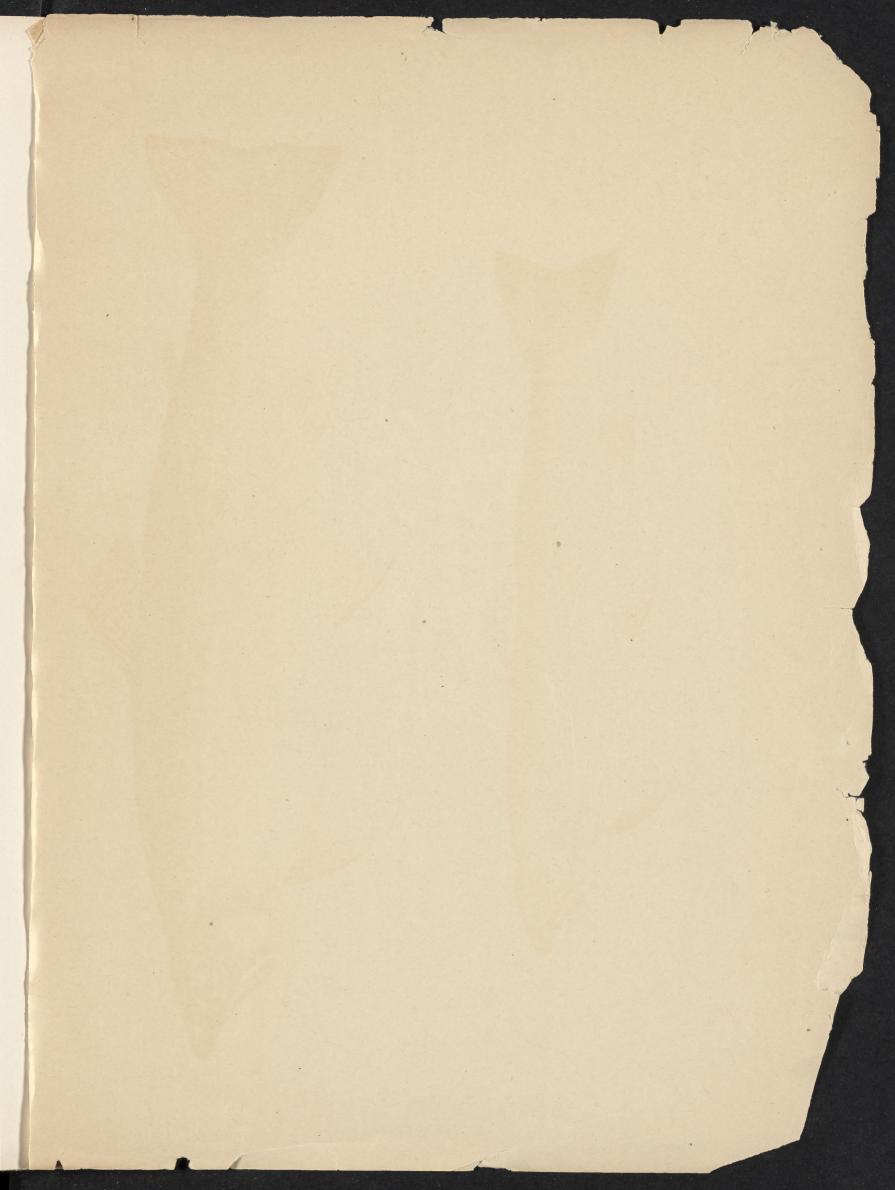


PLATE 7. Fig. 11. Brook Trout, Salvelinus fontinalis (Mitchill). Male (?), from Artificial Pond, Falmouth Foreside, Maine.

#### BOSTON SOC. NAT. HIST. VOL. 8.

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PLATE 7.

KENDALL ON NEW ENGLAND CHARRS.

11

• Werner u.Winter, Frankfurt<sup>a,</sup>M.

Keim, R.C. 1975. The Blueback. Trout, 16(4):9, 27-29. Basin Pond; 277 Bluebacho 6-13 in. stoched in June 1976 from Wadleigh Pond. - Only fish known to be

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1948 first caught Pushines Pond.

