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Meristic characters of the cutthroat trout; Salmo clarki

Gail Dean Zimmerman
The University of Montana

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Meristic Characters of the Cutthroat Trout. (52 pp.)

Director: Dr. George F. Weisel

Some of the few truly native cutthroat trout, _Salmo clarki_ Richardson, remaining in the United States are in western Montana where it has not been previously studied. Populations chosen for this study were from streams in which the cutthroat was the only species of _Salmo_. A taxonomic study of these trout was made, the populations were tested for morphological distinctness, and populations from British Columbia (_S. c. clarki_), eastern Montana (_S. c. lewisi_), and western Montana were compared.

A total of 27 counts and measurements were made. Means, standard deviations, t-tests, and analysis of covariance tests were completed with a 1620 IBM computer.

These tests reveal that cutthroat trout from western Montana more closely resemble those of eastern Montana than those of British Columbia. The cutthroat from western Montana cannot be differentiated from _Salmo c. lewisi_ from east of the Continental Divide except possibly for minor differences in number of lateral line scales, oblique lateral rows, gill raker, anal and caudal fin ray counts, chin length and eye diameter.

Population means of western Montana, eastern Montana, and British Columbia were distinct only in chin length and oblique lateral scale row counts.

No distinctive characteristics were observed among seven populations of western Montana cutthroat, which are considered to be _Salmo c. lewisi_.

MERISTIC CHARACTERS OF THE CUTTHROAT TROUT

Salmo clarki

by

GAIL DEAN ZIMMERMAN

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INTRODUCTION

Some of the few truly native cutthroat trout, *Salmo clarki* Richardson, remaining in the United States are found in western Montana. There are streams and high mountain lakes in this area which have never been stocked. This study is intended primarily to provide a taxonomic study of these fish and to test populations for morphological distinctions. Secondarily, it compares them with the coastal cutthroat, *Salmo clarki clarki* Richardson, and with cutthroat from east of the Continental Divide in Montana, *S. c. lewisi* (Girard). The cutthroat of western Montana may be considered to be geographically intermediate. There has been no previous work on this species along the west slope of the Continental Divide in Montana.

The populations chosen for study were from streams in which the cutthroat was the only species of *Salmo*. Some of the streams had lost their access to the main streams by diversion and others were in isolated primitive areas. Inasmuch as the populations are widely separated, there is the possibility they may have formed morphologically distinct populations.

Another incentive for this study is that *Salmo clarki* may be threatened with extinction. They are unable to compete successfully with the other trout (Hanzel, 1960) and they produce viable hybrids with *Salmo gairdneri* (Hartman, 1956).

Schultz (1941) believes that the cutthroat trout of Northwest United States is represented by one species. This may be divided into two or more races or sub-species, best recognized by color patterns and by the number of scales, above, below, and in the lateral line. The species is usually characterized by the presence of a long maxillary which extends beyond the orbit, cutthroat marks on the lower jaw, large opercle spots, basibranchial teeth, and a pointed snout.

Review of the taxonomic literature on the cutthroat is confusing. Many workers in the field have chosen to use different methods for making their counts. For example, in counting the lateral scales, De Witt (1954) and Carl, Clemens, and Lindsey (1959) counted one row above the lateral line, Vernon and McMynn (1957) counted two rows above the lateral line, and Neave (1943) and Qadri (1959) counted the first 50 lateral line scales posteriorly, then from that point back to the head.

There appear to be differences in lateral line scale counts of the so-called Yellowstone cutthroat, _S. c. lewisi_, and the coastal cutthroat, _S. c. clarki_. Carl, _et al_. (1959) report the lateral line scales of the coastal cutthroat to range from 143 - 180 with the majority in the 150 - 158 range. Vernon and McMynn (1957) reporting on the same species found a range of 146 - 173 with a mean of 158. De Witt (1954), who counted one row above the lateral line, found a range of 122 - 188 with a mean of 152. For _S. c. lewisi_ Andrekson (1949) found a mean lateral line scale count of 143.43 in fish from the Sheep River of Alberta.

