The Structural Characters of Te Anau Salmon

By G. Stokell

[*Received by the Editor, May 7, 1958.*]

Abstract

Comparison of structural features shows that the freshwater-dwelling salmon of Lake Te Anau agree more closely with normal *Salmo salar* than with the lake-dwelling forms known as ouananiche and sebago. The conclusion that the Te Anau salmon have been derived from sea-going salmon is supported by analagous structural modifications in lake-dwelling *Oncorhynchus tschawytscha*. The American forms, ouananiche and sebago, which have been regarded as subspecies or varieties of *Salmo salar*, are reinstated as a distinct species under the original name of *Salmo sebago* Girard.

Introduction

The voluntary freshwater existence of *Salmo salar* at Lake Te Anau was dealt with by the writer in 1934, since when no evidence of a sea-going habit has been observed and nothing has occurred to affect the position as stated. The fish exists throughout Lakes Te Anau and Manapouri, in the Waiau channel between them and at Lake Gunn, on the upper Eglinton. All of these waters are in the valley of the Waiau River, which is possibly the second largest river in New Zealand. It has its source in the outlet of Lake Te Anau, 53 miles in a direct line from its mouth, but some 75 miles by way of the river channel. Above this nominal source there is a large drainage basin extending back for over 40 miles, a considerable part of which ranges from 4,000ft to 6,000ft in altitude and receives a rainfall of from 50 inches to 100 inches annually. Lake Manapouri, which is about 17 miles in length, has an altitude of 599ft and has been sounded to 1,455ft. It receives the drainage from Lake Te Anau in addition to numerous streams in its own catchment area, and discharges at the south-eastern corner about seven miles from where the Wauau channel enters it. Lake Te Anau is separated from Lake Manapouri by about 15 miles of river channel. It is about 36 miles in length, has an altitude of 679ft, and has yielded soundings of over 900ft. On the west these lakes have great arms similar to the ice-cut fiords of the western sea coast and apparently formed in the same manner. Lake Manapouri is surrounded by mountains and dense bush, and Lake Te Anau is of similar character on the western side, but a considerable part of the eastern shore is low and scrub-covered. Lake Te Anau has numerous tributaries, the largest being the Eglinton River, which enters the lake about half way along its eastern shore and drains Lake Gunn some 25 miles upstream. Lake Gunn, which is about two miles in length, has an altitude of 1,575 feet and is heavily bushed. Its water is slightly stained, as is that of Lake Manapouri and, to a less extent, that of Lake Te Anau also, but none of these lakes is ever turgid except for local discolouration in the vicinity of flooded tributaries.

The fishes known from this locality are:

Native.	Introduced.
Retropinna obtusirostris Stokell	*Salmo trutta* Linnaeus
Galaxias lynx Hutton sub sp?	*Salmo salar* Linnaeus
Anguilla dieffenbachii Gray	*Salmo gairdneri* Richardson
Gobiomorphus basalis Gray	

All of these occur in Lakes Te Anau and Manapouri, but only *Galaxias lynx* and *Gobiomorphus basalis* have been collected by the writer at Lake Gunn. The occurrence of *Gobiomorphus basalis* at this altitude is of particular interest, as this fish is normally lowland-dwelling, its customary habitat being estuarine waters both above and within tidal influence. It exists in a few small lakes of about 2,000ft altitude, in some of which it is said to have been introduced intentionally, and at Lake Taupo where there are also reports of its artificial introduction, but its regular occurrence throughout the Te Anau and Manapouri area and in the head tributaries of Lake Gunn leaves no doubt that it is native to the locality. Its occurrence is the more significant in view of the apparent absence of the upland-dwelling eleotrid *Philypnodon breviceps* Stokell which could be expected to inhabit some parts of this extensive area and does occur in the Whitestone and other independent tributaries of the Waiau that join the river below the lakes.

