24445 13th Av. So.
Huntington Park
Kent, WA., 98031
22 August 1978

Robert J. Behnke
Dept. of Fishery & Wildlife Biol.
Colorado State University
Fort Collins, Colo. 80523

Dear Bob:

Enclosed is a copy of the "boiled-down" version of the major thrust of my long-drawn-out ~~versie~~ thesis for a book on the Charrs of America which I have almost given up as ever getting out of my personal files. I had 10 xerox copies made for distribution among my old comtemporary charr men for their files, comments, criticisms, advise, etc.... These would include Ted Cavender, Bob Miller, Carl Hubbs, Vadim Vladykov, Jim Morrow, Al DeLacy, Bob Behnke, maybe Chereshnev or Savviatova (if I felt sure they would get them).

Just sent one to Ted with note that our Wash. Univ. Fishery Librarian doesn't expect to receive the July issue of Cal. Fish & Game until October!! Hope he can fix me up with a Xerox of one of his MS so I can get to work on my specimens of confluentus and see if I can squeeze them into my proposed series, and if so where or how. As I intimated in Fig.6 p.17 Morton 1965 I find no kype in these Columbia Basin-resident-lake charrs (nor from some big ones from Lake Maligne in Canada..or Lake Kintla from Glacier N. Park) and am anxious to complete other checks to see if they will fall into my lake charr series. Hubbs taught me thirty years ago to expect to find one group that would blow my thesis all to hell..maybe this is it! Anyway, I'll be interested, as always, in your reaction and comments.

Right now I am deluged in a project of trying to get out a little mimeographed pamphlet on Federal Fish Hatchery Memoirs..a review of the thumb-nail biographies of ten of my old cronies who have sent material and photograhs for such an effort. I want to deliver it to them on our 5th reunion at Harlan Johnson"s on Aug. 30th!! Am having a hell of a time finding time to complete this little edition. ≤ of pretirees

Your comments on "Good-bye Dolly" were very helpful and I'll send you a copy of my piece on that subject later in the fall. In haste -- as always..

Sincerely,

Mark

Wm. Markham Morton

- Fish & Fur
- Cavender "Dolly"
- Sunapee Idaho
- S. 21 Bks

A SUMMARY OF THE DIFFERENCES I HAVE OBSERVED IN AMERICAN CHARRS (Salvelinus) FROM 1939 TO 1979

Recent warnings from my physician make it imperative that I procrastinate no longer in putting down on paper a brief summary of what I have learned in forty years of spare-time study on American charrs. Although I have long dreamed of one day putting out a book that dealt only with charrs, I waited too long! I now hope I can complete, and find a suitable outlet for, a series of brief papers offering more detailed basic data and/or photographic evidence to substantiate the following resumé of what I believe to be the most natural classification for the genus.

As I have often stated since 1943, I remain convinced that our American charrs all fall readily into one or the other of two major systematic groups based upon their appearance, habits, and structure; all of which are special adaptations for survival in the entirely different natural habitats they occupy, viz:

1. A stream-spawning brook charr series, which could also be called lotic or fluviatile charrs, because they spend most of their lives in a destructive, erosive, kinetic, and usually fairly shallow constantly flowing stream of water.

2. A lake-spawning lake charr series, which could also be be called lentic or lacustrine charrs, because they spend most of their lives in the deep, quiet, comparatively static waters of ponds, lakes, or reservoirs.

The different characteristics which these groups of charrs have developed are summarized briefly in the following Table 1.

Table 1. DIFFERENCES IN CHARRS DUE TO THEIR NATIVE HABITAT

Salvelinus fluviatalis Brook Charrs		*Salvelinus lacustris* Lake Charrs
	EXTERNAL CHARACTERS Usually the	
is green or black.	Predominent Color	is brown or gray.
numerous, mostly smaller than the pupipl of the eye.	Spotting	sparse, most of them as large or larger than the pupil of the eye.
only on underside of mandible.	Cephalic Pores	extend from lateral line over top of head & down opercle or preopercle.
numerous 225 or more; small-almost invisible.	Scales	less numerous 225 or less: larger - easily visible.
truncate in young fish.	Caudal Fin	forked in young fish.
wide and thick.	Caudal Peduncle	narrow and thin.
longest ray shorter than base.	Median Fins	longest ray longer than base.
comparatively short.	Paired Fins	comparatively long.
comparatively small	Eyes and Head	comparatively large.
insertion of dorsal.	Body is Widest at	back of head.
seldom exceeds 10 lbs. 4.5 kg in weight.	Maximum Size	frequently exceeds 20 lbs. 9 kg. in weight.
	INTERNAL CHARACTERS Usually the	
is wider than long.	The Vomerine tooth-plate	is longer than wide.
are absent or uniserial; less than 15 in single row.	Hyomandibular or basibranchial teeth	are in a patch or multiserial; more than 15 in 2 or more rows.
less than 20.	Gill-rakers	more than 20.
less than 62	Vertebrae	more than 62.
less than 30.	Pyloric Caecae	more than 30.

Table 1. DIFFERENCES IN CHARRS DUE TO THEIR NATIVE HABITAT (Cnt.)

Salvelinus fluviatalis Brook Charrs		Salvelinus lacustris Lake Charrs
Number of eggs varies directly with the size of the female, However, comparative size and color might prove of some significance.		
thin& transparent.	Swim Bladder	thick,opaque or pinkish.
	HABITS	
Notably selective and fastidious;insectivorous or benthic feeder.	Feeding	Notably omnivarous & piscivarous; often ingesting indigestable materials.
Frequently anadromous with"smoltification" a common phenomenon.	Migratory	Seldom, if ever, anadromous. No cases of "smoltification" known to me.
Build nests or redds in percolating waters of streams or beaches.	Spawning	Very little, if any, redd building.
Usually spawn in pairs. No "pearl bodies" ever reported or observed.		Usually spawn in groups. "Pearl bodies" reported in spawners.
Definite sexual dimorphism; males develop kypes and humps.		Very little, if any, sexual dimorphism. No notable kypes or humps in males.

The only absolutely true statement I can make about the above table is that every item has to be prefaced by the adverb usually. Because there never has been, are not now, nor ever will be two living organisms exactly alike, there can be no precision. The only biological law I know of that is always true is, "and this, too, shall pass away". I learned long ago that the classification of plants and animals should never be considered a science. Like taxidermy, genealogy or the practice of medicine, it is an art becuase it depends chiefly upon creative human imagination for its interpretatiom and conduct. Our modern systematic fisheries literature is especially cluttered with mathematical attempts to support

our definitions of populations, races, sub-species, species etc., all of which are in a constant state of flux because of our constantly "improving" interpretations; but more obviously because of the constantly and continuing environmental changes so hopelessly accelerated on such a huge scale by the recent Caucasian invasion of our great continent!!

Before outlining my final proposed reorganization for the genus Salvelinus in America, I will present what I believe are the salient characters of the genus: 1. No teeth in the roof of the mouth first pointed out by Willughby in 1683; 2. They frequently (before we came along) reach 20 years of age or more..no other salmonid genus exceeds 10 years very often. 3. They have white anterior margins to the lower fins (often shared by Salmo, but not by Parasalmo); 4. They all have light spots against a darker background - no black spots; 5. They are all fall spawners (as also are Salmo but not Parasalmo). Following the trend from lowest total meristic counts presented in Table 2,my order of species would be:

No. 1. The American brook charr, Salvelinus fontinalis Mitchill 1825, originally found only in Atlantic drainages of temperate North America (now all over the world!). A mottled dorsal fin will identify it from any other charrs at any stage of its life cycle. A black leading edge on paired fins,and a vertebral count of less than 60 are unknown in any other American charrs at least. Related forms would include the Aurora "trout",Salvelinus fontinalis timagamiensis.

No. 2. The Pacific brook charr, Salvelinus malma Walbaum 1792, a member of the "Arctic charr complex" found only in Pacific drainages, south of Bering Strait, of Asia and America..the southern malma of McPhail and Morrow. Related forms would include Salvelinus

malma tudes, lordii, pluvius, leucomaenis Kundscha among others - but not spectabilis or confluentis[2] of western America.

No. 3. The Arctic brook charr, Salvelinus salvelinus or Salvelinus arcturus Linnaeus 1759 (to be selected and re-described)- another member of the"Arctic charr complex" found spawning in Artic streams,circumpolar in distribution in Eurasia and America. I feel this group could well have been the parent stock from which all other charr species may have been derived. If so I would like to see it referred to as S. salvelinus. I am aware that according to the archaic rules of The International Congress of Zoological Nomenclature, these names are already "occupied". However, I feel quite sure that young Peter Artedi[1] would be quite pleased to know that his suggested name now applied to some live fish rather than to a long-lost holotype in a dust-covered museum jar! Related forms: the northern malma of McPhail and Morrow; the stream-spawning forms of S. alpinus of many authors; and Salvelinus salvelinus oquassa Girard 1852. I regret to admit that I have never been able to obtain any specimens of this widely-distributed group except from Maine as can be seen from table 2.

No. 4. The Arctic Lake charr, Salvelinus alpinus Linnaeus 1759, (to be better described), another member of the "Arctic charr complex" found spawning only in Arctic lakes of Eurasia and America. While I can easily understand the difficulty anyone might have distinguishing Arctic brook from Pacific brook charrs, I have never

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1/ There is really nothing new under our sun! Just to-day I "discovered" that Peter Artedi used Trutta fluviatis and Trutta lacustris to describe brook and lake trout under Salmo in his Ichthyologia (1738) p.218 !!-WMM

2/ Havn't been able to obtain a copy of Cavendar's description in CF&G for Juy 1978, at this writing --W.M.M.

been able to understand ~~how~~ why anybody would confuse the Arctic lake charr with either of these brook charrs! The major differences first described by DeLacy and Morton in 1943 still hold true for all of the European, Eastern Canadian, or United States specimens I have been privileged to examine to date. A sample of Sunapee Trout received recently from Maine was easily assigned to the alpinus series, even before the examination verified it as Salvelinus alpinus aureolus Bean 1887.

I was recently thrilled to receive a letter from one I.A. Chereshnev of Vladivostok, USSR, who wrote," As suggested by investigations originated by you, the sympatric zone of S. alpinus and S. malma you found at Karluk exists also at Chukotsk peninsula." A photograph enclosed immediately identified S. taranetzi as a form of alpinus in contrast to the specimen of S. malma also shown. I have never understood why Don McPhail ignored our discovery when he published his alpinus complex ~~story~~ paper in 1962. In fact Dr. Chereshnev is the first ichthyologist I know of who ever gave me credit for what I have always felt was the only new thing I ever found in thirty years of federal service as a fishery biologist!

No. 5. The American lake charr, Salvelinus namaycusch Walbaum 1792, originally found only in American lakes north of the 45th parallel..mostly in Canadian waters, stands at the other extreme of this "natural" attempt at charr classification - and, like fontinalis, almost stands alone. It is a "far-out" species of charr that originally occupied almost every large lake left by the last receding glacier. It has a mottled dorsal fin; no red spots; & an elongated crest of teeth on the vomer. There is no possibility of confusing

it with any other charr on earth. Strangely enough, it hybridizes readily with fontinalis at the other end of the series, and these hybrid offspring known as "splake" have been stocked all over the continent since 1890.

From the thousands of measurements and counts I have made on charrs over the past thirty years, the only physical or mathematical basis I could find that consistently supports my proposed natural arrangement of American charrs is shown in Table 2. This is a summary of the totals of the number of gill rakers + vertebral + pyloric caecal counts of each fish made available to me by many friendly contemporaries.

On the left-hand side of the table are: the species, its origin, and the year I examined it. Below is the range of standard body length in centimeters of the sample.(Standard body length is Total length minus Standard length minus occipital head length.), Juvenile or adult males or females. N= number of specimens examined; X = mean or average count; R = range of counts. My original racial data sheets have my individual identification numbers, or- now ~~they~~ most of them have a Univ. of Wash. museum number as well.