Coloration continues to be important in taxonomic keys for trout. It is the major characteristic used to recognize some species. Spotting below the lateral line is considered by Qadri (1959) as the coloration character to separate *S. c. clarki* and *S. c. lewisi*. *S. c. clarki* has a more intense spotting anteriorly, whereas *S. c. lewisi* has a more intense spotting posteriorly. This is verified by Carl, *et al*. (1959).

Hyoid teeth are claimed by De Witt (1954) and Needham and Gard (1959) as the most reliable character to distinguish the cutthroat trout from the rainbow. But De Witt also states (*op. cit.*) that some cutthroat do not possess hyoid teeth.

MATERIALS AND METHODS

Two hundred and forty-one specimens obtained from 11 different populations are included in this study. The localities for these collections are:

Marshall Creek 4 miles east of Missoula. This stream flows through a culvert well above the water level of the Clark Fork River into which it empties. Twenty-three specimens were obtained from this stream.

Miller Creek about 4 miles southwest of Missoula furnished 14 specimens. Collections were made some 10 miles up the creek. Miller Creek drains into the Bitterroot River.

Pattee Canyon Creek in southeast Missoula supplied 6 specimens. This stream used to drain into the Bitterroot River but has been diverted for irrigation for at least 40 years.

Dirty Ike Creek, 14 miles east of Missoula, furnished 18 specimens. It drains into the Clark Fork River.

Youngs Creek between Haun and Danaher Creeks in the Bob Marshall Wilderness Area is in the South Fork of the Flathead River drainage. Thirty-eight specimens were taken here.

The Middle Fork of Landers Fork of the Blackfoot River in the Helena National Forest provided 43 specimens.

Tin Cup Creek, south of Darby, Montana, drains into the Bitterroot River. Twenty-eight specimens were collected approximately 6 miles upstream from Highway 93.

Weatherwax and Pilgrim Creeks are near White Sulphur Springs, Montana. Weatherwax Creek drains into the Judith River, whereas Pilgrim Creek is a tributary of Belt Creek. Both streams drain into the Missouri River. Twenty-five native cutthroat were taken from these streams.

Arnica Creek, the Game and Fish Pond, and the Gallatin River are near Bozeman, Montana. Eight specimens came from here.

British Columbia coastal cutthroat were from the Prince Rupert area, with 34 of the 38 specimens from the Lakelse River.

Considerable distances separated the three largest collections from western Montana. A Dietzgen map measuring device used on U. S. Forest Service maps of 1/2 inch to the mile was used to approximate the stream mileage separating them. However, the smaller meanderings are not on the maps, so the true stream mileages would be greater than those measured. Youngs Creek to Tin Cup Creek measures 420 miles; Youngs Creek to Landers Fork of the Blackfoot, 525 miles; and Landers Fork to Tin Cup Creek, 254 miles (Figure 6).

A total of 10 counts and 17 measurements were made on each specimen. Measurements of body length were made with Vernier calipers when possible. All head and body depth measurements were made with screw-drive needle point dividers. Lengths exceeding 150 mm. were taken on a measuring board.

Scale, fin ray, and gill raker counts were made under a zoom dissecting scope with 15 power oculars. This attained a maximum magnification of 45 diameters. Gill rakers were counted on the first gill arch of the right side.

Basibranchial teeth were detected under a swinging arm dissecting scope. The fish were held in a vertical position, the mouth illuminated with a Nicholas Illuminator dissecting scope lamp, and a gentle stream of air was forced on the basibranchial bone to remove the mucus and expose the teeth (Figure 5). This procedure was outlined by Miller (1950). Teeth were not checked in some specimens because removal of the gill arches had damaged the area in which the teeth are located.