The number of salmon taken annually at Lake Te Anau appears to be much less than it was thirty years ago, but the position cannot be stated with certainty as no complete records of the output of the water have ever been collected. The writer is indebted to Mr. F. E. Thornton, editor of the New Zealand Fishing and Shooting Gazette, for the following particulars which were recorded by Messrs. N. Cameron and W. Beer of the Te Anau hatcheries staff while acting as boatmen to angling parties during 1925–27. In the 1925–26 season, 316 fish were recorded, and in the following season 1,002. These fish were taken by "harling" at the outlet of the lake, which is the method by which the majority of the early captures were made. The prohibition of this practice a few years later would invalidate any comparison with present-day results even if such were recorded. The size of the fish appears to have suffered some reduction, but not so great as has occurred in brown trout and rainbow trout in most New Zealand waters. The most authentic group of early date consists of the 114 fish dealt with in 1934. Particulars of these were collected for the writer in 1931 by Mr. N. Cameron, and were accompanied by scales of all specimens which permitted a verification of identity. The average weight of this group was 4·2lb. The 1925–26 records mentioned above give an average of 5·6lb, but the weights of the fish taken in the following season are not stated. Mannering (1943) gives particulars of 26 fish taken in 1923, which was the second season of salmon angling at Lake Te Anau. The average weight of this group is 6lb, but it must be noted that the weights of a further 19 fish said to have been taken on the same expedition are not recorded. There are no records of extensive groups of recent date, the only particulars of Te Anau fish available being those of three specimens examined by the writer from 1953 to 1957. These ranged from 3lb to 5¾lb and had an average of 4·18lb. The eight specimens from Lake Manapouri dealt with in the present work averaged 3lb.

During the last ten years no artificial culture of salmon has been practised, and apart from the observance of a normal fishing season and the imposition of certain restrictions on methods and localities the fish is being left to fend for itself. Its ability to persist for ten generations in fresh water with only moderate reduction in size and with no impairment of fertility suggests that it is capable of continuing indefinitely and lends particular interest to the question of its derivation.

Thomson (1922) records the importation of eggs of *Salmo salar* as having commenced in 1866 and having continued with intermissions till 1911, approximately two and a-half million fry being reared from imported eggs and liberated in various parts of New Zealand but principally in Southland. These eggs were obtained from sea-going fish in Great Britain, Ireland, the continent of Europe and North America. In addition one lot of 10,000 was obtained from freshwater-dwelling fish in North America. Some transposition of names or localities has occurred in the account of this lot as Thomson recorded the eggs as being those of Canadian land-locked salmon, *Salmo sebago,* a form which is native to Maine in the United States, while the fish known as lake-dwelling salmon in Canada is called *Salmo* *salar ouananiche*. The late T. E. Donne, Government Tourist Officer, who arranged the procurement of the eggs while on a visit to Canada states (1927) that they were from land-locked salmon of Green Lake, Maine. Thomson states that the eggs hatched well in Southland but that the majority of the fry, which were intended for Lake Te Anau, escaped into the Makarewa River and that the destination of the remainder is unknown. Official records are, therefore, not sufficiently complete to justify more than the statement that the waters of Southland received something like ten thousand fry of fish designated lake-dwelling salmon in addition to some two million bred from normal sea-going fish. There are thus three fishes involved in the confusion surrounding the origin of the Te Anau salmon, two lacustrine forms from North America and normal sea-going *Salmo salar*. All of these are comprehended in the present investigation, which is an attempt to determine the derivation of Te Anau salmon by a consideration of structural characters.

Measurements and Numerical Characters

Table I gives measurements and counts of ten specimens of freshwater salmon, two of which come from Lake Te Anau and eight from Lake Manapouri. Fish from the latter lake are of smaller average size than those from Te Anau but are identical in structure and in the circumstance of at least ten generations of freshwater existence. So far as is known Lake Manapouri was never stocked with salmon but the fish was recognised there shortly after its recognition at Lake Te Anau.

The standard length recorded in the table has been measured from the tip of the upper jaw to the hypural joint, the head from the tip of the upper jaw to the most posterior point of the bony operculum and the length of the caudal peduncle from the base of the last anal fin ray to the hypural joint, the measurements being parallel to the centre line of the fish. These and all other measurements recorded in the tables are given in millimetres. The longitudinal count of scales has

TABLE I.

Measurements and Counts of Ten Specimens of Freshwater Salmon from Lakes Te Anau and Manapouri.