Table 2. AN ARRAY OF CHARR SPECIES ACCORDING TO THE MAGNITUDE OF THE SUMS OF THEIR GILL RAKER + VERTEBRAL + PYLORIC CAECAL COUNTS.

				# Gill Rakers	# Vertebrae	# Pyloric Caecae	SUM
kundscha	USSR	'43	N	10	10	10	10
11.0-16.8	juv M&F		X	17.3	62.4	20.6	100
			R	15-19	61-64	18-23	95-104

Table 2. (continued)

				Gill Rakers	Vertebrae	Pyloric Caecae	SUM
BROOK CHARRS (Total less than 120)							
kundscha	USSR	'43	N	10	10	10	10
11.0-16.8	juv. M&F		X	17.3	62.3	20.6	95-100
			R	15-19	61-64	18-23	104
pluvius	Korea	'43	N	5	6	1	1
10.3-21.6	juv. M&F		X	17	62	22	101
			R	16-20	61-64	22	---
fontinalis	W.Va.	'42	N	4	4	4	4
25.2-25.8	juv. F		X	16	56	27	101
			R	15-18	55-57	25-36	98-109
malma	Karluk Al.	'40	N	12	12	12	12
15.9-23.5	juv. F		X	18	62.5	27.3	108
			R	15-21	61-64	20-38	101-117
fontinalis	Ore.		N	7	7	7	7
14.9-19.5	juv M		X	16	58	36	110
			R	15-18	56-60	31-43	103-117
malma	Karluk Al.	'40	N	12	12	12	12
15.4-22.7	juv M		X	19	62	28	111
			R	18-20	61-64	23-33	105-116
fontinalis	Ore.		N	6	6	6	6
15.6-18.5	juv F		X	15.3	57.7	39	112
			R	14-17	54-60	33-46	105-121
salvelinus	Sweden	'71	N	10	6	7	6
15.0-17.8	ad M&F		X	23	63	30	113
Nilsson's "Blattjen"			R	21-16	61-64	25-37	109-119
s.oquassa	Maine	'69	N	13	9	6	6
	ad M&F		X	21	64	30	115
			R	19-22	63-65	23-34	109-118
s. marstoni	Quebec		N	4	4	2	2
17.7-22.8	juv M		X	17	65.5	35	118
			R	15-18	65-66	32-38	115-121
salvelinus	Alaska	'73	N	96	*	59	59
			X	22.1	62.5	30.4	115
McCart's Canning R.AL			R	19-27	61-64	23-39	103-130
"anadromous alpinus"							

* as McCart & Craig made no vertebral counts, I have substituted what others from the area have shown.

Table 2. (continued)

		Gill Rakers	Verte-brae	Pyloric Caecae	SUM
LAKE CHARRS (Total more than 120)					
umbla France '73	N	12	6	2	2
24.5-28.3 Ad M&F	X	23	63	32	120
(Had a history of hybrid-ization with fontinalis!)	R	21-27	61-64	32-33	118-121
alpinus aureolus Maine '49	N	11	4	6	4
26.3-34.7 ad M&F	X	20	65	37	121
(More prob they were oquassa)	R	17-22	63-67	32-46	116-129
alpinus Karluk, Al '40	N	12	9	5	5
8.2-19.0 juv F	X	23.2	64.4	35.4	123
	R	21-26	63-66	33-49	117-133
alpinus aureolus Me. '49	N	15	8	8	8
15.5-24.6 juv M&F	X	17.2	65	42	124
	R	16-18	62-67	34-47	116-130
a. aureolus Me. '49	N	6	3	2	2
28.5-30.6 ad M&F	X	21	66	37.5	125
	R	18-22	66-67	36-39	124-127
(the above were labelled "S. oquassa" but in view of the above information + the fact they were all "rivetheads" they were obviously misidentified by my well-meaning collaborators!)					
a. stagnalis Labrador '49	N	9	7	5	5
11.3-22.2 juv M&F	X	22	65	39.5	125
	R	20-25	63-66	33-43	118-131
alpinus Karluk Al. '40	N	11	11	3	3
20.0-29.0 juv M	X	23.4	64.6	44.7	133
	R	21-25	63-66	43-48	130-136
alpinus Quebec '50	N	12	5	2	2
23.1-66.1 ad M&F	X	26	66	38	126
	R	23-28	64-68	34-42	122-130
alpinus Sagavanirktok '71	N	67	*	25	25
R. Alaska-McCart&Craig	X	27.5	64.5	45	137
*see footnote p.8 WMM	R	24-33	63-66	35-52	122-149
namaycush L.Mich.Wis. '42	N	20	20	20	20
18.4-23.8 juv M&F	X	21.7	63.6	121.5	212
	R	18-25	62-65	104-163	187-248

* although I felt justified in inserting my estimates of vertebral counts in McCart & Craig's data, I could not do the same for gill raker or pyloric caecal counts due to the much greater spread in these counts. I lost a lot of valuable data from my earlier examinations because I neglected to arrange for verte pyloric caecal counts in particular.. W.M.M.

In conclusion I would like to state that I do not know of one physical feature that anybody has ever added to the three basic ones commonly used to set aside the genus Salvelinus from the rest of the Salmonidae. All three were inadvertently described by Willughby in 1683, when he told us how to separate charrs from trout or salmon in the British Isles. I wonder if the extended longevity I have mentioned above could be another?

It may sound conceited, and may represent a new height in ignorance; but I really believe that my thesis offers, for the first time in history, a natural and workable basis for establishing an intelligent system for classifying all charrs - everywhere!

Respectfully submitted for
Comment and Criticism by
—Mark Morton

Wm. Markham Morton, Ret.
Fish Biologist & Naturalist

24445 13th Ave. So.
Huntington Park
Kent, WA. 98031
206-878-3739
15 August 1978

For your information I am sending xerox copies of my MS to the following "charr-men" to give them a chance to air their views before rather than after I run this through the mill:

Mr. Harry Everhart, F and W Biologist
Colorado State University
Foty Collins, Colorado 80521

Dr. Nils-Arvid Nilsson
Institute of Freshwater Research
S-170 11 Drottningholm, Sweden

Ken Warner and F. W. Kircheis
Fishery Office Bldg., 34 Idaho Ave.
Bangor, Maine 04401

Dr. Sami Qadri
University of Ottawa, Dept. of Biology
Ottawa, Ontario, Canada K1N 6N5

Dr. Robert R. Miller
Museum of Zoology
University of Michigan
Ann Arbor, Mich. 48104

Robert E. Foye
Ass't. Chief Fishery Division
Dept. of Inland Fisheries and Game
Augusta, Maine 04330

Dr. Pierre J. Laurent
Institut National de la Recherche Agronomique
Station d'Hydrobiologie Lacustre
13 Quai de Rives, (74) Thonon, France

Robt. J. Behnke
19 Travis Ave.,
Stamford, Ct. 06905

P.S. - Dear Robt: I need a good swift kick in the teeth! First - for never answering your very good letter acknowledging receipt of Armstrong & Morton's Bibliography & Dolly Vardin and thanks for the reprints you sent. Second - why is it none of my Canadian, European, or American contempararies want to accept my simple, basic idea of our general charr taxonomy? What has Nyman (1972:123-132) added to the question - Eurasiatic or applicable nature? Third I sure enjoyed your paper (1972:369-671) - had it ~~X~~eroxed for my file! Finally - have you left F&WS in Colo which was when I last heard from you?

Best of good things to you

— WM

4700 N.W. Barnes Road
Portland, Oregon 97210
September 10, 1973

Robert J. Behnke
19 Travis Ave.,
Stamford, Ct. 06905

Dear Mr. Behnke:

At long last I have finally been able to assemble the rough draft of a charr paper that I have been working on periodically for almost twenty years. Although it is far from complete, I believe it contains enough new information to justify putting out a preliminary report on the probable taxonomic position of, and more appropriate common names for, two and possibly three species of alpinoid charrs from New England.

As you are mentioned in the manuscript as having contributed information or material pertinent to the general thesis, I am taking the liberty of sending you a copy of this rough draft for review and any comment, corrections, additions, or criticisms you might feel moved to offer before I submit it to Copeia in November for possible publication. There are not many people in this world who are interested in this musty old subject, but from our past correspondence I feel you may be one of them.

I realize that everybody is very busy and if this is an imposition on a heavy schedule of activities, forget it! However, if you can find the time to peruse the paper I would certainly appreciate any editorial comments "straight from the shoulder" that might occur to you. You may keep the manuscript and put comments in a letter, or make whatever notes you wish on the margin and return it. Since retiring from USF & WS in 1968 we spend our summers (March to October) at our home in Portland, and our winters (October to March) in our travel trailer at Space F-119 3020 E. Main St.; Mesa, Arizona, 85203. Thanks for your past assistance — and best wishes.

Mark Morton

Wm. Markham Morton
Fishery Biologist Emeritus

WMM:lw

Enc.

An Outline for a Manuscript Entitled: "On the Taxonomic Position and the Common English Names of the Oquassa 'Trout', *Salvelinus oquassa* Girard 1852; the Sunapee 'Trout', *Salvelinus alpinus aureolus* Bean 1887; and the American Saibling, *Salvelinus alpinus umbla* Linnaeus 1758 from Maine and New Hampshire."

ON THE TAXONOMIC POSITION AND THE COMMON ENGLISH NAMES OF THE OQUASSA "TROUT"[1] SALVELINUS OQUASSA GIRARD 1852; THE SUNAPEE "TROUT"[1], SALVELINUS ALPINUS AUREOLUS BEAN 1887; AND THE AMERICAN SAIBLING, SALVELINUS ALPINUS UMBLA LINNAEUS 1758 FROM MAINE AND NEW HAMPSHIRE

Introduction

The taxonomic status of these New England charr species has been a controversial subject in American salmonoid literature for almost a century. Although there has never been any doubt about their being members of the circumpolar Arctic charr complex most recently described by McPhail (1961), there has always been a question as to whom and how they were most closely related. It is to this relationship, and to the suggested adoption of more suitable common names for these almost extinct charrs, that I wish to devote the following discussion.

Historical Review of Salvelinus oquassa

The oquassa charr, Salvelinus oquassa, received its Indian name from Oquassoc Lake, one of the Rangeley Lakes of western Maine, which provided Dr. Girard with his first specimens of this little salmonoid fish. It is most commonly referred to in fishery literature as the "blueback trout," and is found only in the lakes of western Maine from which it never has been successfully relocated until very recently.

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[1] For several decades I have been objecting vociferously, albeit rather futilely, to the misspelling of charr with a single "r", and to the overburdened use of the name "trout" for American charrs belonging to the genus Salvelinus (Morton 1955). I recently (Morton 1966) have become a strong advocate of the use of "trout" only for the genus Salmo; "charr" only for the genus Salvelinus; and "salmon" only for the genus Oncorhynchus, at least in America.

In its original status, according to Kendall (1914:29-30) it was known to be a dwarfed form of native American stream-spawning charr that seldom exceeded 20 cm. (8 inches) in length or 115 grams (4 ounces) in weight. During the thousands of years that elapsed between the recession of the glaciers and the Caucasion invasion of this part of the country, this tiny charr spent most of its life feeding on plankters and other small aquatic invertebrates near the bottom of the deeper lakes of western Maine. Upon reaching maturity at 3 or 4 years of age, it was known to swarm into the tributary streams of these lakes each fall to spawn.