Vertebral counts were made on X-ray photographs (Figure 4). These were taken with a Kelley-Doet, type 150 N machine with a 150 N transformer. The trout were placed on 10 x 12 cardboard film holders and irradiated for 65 seconds at 5 milliamps and 25 to 35 kilovolts. Kodak Blue Brand Medical film was placed approximately 36 inches from the X-ray tube. It was developed for 5 minutes in both a Kodak X-ray developer and a Kodak X-ray fixer bath. A 30-minute water bath followed development.

The means, standard deviations, t-tests, and analysis of co-variance were calculated with a 1620 IBM computer at the Montana State University Computer Center. Owing to the complexity of the data and the limitations of the computer, the program contained 4 phases. Phase I reduced the data to a frequency distribution table, phase II computed the means and standard deviations, phase III the t-tests, and phase IV the analysis of covariance (See Appendix).

The following measurements were made on each fish. Paragraph numbers indicate the location of the measurement on Figures 1 and 2. The letters in parenthesis indicate the symbols used to identify the measurement or count in the data tables.

1. Snout length - (SL) - The distance from the tip of the snout

to the anterior margin of the eye.

2. Eye diameter - (ED) - The distance across the orbit of the eye from the anterior to the posterior margin.

3. Maxillary length - (ML) - The distance from the tip of the snout to the posterior tip of the maxillary bone.

4. Preopercle length - (PL) - The distance from the tip of the snout to the posterior tip of the preopercle.

5. Head length - (HL) - The distance from the tip of the snout to the posterior edge of the opercle.

6. Snout to dorsal origin - (S-DO) - The distance from the tip of the snout to the origin of the dorsal fin.

7. Snout to adipose - (S-AD) - The distance from the tip of the snout to the origin of the adipose fin.

8. Standard length - (St-L) - The distance from the tip of the snout to the end of the vertibral column.

9. Snout to anal fin - (S-AF) - The distance from the tip of the snout to the origin of the anal fin.

10. Body depth at vent - (BD-V) - The depth of the body at the vent.

11. Peduncle depth - (PD) - Minimum depth across the peduncle.

12. Head depth - (HD) - The distance from the top of the head to the ventral side, measured at the posterior margin of the preopercle.

13. Mouth width - (MW) - The distance across the lower jaw at the posterior tip of the maxillary.

14. Chin length - (CL) - The distance from the origin of the branchiostegal rays to the tip of the snout.

15. Head width - (HW) - The maximum head width at the posterior margins of the preopercles.

16. Internasal width - (INW) - The width of the snout between the nostrils.

17. Interorbital width - (IOW) - The minimum distance between the orbits of the eye.

The following is a list of the counts made on all fish and the method involved in the count.

Lateral line scales - (L-L) - Counted under a dissecting scope using pointed dissecting needle to lift each scale and recorded on a hand tally register. The mucus covering the scales was removed by scraping gently with a glass slide.

Oblique lateral rows - (OBLR) - Made by counting up from the anterior end of the lateral line 8 scale rows and beginning at that point counting posteriorly the length of the body.

Dorsal and anal fin rays - (DF) - (AF) - The last divided ray was counted as one ray and the short rays were not counted. Procedure outlined in Hubbs and Lagler (1956).

Caudal fin ray count - (CF) - The count was made of all branched rays and then the 2 solid rays were added to the count.

Pyloric caeca - (PYC) - Made by counting the caeca as they were removed from the pyloric region.

Vertebral counts - (VC) - Count made by X-ray photography. Divisions of the hypural were counted as vertebrae.

Parr marks - (PM) - Only those parr marks that extended below the lateral line were counted.

Head spots - (HS) - All spots on the head were counted. In some cases the spots were obliterated by preservative or the head was so intensely spotted that the count was not made.

Gill rakers - (GR) - The first gill arch on the right side was removed and all gill rakers counted under a dissecting scope. The same arch was counted on the British Columbia specimens without removal.