No.	1	2	3	4	5	6	7	8	9	10
S.L.	484	546	458	492	529	640	527	478	482	508
Head	96	115	92	114	113.5	135	105	95	93	95
Eye	12	14	11.5	15	12.5	17	15.5	12.5	13	12.5
Rear of eye	41	47	48	50	46.5	58	46	36.5	39	40
Rear maxillary	40	50	48	50.5	48.5	59	45	37	36	38
D. origin	205	234	202	221	227	281	235	203	206	214
V. origin	237	280	221	252	266	332	264	236	244	257
Length P.	67	87	67	77	80	106	82	70	68	77
P. to V.	146	178	139	148	163	204	165	154	158	170
Length V.	50	61	50	57	56	74	48	52	49	57
Ancillary	22	26	22	22.5	24.5	28	24	25.5	20	26
V. to A.	126	125	113	119	123	161	131	116	114	117
Height A.	47	56	46	55	54	76	53	52	47	58
Length peduncle	93	111	89	88	101	113	91	92	87	89
Depth peduncle	34	36	33	36.5	40	48	38	34.5	35.5	36.5
B.	11–12	10–10	11–11	11–12	10–11	11–11	10–11	11–11	10–11	11–11
D.	iii 10	iii 11	iii 10	iii 11	iii 11	iv 10	iii 11	iii 11	iv 10	iii 11
A.	iv 8	ii 8	ii 8	iii 8	iii 8	iii 8	iii 8	iii 8	iii 8	iii 9
Scales lat.	122–124	121–122	121–124	120–120	120–123	122–121	122–125	123–125	121–124	123–124
Scales above line	23–23	24–24	23–23	25–25	24–24	26–26	23–24	25–25	25–25	26–27
Scales below line	15–14	15–16	15–16	14–15	16–17	16–16	16–16	15–16	14–15	16–16
Scales adipose	11–11	10–11	11–11	10–11	11–11	12–12	11–11	11–11	11–12	12–12
Gill rakers	20–21	20–20	17–18	20–21	20–21	21–21	21–21	21–22	20–21	21–21
Pyloric caeca						71	59			
Vertebrae	60	59	59	59	60	59	60	60	59	59

been made immediately above the lateral line and has been continued to the posterior limit of the scale covering. Both sides of each fish have been counted when dealing with this character and with other scale counts also. The scales above the lateral line have been counted from the origin of the dorsal fin obliquely downwards and backward to the lateral line, and those below the line from the origin of the anal fin upward and forward to the lateral line, the pored scale not being included in either count. The adipose fin scale series has been counted from the rear of the adipose fin downward and forward to the lateral line, the pored scale being omitted. All vertebrae having a definite joint at each end have been counted. The anterior joint of the first vertebra is not a flexible one, but its position is indicated by a whitish line at the point of fusion with the skull.

The upwardly deflected posterior vertebrae embodied in the hypural are counted as far as the last visible joint, the terminal bone beyond this being excluded. The pyloric caeca were not in sufficiently good condition for enumeration in the majority of the specimens examined during the present investigation but a quantity of well preserved material examined in 1934 gave an average of 63·4 for 31 specimens with a variation of 54–79.

Discussion

The numerical characters recorded in the table agree substantially with those of *Salmo salar* given by Gunther (1866) and Day (1887). The present fish, however, differ from sea-going salmon in certain proportionate measurements, the most important being the depth-length ratio of the caudal peduncle, the length of the caudal peduncle in relation to the standard length and the length of the head in relation to the standard length. The data on sea-going salmon used in the present comparison were furnished by Dr. Vadim D. Vladykov, Director of the Laboratory, Department of Fisheries, Quebec, who very kindly measured the characters noted in twenty specimens from the St. Lawrence and St. Jean Rivers. The standard length of these fish ranged from 242 mm to 1020 mm. They were mostly at the stage of commencement of development of the gonads, but a few were more advanced or spawning, and the sexes were almost equally represented in the group. The average values for the characters noted, together with similar data of fresh-water salmon from New Zealand and other comparative fishes are given in Table II, in which the length of the head and the length of the caudal peduncle are expressed as decimal fractions of the standard length, and the depth of the peduncle as a fraction of its length.

Table II.

	Head is of S.L.	Length of Peduncle is of S.L.	Depth of Peduncle is of its length.
10 specimens of N.Z. lake salmon	.206	.185	.389
20 specimens sea salmon	.233	.172	.499
4 specimens ouananiche	.238	.146	.580
2 specimens sebago	.223	.159	.495
10 specimens lake quinnat	.253	.159	.495
10 specimens sea quinnat	.242	.143	.545

It will be seen that in the sea salmon the head is longer than in the New Zealand lake salmon by ·027 of the standard length, the caudal peduncle is shorter by ·013 and its depth is greater by ·110 of its length.