Similar isolated populations of dwarfed forms of almost all species of salmon, trout, charr and whitefish have been described from American waters. Behnke (1972:642-646) recently reviewed his observations on similar sibling species of dwarfed charr found in many of the deeper lakes throughout the temperate zone of the world. Except for kokanee (Oncorhynchus nerka), these dwarfed forms are seldom sought or caught by anglers, although they often are netted commercially. Due to the phenomenon of indeterminate growth so aptly demonstrated in this primitive order of fishes, it has long been known that this dwarfism is not so much of genetic origin as it is somatic. In simple terms, a quantitative lack of growth-producing food in their natural diets is almost entirely responsible for their small size.

The most extensive and comprehensive papers ever written on the taxonomy and life history of the first two species under discussion stemmed from the prolific pen of an industrious former federal fishery biologist, Dr. William Converse Kendall. His original research and writings form the basis for almost everything that has been written about these fish up to very recently. Cooper (1940:145-6) condensed

Kendall's history of the blueback most effectively when he wrote:

"Starting before 1850, bluebacks were taken in large quantities (from their spawning grounds). One report stated that the usual catch by net was several bushels per man per night. Another referred to the fish having been hauled away in barrels and cartloads. The surprising fact is that the blueback appeared to maintain its abundance for 30 or 40 years in spite of the slaughter. . . . One of the first recognitions of the possible importance of the Blueback to trout fishing in those waters was a statement in the Maine Fish Commissioner's Report for 1874 to the effect that it was a mistake to allow the Blueback to be taken as they were an important food of the Brook Trout and were responsible for their large size. . . .

"The decline of the Blueback Trout in the Rangeleys started in the early 1890's. A special law passed in 1899 giving them protection. . . . came too late. A few large bluebacks were taken for fish culture in 1902; five were taken in 1903; three in 1904; but none have been reported since then. The last of the bluebacks were unusually large (up to 2 or 2½ lbs.), and this fact was believed by Kendall to have been due to those few remaining fish feeding on the Smelt which was introduced in 1895 and had become very abundant by 1900. The great decline of the Blueback in the early 1900's coincided with the great increase in abundance of the salmon (introduced in 1875). It may have been that over-fishing of bluebacks on the spawning grounds was, in part, responsible for their depletion, but it was Kendall's opinion that predation by salmon was the most important factor."

Although these salmon trout (Salmo salar) undoubtedly fed heavily on the blueback, I am inclined to agree with Robert Behnke's more modern version (1972:647), that "competition with the exploding population of introduced smelt was the most significant factor in the extirpation of the native blueback char from the Rangeley Lakes." The smelt simply replaced the young bluebacks like three-spined sticklebacks had replaced the young red salmon in Karluk Lake, Alaska, by 1940; or like the Pacific anchovies rushed in to fill the vacuum left by the paucity of pilchards (sardines) in the Pacific Ocean off the coast of California after 1945. None of these replacements has been reversed to date.

Cooper commented further (1940:77) that: "No bluebacks were encountered during the present survey. Although this species has apparently become extinct in the Rangeley Lakes region, it is still known to occur in Rainbow Lake on the headwaters of the west branch of the Penobscot River in Piscataquis County, Maine. There is also the possibility that some undiscovered population of the Blueback Trout may occur in some waters in the more northern parts of the state." His prediction became a reality when "bluebacks" were actually rediscovered in several Maine lakes north of the Rangeley group in 1948. ~~Harry Everhardt published the first colored photograph of this fish in 1950; and one of his students, Charles Waters, reported on the first and only comprehensive biological study of the oquassa charr ever made in his master's thesis dated August 1960.~~

& omit - it is repeated on p. 7 mm

In a personal interview in 1968 and again in 1972 with Robert Foye, fishery biologist with the Maine Department of Inland Fish and Game he informed me that "blueback" are now known to be present in seven lakes of northern Maine; and that, although the state has so far been unable to

develop a domesticated brood stock for artificial propagation, the experimental stocking of a few "rehabilitated" lakes with balanced numbers of smelt and blueback has met with considerable success. This program may very well produce a "new" trout fishery for Maine anglers by providing oquassa charr that will go up to 2 or 3 pounds in weight.1/

A Brief Review of the Literature on this Species

Salvelinus oquassa was first described by Dr. Charles Girard in a paper he read before the Boston Society for Natural History on October 20, 1852, and published in their Proceedings in 1854. Incidentally, it is the only one of several species of salmonoid fishes he described while he was associated with the Smithsonian Institute, which has withstood the test of 120 years of time. Dr. George Suckley (1874:150) examined 8 specimens in their adolescent "blue-back" stage from Moosemeguntic Lake and added several helpful observations to Dr. Girard's original description. Suckley's monograph on the genus Salmo written in 1861 was published posthumously by Spencer F. Baird in 1874.

Albert Günther listed Salmo oquassa in his Catalogue of Fishes in the British Museum which was published in 1866. In 1877 he described Salmo naresi, a very dwarfed form of charr found in freshwater lakes near Discovery Bay, Canada. David Starr Jordan in 1878 listed oquassa in his first Manual of Vertebrate Animals in America and in 1884:505 presented resemblances between the saibling or Bavarian charr (Salvelinus alpinus)

1/ In a letter dated July 16, 1973 Mr. Foye stated that he had caught one weighing 3 lbs. 9 oz. from Basin Pond, Maine--and that a record 4 1/4 pound blueback had been taken there this spring.

and our oquassa charr. In 1885 he wrote "8. Salmo naresi - No specimens of this species have yet been compared with S. oquassa, but the figure and description of S. naresi fits the latter very perfectly." In their monumental Fishes of America (1896:506-517) Jordan and Evermann gave excellent descriptions of each of these little charrs, and in their 1896 check list they listed "804. Salvelinus oquassa (Girard 1854); 804a Salvelinus oquassa naresi (Günther 1877); and 804b. Salvelinus oquassa marstoni (Garman 1893)" as dwarfed, lake-inhabiting, possibly a stream-spawning form of charr from northeastern North America.

As stated earlier, the best and most informative publications on Salvelinus oquassa were written by W.C. Kendall during the first two decades of the twentieth century. In his summary dissertation on the Blueback Trout (1914:27-43) he quoted from the following writers of that period: Anonymous 1874, 1877, 1887 and 1898; Barker 1888; Bean 1889; Garman 1885:74; Girard 1854:262-263; Goode 1887:478-479; Goode and Gill 1903:477-78; Günther 1877:476; Holmes 1862:62 and 113; Jordan 1882:389; 1905:108; Kendall 1905:45,105,117; Kingsbury 1874:277; Mather 1887; Merrill 1874; Milner 1874; Rich 1873; 1883; Stanley 1887; Whitney 1896 and 1900; Report of Commission of Fisheries of Maine 1874, 1875, and 1878. Notes of oquassa in Sunapee Lake in New Hampshire were published by Kendall (1914:18-89 and 1915:97-108).

I know of no references to oquassa that were published in the 1920's. In the 1930's oquassa is mentioned in Jordan, Evermann and Clark (1930:60-61); Dymond and Vladykov (1934); Pratt (1935) and Martin (1939). The only reference to this fish that I know of in the 1940's was Cooper (1940:146-8 and 77) referred to above.

Rediscovery of oquassa in Maine during 1948 brought forth a series of papers on these fishes by Dr. W. Harry Everhart and his students from the University of Maine at Orono. An excellent color plate and description first appeared in Fishes of Maine (Everhart 1950B:50) and was repeated in the several subsequent editions of the publication. A good review of the blueback in Maine was published by Everhart (1950A:242 and again in 1966). One of his students, Charles Waters, preserved the results of the first biological field study ever made of oquassa in his unpublished Master's Thesis dated August 1959. A summary of all of these observations was published by Everhart and Waters (1965:393-397).

Other published references to S. oquassa from 1950 through 1970 include Vadim Vladykov (1954) who compared oquassa with other eastern North American charrs; Richard Backus (1957) who described the probable geological origin of this species; and Sami Qadri (1964) who made extensive laboratory studies of the comparative osteology and morphometry of these two species of New England charrs in his unpublished doctoral thesis. His studies led him to agree with other previous students of this subject that oquassa and aureolus were probably subspecies of Salvelinus alpinus. There are no doubt others who have made significant contributions to our understanding of this problem which have not yet come to my attention.

On the Common English Names for Salvelinus oquassa

The term "blueback" is a meaningless name for this or any other salmonoid species because it alludes only to the protective (and usually juvenile) blue and white, or silvery coloration that is acquired by practically all species of anadromous salmonids during their feeding stage

in the crystal-clear waters of large lakes or in the open seas. According to Regan (1911:35-36) when young salmon, trout or charr acquire this protective silvery coloration just before or during their "feeding" migration downstream (from March to July but mostly in May) to a large lake or the sea, they are called "smolts" which means shining. Upon their first return from the sea they are called "grilse." I know of no term for those adult trout or charr who take on this silvery protective coloration as they move out to sea after a second or third spawning. As soon as the young fish have acquired (or the adult fish have restored) their sexual vigor in the larger bodies of water, the color process gradually reverses to their adult breeding coloration as they take up their "breeding" migration from the sea or lake to their natal fluviatile waters where they ~~will~~ reproduce their kind. I never have observed, or read of, this seasonal color change occurring in non-anadromous lake-spawning species of American charr such as namaycush or alpinus.

Some examples of other popular usages of this "blueback" misnomer are the Columbia River Bluebacks (really sockeye salmon); Pacific Coastal Bluebacks (searun cutthroat trout); and Lake Pend Oreille Bluebacks (kokanee salmon). These of course have recently been reduced to colloqualisms by our American Fisheries Society and American Society of Ichthyologists and Herpitologist's joint Committee on Common Names for American Fishes. I would therefore recommend the general suppression of the name "blueback trout" and suggest instead the use of "oquassa charr" as a much more distinctive and meaningful common name for this almost extinct species of native New England charr.

Historical Review of Salvelinus alpinus aureolus

The sunapee charr, Salvelinus aureolus, received its common name

from the Indian name of the lake in which it was first discovered, i.e., Sunapee Lake in southern New Hampshire. According to Kendall (1914:43), "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 water. It is known as the 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."

In its original status, Salvelinus aureolus was known to occur only in Sunapee Lake in New Hampshire; Averill Pond in Vermont; and in Flood's Pond in Maine. It was also known to be a fairly large (often exceeding 24 inches in length and 4 pounds in weight) lake-spawning charr whose American nativity has been questioned ever since the day it was originally described by another industrious former federal fishery biologist, Dr. Tarleton H. Bean in 1887. Principal reason for doubting its nativity stemmed from the fact that thousands of European Saibling or Bavarian charr (Salvelinus alpinus umbla, Linneaus) were introduced into eastern and midwestern U.S. waters along with German Brown Trout and German Carp by the then infant U.S. Fish Commission from about 1880 on. Grave doubts were expressed by practically all of the ichthyologists of that period as to whether aureolus was a native American lake charr or whether "the affinities of this form are closer to the saibling by way of an Atlantic steamer than by way of Greenland and Iceland." To date nobody

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*/Other authors state aureolus means "golden Halo" and refers to the golden belly color of the ripe males in autumn. I often was impressed by the bright golden glint of each absorbed scale, particularly over the backs of mature or old specimens of S. alpinus I observed at Karluk, Alaska, in the early 1940's.

d ♀
m ♀

has set down any differences by which we might distinguish S. alpinus aureolus, the American Saibling, from S. alpinus umbla, the introduced European Saibling. This I hope to accomplish to some degree in this paper.

In contrast to oquassa which, as we know it at this writing, is confined entirely to Maine waters, aureolus is known to have been successfully transplanted to other western American waters. However, the only published records of any presently known survival from such earlier stocking programs outside of New England are in Idaho or Montana (Locke 1929:190) and in Wyoming (Anonymous 1939).