Rambow L. Bluebad discovered by Kendall -

ROBERT BEHNKE

CO-OPERATIVE FISHERIES UNIT COOP. BUILDING SIGMA XI

24 October 1975

Student Center

North Ballroom

Friday Noon

H. L. Brammell, M.D. Director of Research, Rehabilitation and Training in Coronary Artery Disease and Lung Disease, Director of the Coronary Care Unit, University of Colorado Medical Center Denver

#### "Cardiac Rehabilitation: An Overview with Emphasis on the Role of Exercise"

A brief review of the principles and practices of cardiac rehabilitation will be given. The role of exercise will be discussed in greater detail: progression of activity, writing an individualized exercise prescription, when to begin reconditioning following heart attack, safety of exercise, how exercise might modify the natural history of coronary disease, kinds of exercise and some realities regarding reconditioning. A question and answer period will follow.

Mr. Max Morton will introduce the speaker.

SIGMA XI

31 October 1975

Friday Noon

Student Center

North Ballroom

Mr. Paul C. Allen Coordinator, Kodak Colorado Office Corporate Information Department Eastman Kodak Company Windsor, CO

"An Introduction to Kodak Colorado"

<u>Salvelinus agassizi</u> (Garman) Silver trout Order Salmoniformes Family Salmonidae

TYPE LOCALITY: Dublin Pond near Dublin, Cheshire Co., NH (Garman 1885. p. 61-81. In 19th Annu. Rep. Comm. Inland Fish., Mass. for 1884).

SYSTEMATICS: Early thought to have closest affinity with the <u>Salvelinus alpinus</u>, Arctic char, group by some workers, and by others to be a species most closely related to, or a subspecies of <u>Salvelinus fontinalis</u>, brook trout (Kendall 1914. Mem. Boston Soc. Nat. Hist 8:1-103). Regarded as a species with nearest relative being <u>S. fontinalis</u> by Behnke (1972. J. Fish. Res. Bd. Canada 29:639-671) on basis of several characters including morphology and coloration of 13 probable syntypes at U. S. Natl. Mus. Nat. Hist. Nineteen additional specimens, almost certainly syntypes, reside at the Mus. Comp. Zool., Harvard Univ. (K. E. Hartel, pers. com.). Excellent color plate in Kendall (1914) undoubtedly served as template for color painting by Schwiebert (1978. <u>Trout</u>. E. P. Dutton, 1745p.). Lived syntopically with <u>S. fontinalis</u>, also native to Dublin Pond.

DISTRIBUTION AND HABITAT: Known with certainty only from type locality, a small, clear, cold, deep lake fed only by bottom springs, in the Connecticut River drainage. Inhabited deep water during most of the year, occupying upper levels over deep water and shallows only for a brief period shortly after iceout and shallows during fall spawning. Apparently not rare during early part of 1800's. Decline possibly related to overfishing (including snatching, noosing and netting in spawning area) and competitionwith yellow perch and brook trout, the latter being introduced as well as native. Last known capture in 1930 (6 specimens, Mus. Comp. Zool. 40875), prior to analysis of Dublin Pond (Warfel 1939. Biological Survey of the Connecticut River Watershed. N. H. Fish Game Dept. Surv. Rep. 4, 256p.).

SIZE: Specimens taken prior to 1850 usually .1-1.4 kg; 2.3 kg and one of 3.2 kg reported. Later declined in average size.

BIOLOGY: From scant information, fed on aquatic insects, introduced shrimp and (gut contents) "a dark greenish-brown vegetable material." Angled with artificial flies, worms, grasshoppers, minnows and trout eggs. Reproduced in shallows for ca. 2-3 weeks during October, preparing redds in stony-sandy areas, and spawning at least partly during night. Reproduction of brook trout occurred in smae areas, either concurrently or two weeks later. Data from Kendall (1914), who documented early recorded history including newspaper accounts of the species.

Compiler: R. E. Jenkins February 1979



ACADEMIC CAMPUS SCHOOLS The Arts Arts and Sciences Business Community Services Education Social Work MEDICAL COLLEGE OF VIRGINIA CAMPUS SCHOOLS Allied Health Professions Basic Sciences Dentistry Medicine Nursing

# Dept of Biology VIRGINIA COMMONWEALTH UNIVERSITY 901 West Franklin Street • Richmond, Virginia 23284

13 Feb 197a

Dr Robert Behake

CSU

Dean Bob -

Enclosed is my section, for FW Fishes atlas, on Salvelinus agassizi.