A comparison with the fish known as ouananiche has been facilitated by the kindness of Dr. Vladykov, who supplied the writer with four specimens of this fish from Lake St. John, Quebec. Measurements and numerical characters of these

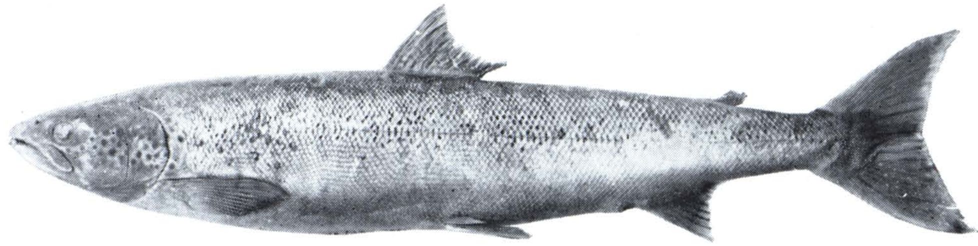

FIG. 1.—Freshwater-dwelling *Salmo salar*. Lake Te Anau. Total length, 652 mm. 26/2/53.

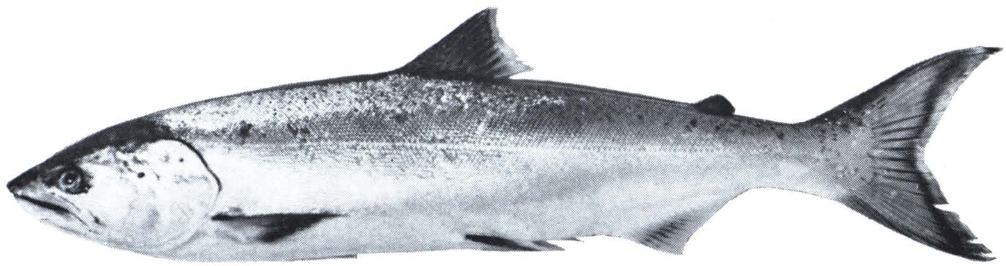

FIG. 2.—Freshwater-dwelling *Oncorhynchus tschawytscha*. Lake Coleridge. Total length, 530 mm. 23/11/52.

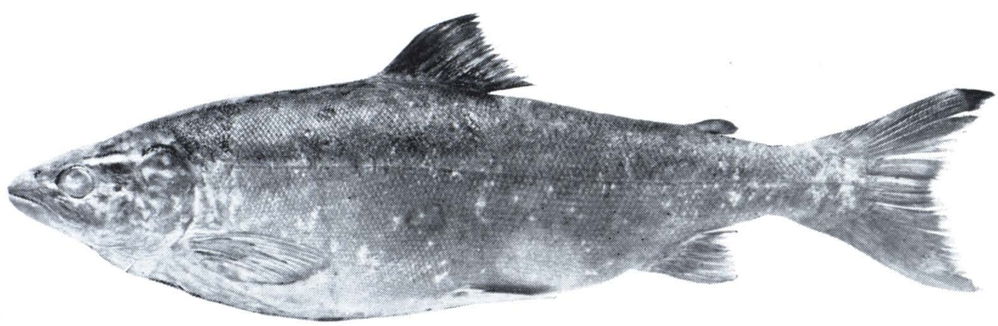

FIG. 3.—*Salmo sebago*. Lake St. John, Quebec. Total length, 381 mm.

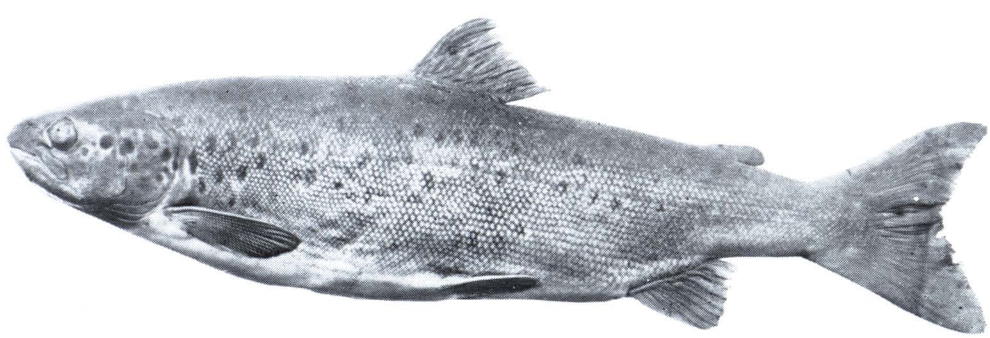

FIG. 4.—*Salmo sebago*. Channel connecting Cross Lake and Mud Lake, Maine. Total length, 384 mm. 6/11/57.