A Brief Review of the Literature on S. alpinus aureolus

The title "Description of a Supposed New Species of Charr, Salvelinus aureolus, from Sunapee Lake, New Hampshire," given to the original description of this charr by Dr. Bean in 1887 indicated a tongue-in-cheek attitude that had considerable credability according to the few federal fish commission records I have so far been able to uncover.

I am grateful to Fred Kircheis (1972) for providing a more detailed list of local references on the explosion of popular articles on this subject which appeared between 1886 to 1896 dealing with these American saibling published in Forest and Stream:

Aiken	1890	Bean	1886	Quackenbos	1886
Aiken and Day	1890	Cheney	1892	Shurtleff	1899
Anonymous	1891	Cheney	1897		

And from The American Angler:

Bean	1888	Kingsbury	1886	Bean	1891:435
Garman	1891	Quackenbos	1886, 1887a;1887b;1890, 1893		
Hodge	1886				

To date I have not reviewed these articles.

The most significant paper published on this species before the turn of the century was Jordan and Evermann's first good description of Salvelinus aureolus in their Fishes of North America (1896 47:506-517).

The most detailed description of aureolus, as in oquassa, ever to appear in our fisheries literature was written by W. C. Kendall from 1900 to 1920. His best descriptions appear in Fishes and Fishing in Sunapee Lake (1913:58-70) and in The Fishes of New England (1914 8(1):43-55). Interesting comments on aureolus also appear in Jordan and Evermann's American Food and Game Fishes (1902:213-217 which was reprinted in 1923 and again in 1934) during this early period.

A review of Bower's Annual Propagation and Distribution of Food Fishes Reports to the U.S. Bureau of Fisheries (1906:41, 1907:42, 1907:57, 1909:61, 1910:68, 1911:80 and 1913:78) indicates that approximately 200,000 fry were stocked annually in Sunapee Lake until 1912. Before 1908 they were referred to as Golden Trout fry. After 1908 they were called Sunapee Trout fry. The last recorded plants of Sunapee trout fry were made in Battlesboro South Pond, Vermont, during 1917 and 1918.

Very few articles were written about the Sunapee charr from 1920 to 1950. Locke (1929:190) reported "aureolus has been planted in several lakes in the Sawtooth Mountains and has been taken by trolling in 'Alice Lake'". In the 1930's aureolus is mentioned in Jordan, Evermann and Clark (1930:60); Dymond and Vladykov (1934); Pratt (1935); Hoover (1937); Martin (1939); and Warfel (1939:165-6). Wyoming Wild Life (Anonymous 1939 4:8) reported aureolus taken from Crystal Lake in the Big Horn Mountains. The only reference to this fish I know of in the 1940's was published by Fuller and Cooper (1946:91-2, 117-8, 212).

Sisson's (1950:529-536) excellent Kodacolor essay on the "Sunapee Golden Trout" paved the way for a new series of more extensive papers on this fish by Everhart (1950); Vladykov and Corson (1953); Vladykov (1954); Bachus (1957); Geagan (1958); and Newell (1958).

During the past two decades Waters (1960); Qadri (1964, 1971); Walden (1964); Everhart and Waters (1965); Havey (1969) and Kircheis (1972) have added much to our knowledge of this fish.

On the Common English Names for S. alpinus aureolus

The sunapee, white, or golden "trout" or charr (S. aureolus) is also referred to frequently in the earlier fishery literature as the American Saibling. The applicability of the common name of white or golden charr is well demonstrated in the excellent colored photographs published by Sisson (1950: 529-536). The adult female shown being spawned on p. 533 shows the white color phase, while the specimens shown on pp. 530 and 531 show the golden color phase very well. These color phases may come and go on individual fishes. Over thirty years ago I observed and recorded these color phases for Salvelinus alpinus and also some blood-red individuals among the thousands of adult Arctic lake charr I examined at Karluk, Alaska from 1939 through 1942. The name golden charr has also been aptly applied to S. alpinus in much of the local literature in Alaska. However, the AFS-ASIH Committee on Common Names has assigned the name Golden Trout to Salmo irideus agua bonita (originally described from Kern County California), so the name Golden Trout is definitely preoccupied. However, the name Golden charr could still be adopted generally at some future date for these ~~beauti~~ beautiful fish ~~in~~ of the American alpinus series if popular usage demanded it.

The name American Saibling originated with early American ichthyologists who believed the aureolus was indistinguishable from the European Saibling or Bavarian charr (S. alpinus umbla) which was being brought over from Germany along with German Brown Trout and German Carp about 1880 to help bolster the ~~feeble~~ short supply of native food and game fish found by our earliest settlers of the mid-west. Until I recently received a shipment of European Saibling from France, I was inclined to be of the same opinion. However, after examining these European specimens I now feel fairly confident that I may be able to distinguish umbla from aureolus and therefore feel that American Saibling is also a meaningless name for this native American form of Arctic lake charr.

My choice of the most appropriate common name for our native New England variety of the American Arctic lake charr (S. alpinus aureolus) would be Sunapee charr after the American Indian name of the lake in New Hampshire from which Dr. Bean obtained his first specimens almost a hundred years ago.

Historical Review of Salvelinus alpinus umbla in New England

I have provisionally selected the scientific name Salvelinus alpinus umbla from Linneaus' (1758:310) ~~later~~ Latin description of Salmo umbla, a charr inhabiting the lakes of Switzerland and Italy, to cover such charrs as are known to have been introduced into New England (and other American waters) from Germany during the 1880's. In his original description of S. oquassa Girard (1852:262) wrote, "The flesh of this fish is highly flavored and more delicate than 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 brook or river tributaries of the lakes."

At this writing I know of only three published references to this introduced Bavarian charr before Dr. Bean described S. aureolus in 1887. They are: 1881 Gilbert on growth of saibling in Plymouth, Massachusetts; 1884 Jordan's detailed description, on page 165, of The Saibling or Bavarian Charr (Salvelinus alpinus) and on page 505 the account of the U.S. Commission of Fisheries planting of 60,000 fry received as a gift of the German government in Lake Winnepesaukee, N.H.; 1885 Garman's account of introduction of Saibling into New England.

In the same year that Bean described aureolus, G. Brown Goode published a revealing statement about the history of this introduced species in his American Fishes (1887:478-9). The same statement appears in ~~Brown~~ Goode and Gill's American Fishes (1903:477-8) and reads as follows:

> "Closely related to the Oquassa is the Saibling, introduced into Massachusetts, New York, New Hampshire and Wisconsin, which, according to Bean, so closely resembles some of our native Chars as to make its recognition difficult. A hybrid between the Saibling and our common Brook Trout has further increased the trouble of identification. . . . The Saibling has been propagated by German fish-culturists for a period of ten years or more, and thrives magnificently in captivity. The hatchery at Oussee, in Germany, produces yearly three or four hundred thousand of artificially brooded Saibling, and plants them in the neighboring lakes. In the tanks at the late International Fishery Exhibition in Berlin were exhibited many superb specimens of this fish, some of them over two feet in length, and one of these was sent to the National Museum by Herr von Behr, president of the Deutscher Fisherei Verein.
>
> "In selecting a place in which to deposit the Saibling eggs received in January, 1881, the Commissioner of Fisheries endeavored to find a lake as similar as possible in depth and temperature to the larger Swiss lakes, and he, therefore, sent them to Newfound Lake near Plymouth, N.H. Here the whole sixty thousand were planted, with the hope, that placing so large a number together in a lake of moderate size, the experiment of introduction may be a success, and this hope was realized, for they proved satisfactorily hardy, and on December 1, 1883, about 600 eggs were taken by Commissioner Hodge.

"There are three other little known fishes of this group, now under study by Dr. Bean. Last of all is the Sunapee Trout, S. Agassizii, a form little understood, occurring in Sunapee Lake, N.H. which is being investigated by Prof. Quackenbos, Col. Hodges and Dr. Bean."

As explained later in the text, I was pleased to receive in January of 1973 a shipment of 12 preserved charr specimens obtained from Lake Leman on the Swiss-French border by Dr. Pierre Laurent. The first thing I noticed about these charrs, besides their unusual spotting arrangements, was that the mucus pores usually found only on the underside of the lower mandibles in charrs, extended up the distal edge of the preopercle and over each eye to the posterior nares. This phenomenon, present in all specimens, was not entirely new to me. I first observed this "rivethead" appearance (see Figure 1) in a batch of 10 charrs I examined at the Stanford University Museum in 1945 which bore the label, "Group No. 11 Cat. #22284- Salvelinus kundscha from Petropavlovsk, Kamchatka, June 18-19, 1906, by the Albatross -- taken at shore." The next time I observed this external marking was in 3 specimens of "Salvelinus oquassa taken from Reed Pond, Aroostock County, Maine by angling Sept. 16, 1949;" and 6 specimens of Salvelinus stagnalis collected in 1929 from Nain Bay and Annatalak Bay, Labrador by W.C. Kendall; sent to me by Harry Everhart.

As I began to compare external and internal characteristics of these French charrs with other charrs in my files, it became increasingly apparent to me that these European specimens were not typical lake-spawning charrs as I had expected S. umbla would be. Instead of the typical round yellow or reddish dots of the alpinus group, these fish had irregularly-shaped smaller spots, often dumbell-shaped, with areas of dark brown splotches, not at all like parr-marks, scattered over the

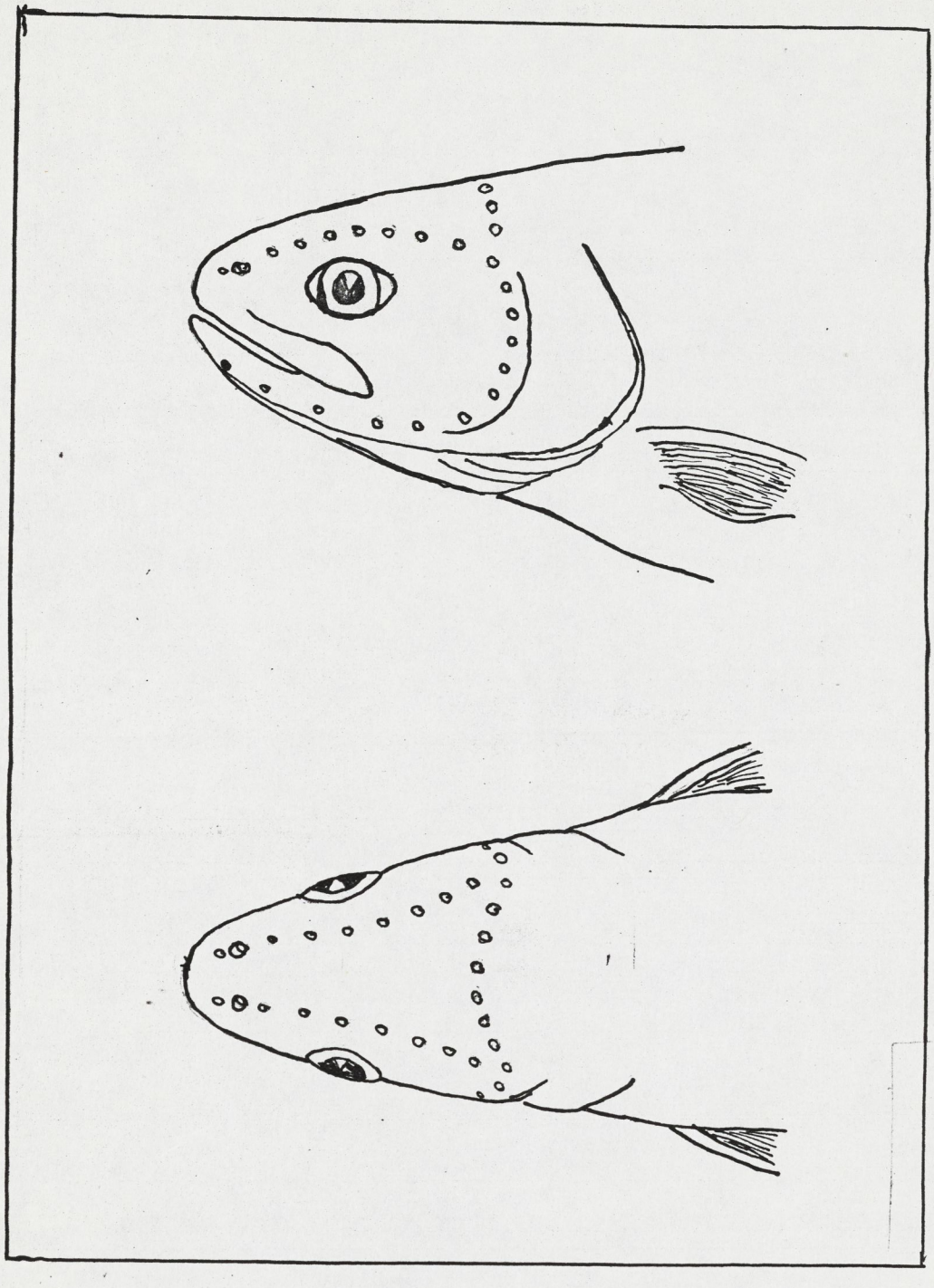

FIGURE 1: Sketch of "rivethead" appearance of mucus pores found in New England and European charr specimens.

back which in the preserved specimens appeared to have been more generally of a greenish than a brownish color.