Could you read it with cally for me?

what do think about the common mame Silver treat? or chan? or public Pond Chan?

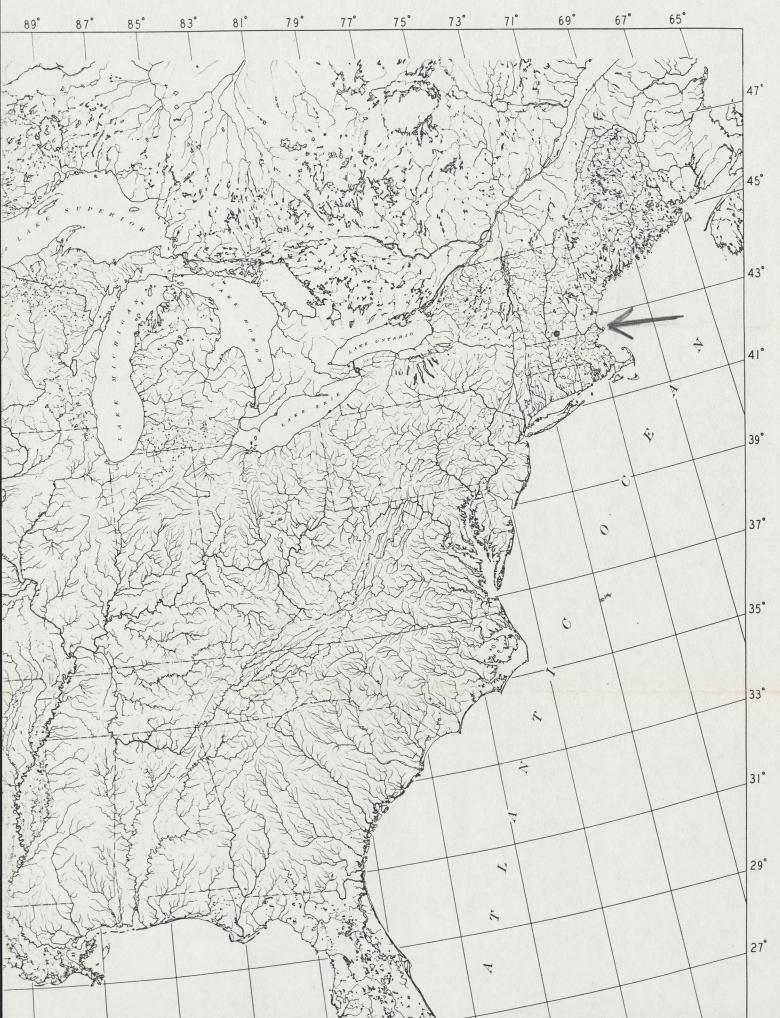
Note I dropped 2Nd "i" from specific epithet. please inform if you think there would be much objection

Bob - + hank you very much for your help.

Sincerel BobJenkin

Robert E. Jenking

\*



A Start



JENKINS - Biolog7 VIRGINIA COMMONWEALTH UNIVERSITY 901 West Franklin Street • Richmond, Virginia 23284



De Robert Behnke Fisheries Science Colorado State University Fort Collins CO 80521

11/5/76

51 Norfolk Street Bangor, Maine, 04401

Dr. Robert J. Behnke Department of Fishery and Wildlife Biology Colorado State University Fort Collins, Colorado, 80523

Dear Dr. Behnke:

Your letter of encouragement for a survey of Wassataquoik Lake was delivered to Fred Kircheis, who, in his quiet, patient way, will lobby for permission to do so. (The state worker morale-budget situation is bleak here. The Independent governor formerly ran an insurance agency and is strictly a bottom-line man. Mr. Kircheis will also need approval from the Baxter State Park Authority, however, this is usually a mere formality.)