Fig. 1

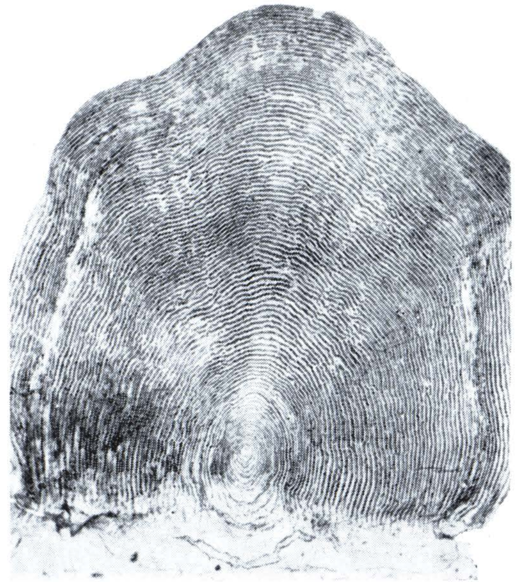

Fig. 3

Fig. 2

Fig. 4

FIG. 1.—Scale of freshwater-dwelling *Oncorhynchus tschawytscha* derived from sea-going parents. Lake Coleridge. Total length, 674 mm. 9/12/30. × 12. FIG. 2.—Scale of freshwater-dwelling *Oncorhynchus tschawytscha* derived from freshwater parents. Lake Coleridge. Total length, 527 mm. 2/11/33. × 12. FIG. 3.—Scale of freshwater-dwelling *Salmo salar*. Lake Te Anau. Total length, 674 mm. 12/1/36. × 12. FIG. 4.—Scale of *Salmo sebago*. Lake St. John, Quebec. Total length, 524 mm. × 12.

specimens are recorded in Table III and the values relevant to the present consideration are included in Table II. In ouananiche the head is longer than in the New Zealand salmon by ·032 of the standard length, the peduncle is shorter by ·039 and its depth is greater by ·196 of its length.

Two specimens of the fish known as *Salmo salar sebago* have been provided by Dr. W. H. Everhart, of the University of Maine, to whom the writer expresses his thanks. These fish were obtained from a channel connecting Cross Lake and Mud Lake, both of which are part of the Fish River Chain of Lakes and of the St. John River drainage. Dr. Everhart chose this locality on account of the possibility of the stock of Sebago Lake having been contaminated by past liberations of fry of sea-going *Salmo salar* in associated waters. The Fish River Lakes were not among those receiving these fish and are isolated by natural barriers from the anadromous salmon that run in the lower section of the St. John. Data from these two specimens are recorded in Table III and the values relevant to the present discussion are expressed in Table II. In this group the head is longer than in the New Zealand salmon by ·017 of the standard length, the peduncle is shorter by ·026 and its depth is greater by ·170 of its length.

A useful comparison is provided by freshwater-dwelling quinnat, *Oncorhynchus tschawytscha*, occurring in upland lakes in Canterbury and Otago. As noted by the writer in 1934 these fish agree with the Te Anau salmon in the indefinite scale structure but differ in the circumstances of their freshwater existence. While the Te Anau salmon have maintained a freshwater colony for at least ten generations in a country where no sea-going *Salmo salar* exist the lake-dwelling quinnat, when occurring naturally, are always associated with a normal run of quinnat from the sea. So far as the writer is aware they have not shown themselves capable of continuing for more than two generations even under the most favourable circumstances. The first generation observed at Lake Coleridge in 1930 attained weights of from five pounds to six pounds in fish that matured at the age of three years, and about eight pounds in fourth year fish taken the following year. The reproductive organs of these fish were normal, and extensive spawning took place in several tributaries. The eggs hatched and the majority of the young fish descended to the lake when about two inches in length. This generation, derived from freshwater parents, grew to only two or three pounds in weight and in the third year of life were subnormal in condition. Their degeneration is manifest in the scale structure which is much more clearly defined than that of the first generation, as indicated in Plate 20, Figs. 1 and 2. The eggs of all females observed, including a group obtained at the mouth of the Ryton in April, were subnormally developed and showed progressive degeneration. None of this second generation observed, with the possible exception of some two-year-old males which may have belonged to it, was capable of reproduction. At Lake Kanieri, in Westland, where no run of sea-going quinnat occurs, quinnat fry were introduced several times between 1916 and 1925, but failed to establish a self-supporting colony. The fish grew to about three pounds in weight in their third year and then disappeared.