The morphometric and meristic data; unexpected spotting arrangement; shape of head; and general color pattern strongly suggested hybridization with a stream-spawning species. This assumption was given considerable credibility by a statement published by Dr. Laurent (1972:873) to the effect that hybridization of local charrs and Salvelinus fontinalis had been practiced in the fish culture and management programs at Lake Leman.

Although this casts considerable doubt on the taxonomic utility of these European charr specimens for the purpose I had intended, I still believe it might be possible that the New England charrs with "rivetheads" may have inherited this trait from earlier ancestors introduced from Europe. This of course, assumes that "rivetheads" are common in Swiss lake charrs, which I doubt. Finally, it is hard for me to believe that such an obvious character would have escaped the sharp eyes of such extremely capable early ichthyological taxonomists as Bean, Jordan, or Kendall. Nevertheless, until (or unless) someone can offer a better explanation of the origin of this phenomenon, I suggest it be considered in our New England states as a possible characteristic by which we might be able to distinguish the descendants of the introduced European saibling from our two native charr species in question.

I would also suggest the name American saibling or Bavarian charr (Salvelinus alpinus umbla) be retained for this introduced species in New England waters when or if it can be identified by the mucus-pore arrangement described above.

Why I am Especially Interested in this Problem of Relationship

One of the most exciting, as well as one of the most frustrating, assignments I had in my 30-year career as an aquatic biologist with the old U.S. Bureau of Fisheries and its subsequent reorganizational changes was to assist Allen C. DeLacy in pursuing his studies of the role of Dolly Varden "trout" as salmon predators at Karluk Lake on Kodiak Island, Alaska, from 1939 to 1942. His experiments on growth and movement required capturing thousands of these charrs for tagging, marking, weighing and measuring. Other aspects of these fish intrigued me, and with Allen's encouragement and assistance I soon was involved in a program of systematically dissecting the dead specimens for food, parasitological and morphological analysis in my "spare" time.

These studies indicated almost immediately that we were dealing with two and possibly three species of charr, each inhabiting a distinctly different ecosystem in the Karluk watershed. Although we published a general report on this phase of our work (DeLacy and Morton 1943) we did not emphasize that the best character for separating the lake-spawning S. alpinus from the stream-spawning S. malma at Karluk was found in the gill-raker counts wherein there was practically no overlap in the number of rakers on the lower arch. These data were presented recently in more detail by Morton (1970:584-5). Results of my extensive studies on the food and parasites of these charrs have never been published.

From the writings of other fishery biologists of that era, we assumed that most of these meristic and morphological differences were due more to environmental adaptation than to inheritance, and that these same differences might probably occur in other charr species. To test

such an hypothesis I needed an array of similar measurements and counts of other American charr species which would include all age groups of both sexes such as I had obtained for S. alpinus and S. malma at Karluk.

After termination of my official duties at Karluk following Pearl Harbor, I continued to collect morphometric and meristic data from other American charr species until by 1950 I had accumulated a fairly complete series of such data from approximately 100 specimens of each of the four better known species of American charrs (Salvelinus) which were (and still are):

American brook charr (S. fontinalis), American lake charr (S. namaycush), Pacific brook charr (S. malma), Arctic lake charr (S. alpinus)[1/]

Specimens chosen for this serial study ranged from approximately 5 to 60 centimeters in length, and a special effort was made to select at least one male and one female in each centimeter-size group. This provided an array of data by which any other author's measurements or counts could be intelligently compared without regard for such variables as differences due to size, sex, season, age, or degree of maturity in small samples.

Although I experienced no great difficulty during the 1940's in obtaining specimens to fill in the desired arrays for the four better known species listed above (thanks to H.S. Davis of Kearneyville, West Virginia; Smith Bros. Fisheries, Port Washington, Wisconsin; Arthur Welander, Seattle,

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1/ I am becoming more convinced with each sample of charrs that I receive for study that we need (and that I will eventually describe) one other "good" species to complete this series. That will be the Arctic brook charr (Salvelinus sp.? probably salmarinus or salvelinus) to take care of the many circumpolar anadromous stream-spawning forms assigned presently to the S. alpinus group. McCart and Craig (1971) recently produced the first published evidence for support of my original hypotheses stated by Morton and Miller (1954:118-120).

Washington; Joe Wales, Sacramento, California; and Margaret Storey, Stanford University, California among others), I found it much more difficult to obtain specimens of the lesser known eastern charr species such as the sunapee (S. aureolus); blueback (S. oquassa) or Lac du Marble (S. marstoni) "trouts."

However, in 1949 I had the great good fortune, through the efforts of Reeve Bailey, to receive from the University of Michigan the loan of four specimens of S. marstoni and eight S. alpinus collected by Vianney Le Gendre from Quebec lakes. In 1950 Harry Everhart loaned me seven small immature S. stagnalis; three adult S. oquassa and 13 S. aureolus specimens from the University of Maine's fish collections for my study. In 1955 Philo Wolfe sent me six specimens of S. alpinus from Swedish lakes. My preliminary examination of these charrs indicated that the alpinus from northern Quebec lakes had the same high gill-raker, vertebral, and pyloric caecal counts I had found in the alpinus from Karluk Lake in Alaska. The Swedish alpinus had the same high gill-raker count I had found in alpinus at Karluk, but the vertebral count was lower--more like S. malma at Karluk. The juvenile S. stagnalis specimens showed lower counts in both gill rakers and vertebrae. The few specimens of oquassa and marstoni demonstrated the higher vertebral count of S. alpinus, but the gill-raker counts were lower.

Biggest shock to me was that the S. aureolus, which had the typical high vertebral count; was known to be a lake-spawner; and which "looked" so much like the Karluk alpinus; actually had one of the lowest gill-raker counts I had ever found among the charrs I had examined up to that time. This was a severe blow to my thesis that the lake-spawning and the stream-spawning charr species would eventually fall into as distinct categories as malma and alpinus did at Karluk based upon their gill-raker counts as

described by De Lacy and Morton 1942; McPhail 1961; and Morton 1970. A review of Dr. Kendall's meristic data (1914:51-53) showed this same low gill-raker count for S. aureolus.

I did not pursue this subject further at that time for various reasons among which were: (1) the above samples were quite inadequate for any finalization of analysis; (2) oquassa was considered to be extinct in Maine at that time; and (3) Don Mc Phail's (1961) detailed study of gill-raker counts of malma and alpinus in northeastern Pacific and Arctic waters of America, and K. Savvaitova's (1961) work on the same charr species in northwestern Pacific and Arctic waters of Asia indicated such a confused mess in meristic counts that I lost all hope of ever bringing about any order out of all that apparent chaos. A final deterrant to further studies along this line stemmed from my consistent inability to obtain any significant number of specimens of anadromous stream-spawning "alpinus" specimens from Canadian or Alaskan waters.

While on a travel-trailer tour of Maine, following my retirement from the U.S. Bureau of Sport Fisheries and Wildlife at Portland, Oregon in June of 1968½, I called on Robert Foye, fishery biologist of the Inland Fish and Game Department at Augusta, who made arrangements for me to visit one of their state hatcheries north of Orono where I was privileged to see for the first time in my life a couple of dozen live adult oquassa charrs being held in a circular pond for artificial propagation experiments. This exciting experience aroused my latent hopes for further study of these fish. While in that vicinity, I deeply enjoyed the opportunity for delving into the rich fishery literature on this subject which I found stored in the libraries at Orono, Bangor, and Augusta.

Mr. Foye graciously agreed to freeze any fish that might die of natural causes during this experiment, as well as any mortalities that might occur in a lot of sunapee charrs being reared for broodstock at another state hatchery. I was, therefore, pleasantly surprised to receive, early in 1969 via air express, a carton of a dozen frozen specimens of spawning adults of each of the above species.

In 1971 I was asked to review a manuscript prepared by Sami Qadri in which he recommended placing S. oquassa, marstoni, and aureolus all in subspecific status to S.alpinus as a result of his detailed and extensive research into their osteological characteristics. I objected to this because of some of the demonstrable differences I had found in Mr. Foye's specimens. I could agree to placing aureolus in that category but not oquassa.

In 1972 Nils-Arvid Nilsson sent me a sample of sibling dwarfed Arctic charrs, referred to as "Blattfjen" which he had recently described (Nilsson and Filipsson 1971 (51:90-108) from Lake Oure Bjorkvottnet in Sweden. In response to my inquiry as to how I might obtain some lake charrs from southern Germany, he suggested that I write to Pierre Laurent at Thonon, France. As a result of that suggestion, I was pleased to receive, in January of 1973, a dozen formalin-preserved specimens of charr from Lac Leman which I assumed would probably be as close to Bavarian charrs as any I would ever be able to obtain from this region during my lifetime. Results of their examination surprised me so, I decided to publish my findings as soon as I could put these data all together. As a matter of convenience I shall refer to these French charrs as Salvelinus alpinus umbla for reasons given earlier in this paper (see p. 13).

←——— Taxonomic Comparisons of S. oquassa with S. aureolus and S. umbla.

a) External Morphometric Differences (Measurable Items):

The first step in comparing the frozen specimens of the oquassa and sunapee charrs, sent to me in 1969 by Robert Foye of Augusta Maine, was to photograph them in color before they had thawed completely. This sample of specimens was composed of mature, adult fish of almost identical size with a fairly even distribution of sexes. Visual external differences between the two species were immediately apparent. Most obvious were the short vermillion-colored paired fins of oquassa compared to the longer orange-colored paired fins of aureolus. Also the heads of the oquassa charrs were definitely smaller and conical-shaped, while the heads of the sunapee charrs were notably larger, broader, and more blunt.

Comparison of Fin Lengths → (center)

It has long been known that male salmonids generally have longer fins than females; that adult or spawning salmonids have longer fins than immature or adolescent ones; and that salmonids of the same species in more southerly latitudes will usually have longer fins than those from the extreme north. In addition I have found that shorter fins are usually typical of stream-spawning charr species, while longer fins are more common among the lake-spawning charr species in America. These differences between oquassa and aureolus are well demonstrated in Table 1, wherein no overlap of ratios was found. A general comparison with other charr species (using the pectoral plus ventral plus dorsal fin lengths divided by the standard body length) is presented in Table 2. Except for fontinalis and the little "Iwana" from Japan, most of the stream-spawners are generally found in the lower ratio group--while for most of the lake-spawners the three fin lengths

sp. -

Table 1. Comparison of Ratios of the Sum of the Pectoral, Ventral, and Dorsal Fin Lengths[1] to the Standard Body Lengths[2] for New England Charrs in the 15 to 25 cm. (6 to 10 in.) Size Groups.