In reviewing some of Dr. Kendall's notes, plus his own copy of his monograph, one vital questions arises: Were any Dolly Varden (S. malma) eggs, fry, juveniles or adults ever sent by a western state to New Hampshire or Maine? I'll check the two states here (I hope New Hampshire has enough personnel left to take time for this; fish and game research there has virtually ceased due to budget cuts.). Could you raise this question with appropriate authorities in the West?

The reason: in Kendall's notes which became Page 68 in his monograph, the final paragraph, in his hand, does not appear in the text concerning the Silver Trout/Monadnock Trout (Charr) of Dublin Lake. The excluded paragraph reads:

"It shows a relationship to <u>S. fontinalis</u>. One could with about as much reason consider it a subspecies of <u>Salvelinus</u> <u>malma</u> of the Pacific Coast as of <u>S. fontinalis</u> for as a matter of such in most of its structural characters it is even closer to malma."

Mr. Kirchies said yesterday that from appearance the Sunapee and Blueback, in coloration and shape, are more like a Dolly Varden than a brook trout. However, he said he has never studied a Dolly Varden internally. This layman, having caught one Dolly Varden in the Muskeg River, Alberta, in Sept., 1974, fully agrees with Mr. Kircheis's statement.

I'm hoping to obtain more of Dr. Kendall's notes, correspondence and/or unpublished papers within a week. Hopefully therein will lie a clue to "in a lake in Maine."

Dr. Kendall made many notations, in pen, on the blank pages in his monograph. One raises doubts if he ever saw a live Christine Lake specimen. I hope further research will erase those doubts. Anway, the notation reads:

"A mounted specimen, poorly painted, of the Christine Lake 'Trout' is in the possession of Dr. Kendall at Freeport. It is regarded as a distinct species, as evidenced by the structural differences shown by comparison with a brook troutcaught in the same lake, of about the same size. The proposed name for it is Salvelinus aureolus." The remainder of this paragraph refers to observations of Dr. John D. Quackenbos in "Geological Ancestors of the Brook Trout and Recent Forms from which it Evolved" and Dr. Kendall writes Quackenbos received Christine Lake specimens in 1916 and termed them as "almost a fontinalis."

While notations in Dr. Kendall's copy of his monograph are dated as late as April 9, 1931, and from what I can determine are all in his handwriting, no date is given for his Christine Lake notation, nor any indication when, how, from whom, in what form or condition the mounted Christine Lake specimen was received. Likewise for the brook trout.

Concerning hybrids: Allegedly New Hampshire produced, or so it claimed, two fertile hybrids--German saibling and brook trout plus a Sunapee trout and brook trout eross. This was reported during the debate over the Sunapee's identity that was waged for years in the columns of Forest and Stream. I'll report the precise reference in a future letter and, hopefully, information on what happened to them. I don't recall that these allegedly fertile hybrids were reported distributed in any New Hampshire waters.

To be continued.

1890 7 × 5. 35:429 - "Is the golden trot 2 hybrid." - Əlpino Jontinic" Tradi Day (Brit. + Jun Schward 1580 (Brit. + Jun Schward)

Sincerety, Oger . Seim Roger C. Keim

Roger C. Keim 51 Norfolk Street Bangor, Maine, 04401



Dr. Robert J. Behnke Department of Fishery and Wildlife Biology Colorado State University Fort Collins, Colorado, 80523

appl

-NO with Dolly Varden vert. creeco fins, border histeling .t (Thyones = Long ale one. - Calif 7 0 1393-94 - Not proper atted a sligerid Quelcarrays - Col Like - and a second second And a second

### University of Toronto

DEPARTMENT OF ZOOLOGY

J. Moenig RAMSAY WRIGHT ZOOLOGICAL LABORATORIES 25 HARBORD ST. TORONTO 5, ONTARIO, CANADA

June 26, 1972

Dear Dr. Behnke:

I thought that you might be interested in the enclosed photostats. In doing some research on the historical aspects of Lake Erie lake trout ( now unfortunately extinct ) I came across references to the introduction of Saibling (<u>Salmo salvelinus</u>) into New Hampshire lakes in 1881. On page 648 of the June J.F.R.B. (SCOL papers) you refer to the silver char of Dublin Pond of which you examined 13 specimen obtained in the 1880's. Is there some connection here? Waiting to hear from you.

sincerely, Joachim Molnig Joachim Moenig