Particulars of ten freshwater quinnat from Lake Coleridge and ten normal sea quinnat are included in Table II. In the lake fish the head is longer than in the sea fish by ·011 of the standard length, the caudal peduncle is longer by ·016 and its depth is less by ·050 of its length. The difference in caudal peduncle length in relation to standard length is actually greater than occurs between Te Anau salmon and sea salmon, and while the difference in peduncle depth is much less than in the salmon it is in the same direction. A reversal occurs in the proportionate length of the head, the lake quinnat having a longer head and the lake salmon a shorter head than the normal sea-going representative of these species.

A consideration of these data shows that the freshwater-dwelling salmon of Lake Te Anau and other lakes within the Waiau basin agree more closely with anadromous salmon than with the lake-dwelling forms ouananiche and sebago. So far as numerical characters are concerned the agreement with seagoing salmon is almost complete, but important differences occur in the proportionate length and depth of the caudal peduncle. While the peduncle-standard length ratio of the Te Anau salmon differs from that of sea-going salmon by ·013 of the standard length the difference between ouananiche and sea salmon is ·026 and between sebago and sea salmon ·013. The significance of these differences lies in the fact that they are in the opposite direction; the Te Anau salmon have a longer peduncle than sea salmon, while in ouananiche and sebago it is shorter. In the depth-length ratio of the caudal peduncle the Te Anau salmon differ from sea-going salmon by ·110 of the peduncle length, ouananiche by ·081 and sebago by ·060. The differences in ouananiche and sebago are less than in the Te Anau salmon but they are still in the opposite direction. The head is shorter in the Te Anau salmon than in sea salmon by .027 of the standard length and in sebago by ·010, but in ouananiche it is longer by ·005. The two latter differences are so slight and are based on such small groups that they cannot be invested with any statistical significance. As already noted similar differences in caudal peduncle length and depth occur between lake-dwelling quinnat and sea-going quinnat, but the parallel does not extend to the head-standard length ratio, the lake quinnat having a proportionately longer head than the sea-grown fish, while the reverse obtains in the lake salmon. Lake quinnat also differ from sea quinnat in a numerical character not recorded in the present table, namely, the number of pyloric caeca. A group of twenty freshwater quinnat from Lakes Coleridge and Wanaka had an average of 181 caeca, while a similar group of sea quinnat averaged 171. Whether the difference is merely accidental or the result of some internal or external influence is not clear. The writer has seen no evidence of the number of caeca being affected by environment, and has found in several introduced salmonoids that it does not vary with age. A group of 30 quinnat smolts averaging 95 mm in total length taken while descending the Waimakariri River in March had an average of 173·5 caeca, which is slightly higher than the average for mature sea-run fish recorded above.

In addition to anatomical differences between ouananiche and Te Anau salmon a marked difference in habits is revealed by the scale structure. The majority of the Te Anau scales possess a broad zone of freely-grown uniform structure extending from the parr section to the edge or the spawning mark. As demonstrated in 1934, this indefinite zone includes the ridges formed in the winter preceding maturity and, when the parr section merges into the more open structure without demarcation, those of the first winter also. A scale of a spawned fish is shown in Plate 20, Fig. 3, and a scale of an ouananiche is presented at the same magnification in Fig. 4. While the ouananiche scale possesses definite winter bands in the section formed previous to maturity the Te Anau scale shows no corresponding bands, the formation of open structure having proceeded throughout summer and winter without intermission. Only one spawning mark occurs in the Te Anau scale while that of the ouananiche, which is from a smaller fish, has three. The ouananiche scale shows that the fish has been leading a normal freshwater existence, undergoing seasonal changes in growth rate and spawning regularly for several years. Another specimen shows four spawning marks, which indicates a much higher spawning frequency in this fish than in the New Zealand salmon. Of the 133 samples available 48 have spawned once, 8 twice and one is a questionable third spawner. In one of the specimens from Maine the scales are less freely grown than those of ouananiche but otherwise similar, while in the other the prematurity summer zone is of open structure and the winter band preceding it is wide with only a moderate closing of the ridges.

TABLE III.

Measurements and Counts of Six Specimens of *Salmo sebago*.