My I.D.	Sex	P + V + D = X	St. B.L. = R
S. oquassa - Maine 1969			
BB7.F	F	30+20+22 = 72	164 = 0.44
BB2.M	M	30+22+26 = 78	171 = 0.46
BB1.F	F	31+21+23 = 75	173 = 0.43
BB1.F	F	31+21+23 = 75	173 = 0.43
BB4.F	F	30+21+26 = 77	175 = 0.44
BB5.M	M	33+21+30 = 84	177 = 0.48
BB9.F	F	32+23+26 = 81	179 = 0.45
BB6.M	M	32+21+25 = 78	182 = 0.43
BB8.M	M	28+22+24 = 74	188 = 0.40
BB3.M	M	32+25+22 = 79	188 = 0.42
		Average	= 0.44
S. alpinus umbla - France '73			
FrC 6F	F	36+25+35 = 96	197 = 0.49
FrC 5F	F	37+28+29 = 94	205 = 0.46
FrC 3M	M	42+31+33 = 106	206 = 0.51
FrC 4F	F	40+28+33 = 101	218 = 0.46
FrC 2F	F	38+30+32 = 100	223 = 0.45
FrC 1M	M	37+30+34 = 101	232 = 0.44
		Average	0.47

My I.D.	Sex	P + V + D = X	St. B.L. = R
S. aureolus - Maine 1969			
8842*	F	23+19+21 = 63	126 = 0.50
8660*	M	35+31+32 = 98	187 = 0.52
SuT 2M	M	35+31+32 = 98	187 = 0.52
SuT 2M	M	41+28+31 = 100	189 = 0.53
SuT 3M	M	41+31+32 = 104	201 = 0.52
SuT 1M	M	43+33+35 = 111	206 = 0.54
SuT 6M	M	41+34+34 = 109	214 = 0.50
SuT 4M	M	49+39+40 = 128	233 = 0.55
SuT 5F	F	49+36+35 = 120	257 = 0.50
*Stanford Museum Specimens 1943			
		Average	= 0.52
S. staggnalis (umbla?) Labrador '29			
LC 142M	M	26+20+22 = 68	154 = 0.44
LC 141M	M	29+22+26 = 77	177 = 0.44
S. oquassa (umbla?) Maine '49			
LC 150M	M	37+31+32 = 100	226 = 0.44
LC 149?	?	41+34+34 = 109	235 = 0.46
LC 148M	M	43+33+36 = 112	243 = 0.46
		Average	0.45

[1] Because I failed to include anal fin lengths in many of my earlier field measurements, I omitted them here to preserve uniformity in other comparisons.

[2] Standard Body Length is the Standard Length (tip of snout to base of tail) minus the Occipital Head Length (tip of snout to occiput or nape).

[3] These were all "rivetheads."

Table 2. A Comparison of the Ratios of the Sum of the Pectoral, Ventral and Dorsal Fin Lengths to the Standard Body Length of Small Samples (5 to 10 specimens) in the 10 to 30 cm (4 to 12 inch) Size Groups of various Salvelinids

n	Species	Origin	Sex	Age	Range	Mean Ratio
	Generally Stream-spawners:					
10	malma	Alaska '40	F	juveniles	0.40-0.46	0.42
9	oquassa	Maine '69	both	adults	0.40-0.48	0.44
10	malma	Alaska '40	M	juveniles	0.42-0.48	0.45
5	stagnalis	Me.'49 Lab.'29	both	juveniles	0.44-0.46	0.45
6	umbla	France '73	both	adults	0.44-0.51	0.47
10	kundscha	Stanford '45	both	juveniles	0.44-0.51	0.48
7	pluvius	Stanford '43	both	juveniles	0.44-0.54	0.49
6	fontinalis	Oregon	M	juveniles	0.48-0.57	0.50
6	fontinalis	Oregon	F	juveniles	0.49-0.55	0.51
5	"Iwana"	Stanford '43	Both	juveniles	0.50-0.54	0.51
4	fontinalis	W. Va.	F	adults	0.52-0.54	0.52
5	fontinalis	W. Va.	M	adults	0.52-0.54	0.59
	Generally lake-spawners:					
10	alpinus	Alaska '40	F	juveniles	0.45-0.54	0.48
8	alpinus	Sweden '55	both	adults	0.45-0.51	0.49
10	alpinus	Alaska '40	M	juveniles	0.45-0.54	0.50
10	namaycush	Wisconsin	both	juveniles	0.47-0.56	0.51
8	aureolus	Me'69 Standord '43	both	adults	0.51-0.55	0.52
9	"blattyen"	Sweden '72	both	adults	0.52-0.63	0.57

add up to a little over 1/2 of the standard body length in these small fish.

Comparison of Head Sizes ——→ (center)

The same general rules applying to fin lengths just described seem to apply as well to shape and size of heads of charrs; i.e., larger heads occur more predominantly among males than among females; among adult fish than among juveniles; and possibly among southern races more than northern; or even more typically in lake-spawning than stream-spawning charr species. These differences observed in oquassa and aureolus are demonstrated in Table 3 wherein the summation of the snout, eye, and occipital head depths and widths divided by the standard body length produced the following ratios which show no overlap in range between the two species. As in Table 1 umbla, or the "rivethead" specimens again seem to fall in between oquassa and aureolus in these comparisons.

In a comparison with charrs from other areas in Table 4, the ratios demonstrate the difference between sexes and between juveniles and adults, but do not show an array in support of a north vs south or lake vs stream-spawner differentiation.

b) External Meristic Differences (Countable items):

The most obvious and easiest to count of the external characters are the fin and branchiostegal rays. After making such counts on hundreds of specimens of salmon, trout, and charr over the past three decades, I am finally convinced that Albert Gunther (1866) and C. Tate Regan (1911:79) were absolutely correct when they wrote that counting fin and branchiostegal rays in salvelinoid fishes for taxonomic purposes was almost a complete waste of time. George Rounsefell's (1962:242 and 246-7) summary tables demonstrate the uselessness of comparative branchiostegal and fin-ray counts in charr taxonomy

Table 3. Comparison of the Ratios of Summation Snout, Eye, and Occipital Head Depths and Widths to Standard Body Lengths of New England charrs in the 15 to 25 cm (6" to 10") Size Groups

My I.D.	Sex	H.D.+H.W. = X/St. B.L. = R
S. oquassa - Maine '69		
BB7.	F	56+37 = 93/164 = 0.57
BB2.	M	56+36 = 92/171 = 0.54
BB1.	F	61+33 = 94/173 = 0.54
BB4.	F	56+36 = 92/175 = 0.53
BB5.	M	61+42 = 103/177= 0.58
BB9.	F	62+40 = 102/179= 0.57
BB6.	M	60+38= 98/182 = 0.54
BB8.	M	57+37= 94/188 = 0.50
BB3.	M	63+42= 105/188 = 0.56
		Average 0.55
S. umbla - France '73[1]		
FrC6	F	79+51= 130/197= 0.66
FrC5	F	74+44= 118/205= 0.58
FrC3	M	81+47= 128/206= 0.62
FrC4	F	85+52= 137/218= 0.63
FrC2	F	87+58= 145/223= 0.65
FrC1	M	84+54= 138/232=0.60
		Average 0.62

My I.D.	Sex	H.D.+H.W. = X/St BL = R
S. aureolus Maine '69		
8842*	F	48+28 = 76/126 = 0.60
8660*	M	75+50 = 125/187= 0.67
SuT2	M	85+53 = 138/189= 0.73
SuT3	M	90+54 = 144/201= 0.72
SuT1	M	95+58 = 153/206= 0.74
SuT6	M	87+56 = 143/214= 0.70
SuT4	M	105+65= 170/233= 0.73
SuT5	F	102+60= 162/257= 0.63
*Stanford Museum Specimens '43		
		Average 0.69
S. stagnalis (umbla?) Labrador '29[1]		
LC142	M	49+33 = 82/154 = 0.54
LC141	M	57+43 = 100/177= 0.57
S. oquassa (umbla?) Maine'49[1]		
LC 150	M	76+51 = 127/226= 0.56
LC 149	?	87+51 = 138/235= 0.59
LC 148	M	89+58 = 147/243= 0.60
		Average 0.57

[1] These are all "rivetheads"

Table 4. A Comparison of the Ratios of Sum of all Head Widths and Depths to Standard Body Length of small samples (5 to 10 spec.) in the 10 to 30 cm (4 to 12 inch) Size Groups of various Salvelinids.

n	Species	Origin	Sex	Life Stage	Range	Mean Ratio
9	oquassa	Maine '69	Both	Adult	0.50-0.58	0.55
5	stagnalis (umbla?)	Me.'48, Lab.'29	Both	juvenile	0.54-0.60	0.57
7	alpinus*	Sweden'55,'71	Both	adult	0.55-0.59	0.57
6	umbla	France '73	Both	adult	0.58-0.66	0.62
12	malma	Alaska '40	F	juvenile	0.60-0.65	0.62
20	namaycush*	Wisconsin	Both	juvenile	0.57-0.65	0.64
10	kundscha	Stanford '45	Both	juvenile	0.62-0.71	0.65
12	malma	Alaska '40	M	juvenile	0.60-0.72	0.68
7	alpinus*	Alaska '40	M	juvenile	0.64-0.74	0.68
8	alpinus*	Alaska '40	F	juvenile	0.67-0.72	0.69
8	aureolus*	Maine '69	Both	adult	0.60-0.74	0.69
6	fontinalis	Oregon	F	juvenile	0.64-0.71	0.69
4	fontinalis	W. Va.	F	adults	0.70-0.75	0.73
5	"Iwana"	Stanford '45	Both	juvenile	0.63-0.77	0.70
4	"Blatt[j]en"	Sweden '71	Both	adult	0.68-0.77	0.71
6	pluvius	Stanford '45	Both	juvenile	0.62-0.80	0.73
7	fontinalis	Oregon	M	juvenile	0.70-0.81	0.75
4	fontinalis	W.Va	M	adults	0.83-0.86	0.85

*Known to be primarily lake-spawning.

very well. The general formula for such counts in American charr species, at least, is: branchiostegals 10 ± 2; anal 10 ±1; dorsal 11 ± 1; caudal 20 ± 2; pelvic 14 ± 1; ventral 9 ± 1; and as far as my present scope of knowledge is concerned, that will just about cover them all.

In fact the only real significant application I have ever seen made of any salmonoid fin-ray counts that has withstood the test of time was Günther's original reference to the anal-ray counts of Oncorhynchus when he wrote (1866:127); "Although we adopt the genus proposed by Dr. G. Suckley, we found it upon a character entirely neglected by that author, namely the elongate anal fin, caused by the increased number of rays, which is of greater importance than the hook-like production of the upper and lower jaws in the males." To this day, this is the only diagnostic character I know of by which we can immediately separate a specimen of that genus (Oncorhynchus) from any other salmonoid genus at any stage in its life cycle.

Other external meristic counts that can be made without killing or dissecting the animal are: scale, sensory pores in the lateral line, vertebral (by x-ray); gill-raker, tooth and mandibular pore counts. Of this group I have found (as Günther and many other earlier writers have indicated) that gill-raker and vertebral counts are the easiest to make, and the most likely to show significant differences for diagnostic purposes among the charrs at least. Because of their very small size, I have always found scale counts very difficult to make ~~in~~ charrs without magnification. Furthermore scales are practically absent in the very large specimens due to adsorbtion. I have also found that the variation in the number of sensory pores along the lateral line, or the number of mucus pores on the lower jaw, as well as the number of teeth is usually very slight and, with a few

exceptions, of practically no value for specific distinction.

Since reading Stokel (1940), I have been making more intensive studies of the arrangement of vomerine and basibranchial (called "hyoid" in table 5 to save space) teeth, and have met with a fairly significant degree of success in laying out some further good differences between stream-and lake-spawning species of charrs. The differences in number and arrangement of basibranchials pointed out by Morton and Miller (1954: 118-119) are fairly well demonstrated in Table 5 wherein oquassa, a known stream-spawner, shows from 4 to 7 prominent teeth in a single or alternating row, while aureolus, a known lake-spawner, shows from 9 to 30 teeth mostly in double rows down the center of the arch. Umbla showed such a variety of combinations it was difficult to record a definite pattern--however, the pattern generally showed 2 to 9 teeth in a single row at the anterior end followed by patches of teeth with from 6 to 26 more or less prominent teeth in double or alternating rows toward the posterior end of the arches.

The arrangement of teeth on the vomerine bone in the roof of the mouth as pointed out by Morton and Miller (1954:118) continues to be a helpful diagnostic character in these New England charr species under discussion. Although I have been unable to tabulate the results at this writing, the tooth-bearing plate at the head of the vomer of aureolus, the lake-spawner, tends to be longer than wide (as demonstrated in 1954 for alpinus and namaycush); while the tooth-bearing plates of oquassa, the stream-spawner, tends to be wider than long (as demonstrated in 1954 for malma and fontinalis in the above reference).

With regard to the mandibular pore extension in the "rivetheads" described earlier and shown in Figure 1, I have not as yet had time nor

Table 5. A Comparison of Meristic Counts of S. oquassa, aureolus and umbla.

My I.D.	Sex	Fork Length in mm.	Scale Counts oblique; above; below			L.L. pores	Hyoids No. Arr	Gill-rakers Upper	Lower	Total	Vertebrae Abdom.	Caud.	Total	Pyloric Caeca
			Salvelinus oquassa - Maine 1969											
BB4	F	207	220	35	37	135	6 alt.*	7 8	14 13	21 21	38	25	63	29
BB7	F	207	204	-	-	133	4 alt.	8 8	13 14	21 222	41	24	65	-
BB1	F	215	226	36	38	122	6 alt.	6	14	20	38	27	65	30
BB9	F	224	-	-	-	-	7 S.R.	8 8	12 13	20 21	38	25	63	-
BB2	M	218	-	-	-	-	none	7	12	19	39	26	65	34
BB5	M	220	190	37	38	120	7 S.R.	-	-	-	39	26	65	23
BB8	M	220	214	-	-	137	4 alt.	8 8	13 13	21 21	37	26	63	-
BB6	M	228	211	37	36	123	5 S.R.	8	14	22	40	24	64	31
BB3	M	235	235	37	38	132	4 S.R.	9 8	13 12	22 20	39	26	65	33
	Average		214	36	37	129	-	8	13	21	39	25	64	30
			Salvelinus aureolus - Maine 1969											
Su5	F	327	206	37	36	122	30 dr*	7 8	14 13	21 21	39	24	63	s
Su2	M	249	-	-	-	124	9 dr	8 8	14 14	22 22	40	25	65	s
Su3	M	260	-	-	-	-	15 s.r.	8 7	14 14	22 21	40	24	64	s
Su1	M	270	201	38	36	124	25 dr	9	13	22	39	25	64	s
Su6	M	278	194	-	-	-	17 patch	7	14	21	40	24	64	s
Su4	M	309	-	-	-	121	18 alt.	8 8	13 13	21 21	38	24	62	s
	Average		200	38	36	123	-	8	14	22	39	24	64	

Table 5 (Cont.)

My I.D.	Sex	Fork Length in mm.	Scale Counts oblique; above; below			L.L. pores	Hyoids No.Arr	Gill-rakers Upper	Lower	Total	Vertebrae Abdom.	Caud.	Total	Pyloric Caeca
		Salvelinus umbla	France 1973**											
							5sr*	9	14	23				
Fr.C.6	F	245	198	33	38	125	26dr	10	14	24	37	24	61	33
							9sr	8	14	22				
Fr.C.5	F	250	-	31	38	125	18dr	10	14	24	38	25	63	
							6dr	9	15	24				
Fr.C.3	?	258	214	32	37	122	2sr	9	16	25	37	27	64	
Fr.C.4	F	265	-	-	-	123	patches	8	13	21	36	25	61	
								8	13	21				
							6dr	10	14	24				
FR.C.2	F	276	236	35	42	125	4sr	10	14	24	37	27	64	
Fr.C.1	M	283	203	32	39	124	8dr.	11	14	25				
							9sr.	11	16	26	36	27	63	32
			210	35	39	124		9	14	23	37	26	63	

*s.r.= single row; d.r. = double row; alt. alternating; patches or none = no definite rows of more prominent teeth.
**These were all "rivetheads"

			Salvelinus aureolus Stanford Univ. Mus. 1943											
								5	12	17				
LC164	F	155	220	-	-	-	-	5	12	17	39	25	64	43
								4	12	16				
LC163	F	161	220	-	-	-	-	6	12	18	41	25	66	46
								6	12	18				
LC162	F	167	-	-	-	-	-	6	12	18	38	27	65	37
LC160	F	169	-	-	-	-	-	6	11	17	39	26	65	43
								6	11	17				
LC159	F	186	224	-	-	131	-	5	11	16	40	27	67	47
LC158	F	243	-	-	-	-	-	6	11	17				
								5	12	17	35	27	62	43
LC161	M	168	221	33	35	125	-	7	11	18	39	26	65	34
								5	12	17				
LC157	M	246	-	-	-	-	-	6	11	17				
								6	12	18	39	26	65	42
		Averages	222	33	35	128	-	6	12	18	38.8	26.2	65	42

Table 5 (Cont.)

My I.D.	Sex	Fork Length in mm.	Scale Counts oblique; above; below			L.L. pores	Hyoids No. Arr	Gill-rakers Upper	Lower	Total	Vertebrae Abdom.	Caud.	Total	Pyloric Caeca
S. stagnalis (umbla?) Labrador 1929 **														
LC142	M	193	214				-	10 9	15 13	25 22	40	25	65	43
LC141	M	222	197	35	34	135	-	10	14	24	39	26	65	36
S. oquassa (umbla) Maine '49**														
LC150	M	285	241	42	43	131	-	9 8	13 13	22 21	39	27	66	36
LC149	?	295	219	37	41	133	-	8 9	9 13	18 22	40	26	66	-
LC148	M	306	230	34	43	134	-	9 9	13 12	22 21	39	28	67	39
Average			220	37	40	133	-	9	13	22	40	26	66	38

**These were all "rivetheads"

enough specimens to make comparative counts, but I would like to say at this time that the "rivethead" situation described for kundscha specimens examined at Stanford in 1945 were not derived from mandibular pores--but were an extension of lateral line pores that came over the top of the head and completely encircled the eyes of one specimen, according to my notes on these fish.

c) Internal Morphometric and Meristic Differences

The number of pyloric caecae can be very useful, but they are also often difficult to ~~make with confidence~~ count accurately unless they have been well-fixed or hardened in ~~formation~~ in beforehand. Furthermore, because dissection is necessary, the counts can seldom be obtained from museum specimens. Although the gill-rakers and vertebral counts are not significantly different in these New England charrs, the sum of the gill-raker, vertebral, and pyloric caecal counts puts them in their proper perspective in relation to other charr species as shown in Table 6. Incidentally this table provides the best basis I know of for separating stream and lake-spawning charr species. This was also demonstrated in part by Morton and Miller 1954.

I have a large collection of scales and otoliths that I hope to examine in more detail at some future period. I feel quite confident that the shape of the ololiths may be important taxonomically as was demonstrated recently by Nilsson and Felipsson (1971:92)

Before closing this paper, I would like to offer a few comments about making gill-raker counts. I have included gill-raker counts I made of museum specimens of aureolus in the Stanford Museum collection in 1945 with those I made on frozen specimens received from Maine in 1969 to illustrate the point I am about to make. There are two major sources of possible error

Table 6 - A Comparison of the Sums of the Gill-raker, Vertebral, and Pyloric Caecal Counts of Various Small Specimens of Salvelinid Species.

Range of St. Body L. in mm.	Sex	Life Stage	Species	Origin	Gill-rakers n	(R)	ave.	Vertebrae n	(R)	ave.	Pyloric Caeca n	(R)	ave.	Sum N	(R)	ave.
The Following are Believed to be Stream-Spawners:																
103-216	B	juv.	pluvius	Korea '05	5	(16-20)	17	6	(61-64)	62	1	-	22	1	-	100
110-168	B	juv.	kundscha	USSR'06	10	(15-19)	17	10	(61-64)	62	10	(18-23)	21	10	(95-104)	100
252-258	F	juv.	fontinalis	W.Va.'42	4	(15-18)	16	4	(55-57)	56	4	(25-36)	27	4	(98-109)	101
213-244	M	juv.	fontinalis	W. Va.'42	5	(15-19)	17	5	(56-58)	57	5	(23-30)	27	5	(96-105)	101
159-235	F	juv.	malma	Alaska '40	12	(15-21)	18	12	(61-64)	62	12	(20-38)	27	12	(101-117)	108
154-227	M	juv.	malma	Alaska '40	12	(18-20)	18	12	(61-64)	62	12	(23-33)	28	12	(105-116)	110
149-195	M.	juv.	fontinalis	Ore. '55	7	(15-18)	16	7	(58-60)	58	7	(31-43)	36	7	(103-117)	110
156-185	F	juv.	fontinalis	Ore. '55	6	(14-17)	15	6	(54-60)	58	6	(33-46)	39	6	(105-121)	112
150-178	B	adult	"Blattjen"	Sweden '71	10	(21-26)	23	6	(61-64)	63	7	(25-37)	30	6	(109-119)	113
	B	adult	oquassa	Maine '69	13	(19-22)	21	9	(63-65)	64	6	(23-34)	30	6	(109-118)	115
?	B		alpinus*	Alaska '71	96	(19-27)	22	?*	(61-64)	63	59	(23-39)	30	60	(103-130)	115
177-228	M	juv.	marstoni		4	(15-18)	17	2	(65-66)	66	2	(32-38)	35	2	(115-121)	118
The Following are Believed to be Lake-Spawners:																
245-283	B	adult	umbla**	France '73	12	(21-27)	23	6	(61-64)	63	2	(32-33)	32	2	(118-121)	120
263-347	B	adult	aureolus	Maine '49	11	(17-22)	20	4	(63-67)	65	6	(32-46)	37	4	(116-129)	121
260-327	B	adult	aureolus	Maine '69	10	(21-22)	21	6	(22-65)	64	6	(est.)	38	6	(115-130)	123
155-246	B	juv.	aureolus	Maine '49	15	(16-18)	17	8	(62-67)	65	8	(34-47)	42	8	(116-130)	124
285-306	B	adult	oquassa**	Maine	6	(18-22)	21	3	(66-67)	66	2	(36-39)	38	2	(124-127)	125
113-222	B	juv.	stagnalis**	Maine	9	(20-25)	22	7	(63-66)	65	5	(33-43)	40	5	(118-131)	125
232-370	B	adult	alpinus	Sweden 50 71	13	(21-25)	24	9	(62-64)	63	8	(31-46)	40	8	(110-133)	126
231-661	B	adult	alpinus	Quebec 50	12	(23-28)	26	5	(64-68)	66	2	(34-42)	38	2	(122-130)	126
161-214	M	juv.	alpinus	Alaska '40	9	(21-25)	24	9	(63-66)	65	9	(33-49)	41	9	(120-138)	130
157-228	F	juv.	alpinus	Alaska '40	12	(21-26)	23	10	(62-67)	65	10	(33-52)	42	10	(119-140)	130
200-290	M	yng adults	alpinus	Alaska '40	11	(21-25)	23	11	(63-66)	65	3	(43-48)	45	3	(130-136)	133
?	B	adults	alpinus*	Alaska '71	67	(24-33)	28*		(63-66)	65	25	(35-52)	45	25	(122-149)	137
184-238	B	juv.	namaycush	Wis. '42	20	(18-25)	22	20	(62-65)	64	20	(104-163)	122	20	(187-248)	212

*Data from McCart & Craig '71. The vertebral counts are my own estimation or guess -WMM

**Rivetheads

M - male F - female B - both

that may be overlooked when trying to compare counts on the same species by various investigators: a) there is almost always one gill raker located right in the angle of the arch. Although I have tried to follow the precedent established by Carl Hubbs in counting this one in the upper arch, I know that I (and some others) have been guilty of occasionally including it in the lower arch count; and b) there is always much more variation in upper than in lower arch counts primarily because the uppermost one to three or four rakers are often vestigeal or very rudimentary. These are almost impossible to detect or locate when the gill-arch cannot be dissected from the back of the oral cavity. This brings up the question: Should we count only the functional rakers or should we include the little "bumps" which did not develop into functional processes? I have always counted these vestigeal "bumps" along with the longer functional ones--as long as I could "feel" them with a dissecting needle. However, when I could not dissect museum specimens, especially those with small mouths, I had little confidence in my counts. I believe this accounts for the wide discrepancy in the aureolus gill-raker counts mentioned above.