	Four Specimens from Quebec.				Two Specimens from Maine.	
	1	2	3	4	5	6
S.L.	340	365	462	471	341	344
Head	79	82	114	121	79.5	73.5
Eye	13	13.5	17	17.5	14	14
Rear of eye	33.5	37.5	52	56.5	39	32.5
Rear maxillary	33.5	37	52.5	58	38	30
D. origin	149	160	211	223	158	159
V. origin	182	197	246	265	187	181
Length P.	61	60	80	82	56	57
P. to V.	110	123	138	150	105	114
Length V.	46	48.5	60	64	42.5	42.5
Ancillary	15.5	17	21	20	12	12.5
V. to A.	76	83	107	109	72	75
Height A.	41.5	42.5	55	60	35	35
Length peduncle	49	54	73	65.5	54	55
Depth peduncle	30.5	30.5	40	38.5	30.5	30.5
B.	10–12	11–11	11–12	10–11	10–12	10–10
D.	iii 11	iii 10	iii 10	iii 10	iii 12	iii 10
A.	iii 8	iii 8	iii 9	iii 10	ii 9	iii 9
Scales lat.	117–118	121	118–121	118–116	118–115	114–114
Scales above line	24–25	25–25	22–24	25–25	23–24	21–21
Scales below line	18–18	18–18	17–18	17–18	18–19	15–16
Scales adipose	11–12	11–12	11–12	11–11	12–13	12–12
Gill rakers	20	20	20	19	19–19	15–17
Pyloric caeca		52	67	69	70	49
Vertebrae	57	57	59	57	57	57

The evidence now assembled makes it clear that the freshwater salmon of Lake Te Anau and other waters within the Waiau basin are not descended from ouananiche or sebago. It is obvious that the long caudal peduncle of the Te Anau fish is a locally acquired character associated with lake existence, as the same feature occurs in lake-dwelling quinnat, the derivation of which from sea-going stock is unquestionable. The similarity of freshwater quinnat and Te Anau salmon in this respect constitutes the strongest evidence of the derivation of the latter fish from anadromous *Salmo salar*. There can be little doubt that a freshwater colony has been developed from an anadromous salmonoid in one generation, but it would be unsafe to regard the influence responsible for this as primarily environmental. Changed environment has brought about a changed morphology, but some physiological influence must have been operative in the first place to cause the fish to remain permanently in fresh water. The governing law, that the more rapid the growth of the young fish in fresh water the earlier the age at which migration to the sea occurs, discredits any suggestion of a particularly favourable food supply being responsible. A super abundance of upstream food would have the effect of sending the smolts to sea at the minimum migration age. It has been found in *Oncorhynchus tschawytscha* that the instinctive urge of smolts to migrate to sea becomes inoperative in certain individuals, and if, as seems probable, the same phenomenon occurs in *Salmo salar,* those aberrant individuals present in the fry liberated at Te Anau would be placed in unusually favourable conditions for establishing themselves by reason of the absence of competition with sea-going fish. There is no evidence to suggest that the whole or any large proportion of the young salmon released at Te Anau remained there and founded the existing colony; it is much more probable that the present fish have descended from a small number of aberrant individuals which would have been overwhelmed by the normal stock in any natural salmon water. The regular introduction of large numbers of fry for several years could contribute sufficient aberrant individuals to permit reproduction, and the failure of any of the normal fish to return from the sea would provide the opportunity for the establishment of a freshwater-dwelling colony.

Systematic

The present evidence also reveals the unsoundness of the popular conception that ouananiche and sebago are derivatives of normal sea-going *Salmo salar*. The retention of this view would now necessitate the belief that lake existence has modified the peduncle proportions in these fishes in the opposite direction from what it appears to have done in the Te Anau salmon and definitely has done in the freshwater quinnat. It is extremely unlikely that a morphological change resulting from changed habit would be reversed by a continuation of the habit that induced it. It is further to be noted that ouananiche and sebago differ from sea-going salmon in an important numerical character—the number of vertebrae. Fifty-seven vertebrae have never been recorded in *Salmo salar*, but this is the dominant number in *Salmo trutta,* with which the present specimens of ouananiche and sebago possess other affinities. They are not admissible to *S. trutta* or to any other recognised species, and it becomes necessary to reinstate *Salmo sebago* Girard (1853) for the accommodation of both forms, as they cannot be differentiated even subspecifically. Girard's name was the first to be used in a regular manner, the name ouananiche not appearing as a scientific one till 1896 when Jordan and Evermann used it subspecifically. Jordan and Evermann listed *Salmo salar sebago* and *Salmo salar ouananiche* but gave no descriptions and appear to have had no first-hand knowledge of the fish.