Among the namaycush I have examined, these "bumps" looked more like "burrs." Among the alpinus I have often observed a few branched rakers, usually just below the angle, and in some samples the larger rakers have had a series of barbs along their shafts. As to the number of gill-rakers increasing with size and/or age (Vlakekov 1954). I have found this true in very few cases. Some of my longest arrays of specimens from fingerling to large adult stages have shown no such differentiation. It has long been known that meristic counts generally tend to decrease from northern to southern latitudes among salmonids. This was well demonstrated in gill-raker counts for S. malma by McPhail (1961:App) but not for S. alpinus.

Conclusions (Abstract or Summary)

Until 1968, I had never been able to obtain a significant sample of adult oquassa and sunapee charrs for comparative morphometric and meristic studies with other American charr species. The receipt of a gift of a dozen frozen adult specimens of each species from Robert Foye of the Maine Department of Inland Fisheries in 1969 enabled me to fill in some of the gaps in our knowledge of these native American charrs.

A review of all the available literature I could find on these New England charrs (best summed up by Kendall in 1914) seemed to indicate that most of our early American ichthiologists believed that the sunapee charr was identical to (with:) the Bavarian charr which had been introduced into American waters from Germany in the early 1880's before the sunapee was "discovered" in Sunapee Lake, New Hampshire. Many of these early writers stated further that both of these "trout" were almost indistinguishable from the "blueback trout" of Maine. More recent authors have been inclined to assign them all to subspecific status of Salvelinus alpinus Linnaeus, the circumpolar Arctic charr. I do not agree with these concepts.

The morphometric and meristic data obtained from the frozen specimens of sunapee and oquassa charrs from Maine in 1969 agreed quite well with the counts and measurements published by Kendall (1914). Furthermore they indicated several features by which oquassa could be distinguished from aureolus namely:

1) aureolus has significantly longer paired fins;

2) the larger and more blunt head of aureolus showed considerable contrast to the smaller conically shaped head of oquassa;

3) the greater tendency to a uniserial arrangement of the basibranchial teeth in oquassa was in contrast to the multiserial or "patch" arrangement of basibranchials in aureolus; and

4) the vomerine tooth plate was wider than long in all of the oquassa examined, whereas several specimens of aureolus demonstrated this plate as longer than wide, a characteristic I have found so far only in Arctic Lake (S. alpinus) and American Lake (S. namaycush) charrs.

5) I could not find any significant difference in gill-raker or vertebral counts, but the lower pyloric caecal count in oquassa placed it with the stream spawners in Table 6, whereas the higher caecal count*/ of aureolus placed it in the lake-spawning group in that table.

As the above differences are generally indicative of the stream- and lake-spawning charrs described by Morton and Miller (1955), I do not hesitate to assign Salvelinus oquassa as a dwarfed form of the yet-to-be-described circumpolar Arctic brook charr (Salvelinus salmarinus(?)) series, and Salvelinus alpinus aureolus as a regular form of the circumpolar Arctic lake charr (Salvelinus alpinus) series.

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*/ Although I lost the jar of pyloric caeca for the '69 specimens of Aureolus, I was able to estimate the probable average for Table 6 from the 14 specimens counted at Stanford University in 1949. Kendall (1914:) found 49 p.c. in a specimen of aureolus.

In regard to the possible similarity between aureolus and the introduced Bavarian charr, Salvelinus umbla, Linnaeus, I was long ago perturbed over the low gill raker count of aureolus compared to more northern representatives of the Arctic lake charr series I had examined. Was this due to the normal reduction in meristic counts of salmonids due to its more southerly latitude, or was it typical of the introduced European charr, and thus inherited? To get some possible answers to this question I needed some specimens from southern Europe--preferably the Swiss lakes. Dr. Laurent finally came to my rescue with specimens of S. umbla from Lac Leman on the Swiss border he sent me in 1973. Before examining these specimens I was prepared to disagree with Dr. Kendall's militant crusade to establish aureolus as a native American species, and assign it to the general "alpinus complex" of European introduction .

However, these French charrs were quite different from any charrs I had ever examined here in America. It became increasingly apparent that these fish were hybrids and not typical of the alpinus series as we know it or as I found it in specimens from Sweden. The morphometric and meristic data tended to fall somewhere between those of oquassa and aureolus. But the fact that every specimen was a "rivethead" (mandibular pores extended up the operculum to the nape and over the eyes to the posterior nares) seemed to be the major mark of identity for this European charr, a mark which I had also observed previously in a few museum specimens labelled oquassa or stagnalis from Maine. I have never observed this phenomenon in any of the aureolus specimens I have had the privilege to examine. Although this could be a result of hybridization

with S. fontinalis in both cases, I have suggested it might also be a character some of our New England charrs inherited from the early introductions from Europe.

Finally I would like to recommend to the Committee on Common Names for American Fishes that we adopt the name oquassa charr (Salvelinus sp. oquassa Girard) as a more appropriate name for the "blueback trout" of Maine; and that we adopt sunapee charr (Salvelinus alpinus aureolus Bean) as the common name for the "golden charr" -- our only native representative of the alpinus series in the United States; and American saibling (Salvelinus alpinus umbla Linnaeus) as the common name for all "rivet-heads" in New England until more is learned about these interesting members of the circumpolar Arctic charr complex.

Acknowledgements

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Lawton ?

Goode

– Dolly Varden

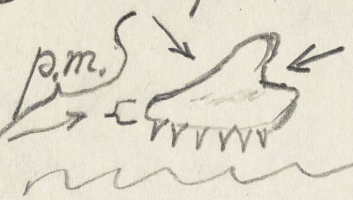
– <u>S. albus</u>

Glubokovsky, colleague

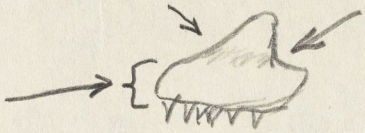
Chereshnev.

77 >30-40 cm

S. alpinus

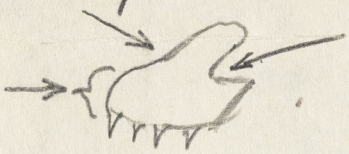


S. malma

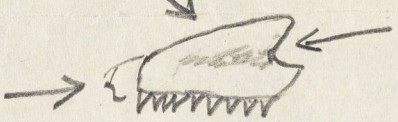


S. leucomaenis

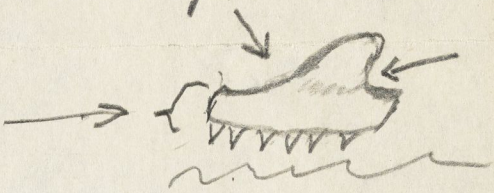
S. fontinalis



S. sp. (Kronozkoe lac)

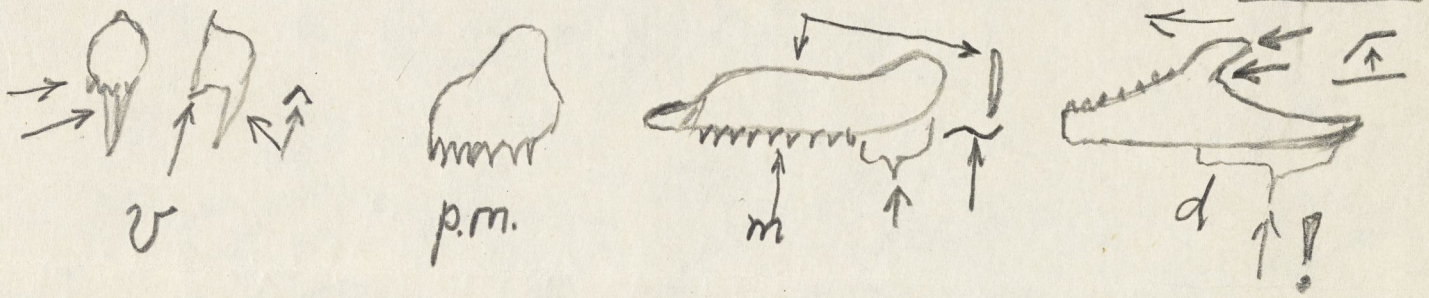


S. sp (Dalnee lac.)



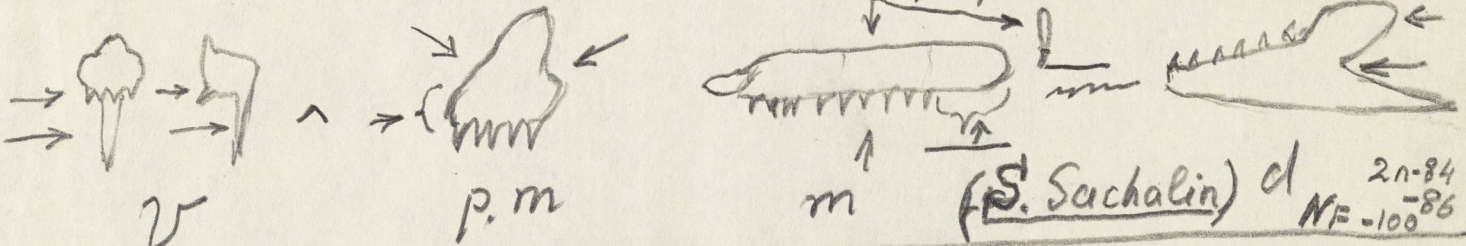
S. malma ssp (sp.?) (Kronozkoe lac.)

variabile 30-40 cm <45 cm



S. malma curilus 12-18 cm <25 cm

(S. pluvius?)



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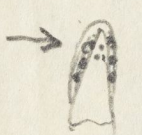
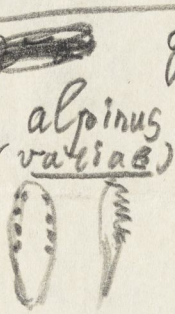
glosoh.

S. leuc.

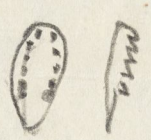


S. fontin.

S. alpinus (variab)



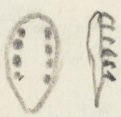
S. malma



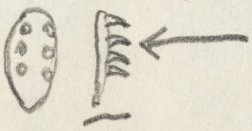
S. sp (Kr.)

S. sp. (Dal

S. malm s.sp (Kr.)



S. malma curilus



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