The following description of *Salmo sebago* is based on the four specimens from Quebec and the two from Maine used in the present investigation.

Salmo sebago Girard

Salmo sebago Girard. *Pro. Acad. Nat. Science Philadelphia* 1853, p. 380
Salmo salar sebago Jordan and Evermann. *Bull. U.S. Nat. Museum* 1896, 47, p. 487.
Salmo salar ouananiche Jordan and Evermann. *Bull. U.S. Nat. Mus.* 1896, 47, Part 1, p. 487.
Salmo sebago Kendall. *Bull. Bur. Fish.* XXXV 1915–16, p. 488.
B. 10–12. D. iii 10–12. A. ii–iii 8–10.

Number of transverse series of scales immediately above lateral line 114–121, scales from anterior of dorsal fin downward and backward to lateral line 21–25, from anterior of anal fin upward and forward to lateral line 15–19, from rear of adipose fin downward and forward to lateral line 11–13. Teeth normal on premaxillaries, maxillaries, palatines, mandible and tongue, head of vomer with three teeth, body of this bone may be toothless or have up to six teeth in a scattered row; no basi-branchial teeth. Gill rakers on anterior gill arch 15–20, pyloric caeca 49–70, vertebrae 57–59.

Head .21–.26, caudal peduncle .14–.16 of standard length, eye .14–.18 of head, maxillary extending nearly to or slightly past rear of eye. Dorsal fin originating at .41–.46, ventral at .51–.56 of the standard length. Pectoral fin extending .48–.57 of the distance from its root to the ventral, ventral extending .56–.60 of the distance from its root to the anal, ancillary process .28–.35 of the height of ventral, height of anal .63–.91 of the length of caudal peduncle, least depth of caudal peduncle .54–.65 of peduncle length. Caudal fin moderately emarginate.

Diameter of eggs of ripe specimen taken on November 6 preserved in formalin 6.7–7.2 mm. Maximum total length observed, 530 mm.

Differs from *Salmo salar* in the lower number of vertebrae, the shorter and deeper caudal peduncle, the larger head, the longer pectoral fins and the higher number of branched rays in the anal fin; from *Salmo trutta* in the lower number of scales in the adipose fin series, the lower number of scales in the dorsal fin series above the lateral line and the higher average number of branched rays in the anal fin.

Photographs of specimens from Quebec and Maine are shown in Plate 19, Figs. 3 and 4 respectively.

ACKNOWLEDGMENTS

The writer expresses his thanks to Dr. Vadim D. Vladykov, Director of the Laboratory, Department of Fisheries, Quebec, for four specimens of *Salmo sebago* and measurements of a group of sea-run *Salmo salar* from Quebec; to Dr. W. H. Everhart, University of Maine, for two specimens of *Salmo sebago* from Maine; to Mr. C. Stokell, Canterbury, for the collection of the Te Anau and Manapouri specimens used in this investigation; to Mr. N. Cameron, Southland, for scales, stomachs and data of Te Anau fish collected in 1929; and to Mr. F. E. Thornton, Wellington, for early Te Anau records.

REFERENCES

DAY, F., 1887. *British and Irish Salmonidae.* Williams and Norgate, London.

DONNE, T. E., 1927. *Rod Fishing in New Zealand Waters.* Seely Service and Co., London.

GIRARD, 1853. *Pro. Acad. Nat. Science, Philadelphia,* p. 380.

GUNTHER, A., 1866. *Cat. Fishes British Museum,* Vol. 6.

JORDAN, D. S. and EVERMANN, B. W., 1896. The Fishes of North and Middle America. *Bull. U.S. Nat. Museum* 47, Pt. 1, p. 487.

MANNERING, G. E., 1943. *Eighty Years in New Zealand.* Simpson and Williams, Christchurch, N.Z.

STOKELL, G., 1934. New Light on New Zealand Salmon. *Salmon and Trout Magazine,* No. 76. London.

THOMSON, G. M., 1922. *The Naturalisation of Animals and Plants in New Zealand.* Cambridge University Press.

G. STOKELL,
Shand's Track,
No. 4 R.D., Christchurch.