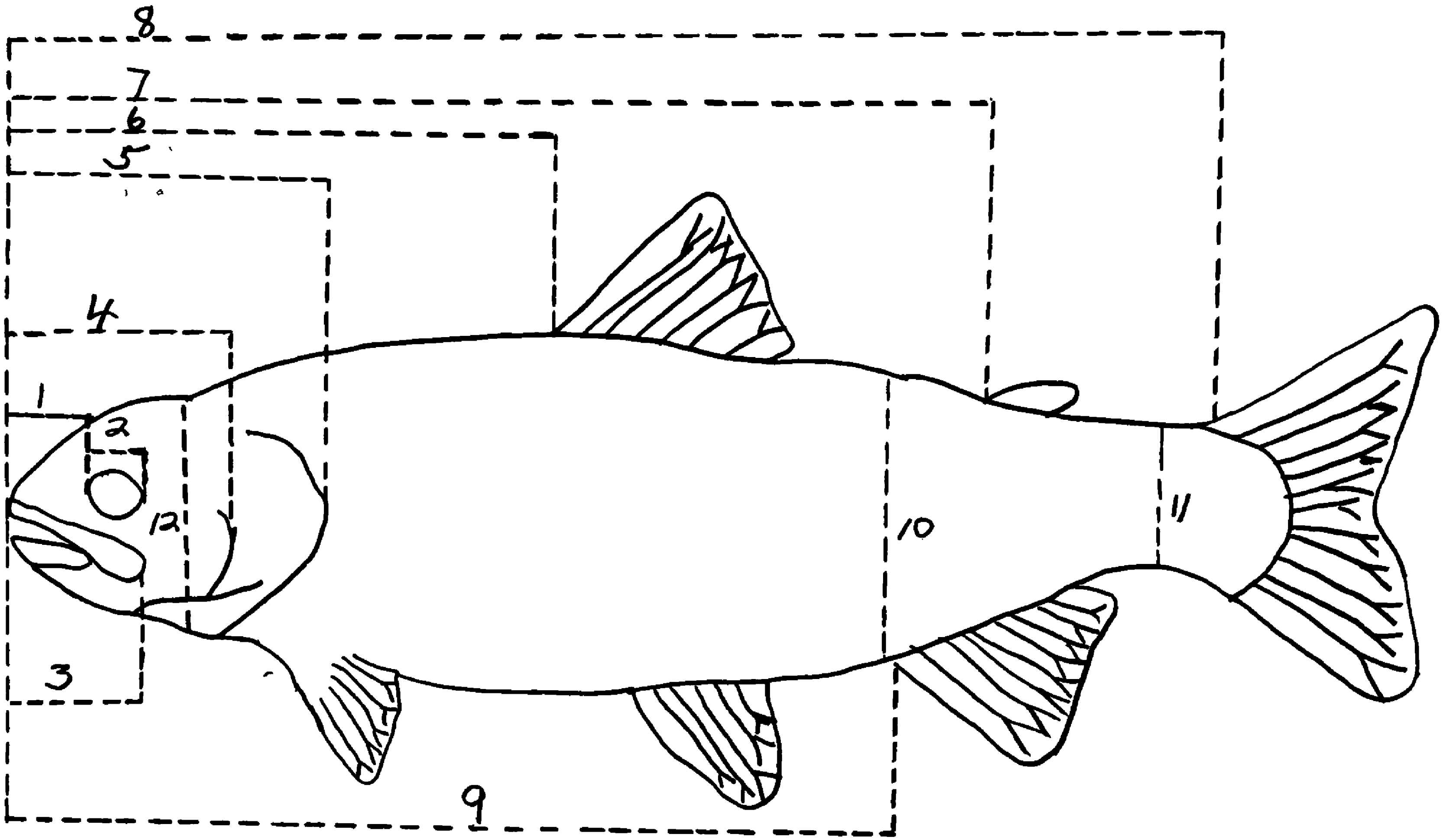


Figure 1. Measurement Locations.

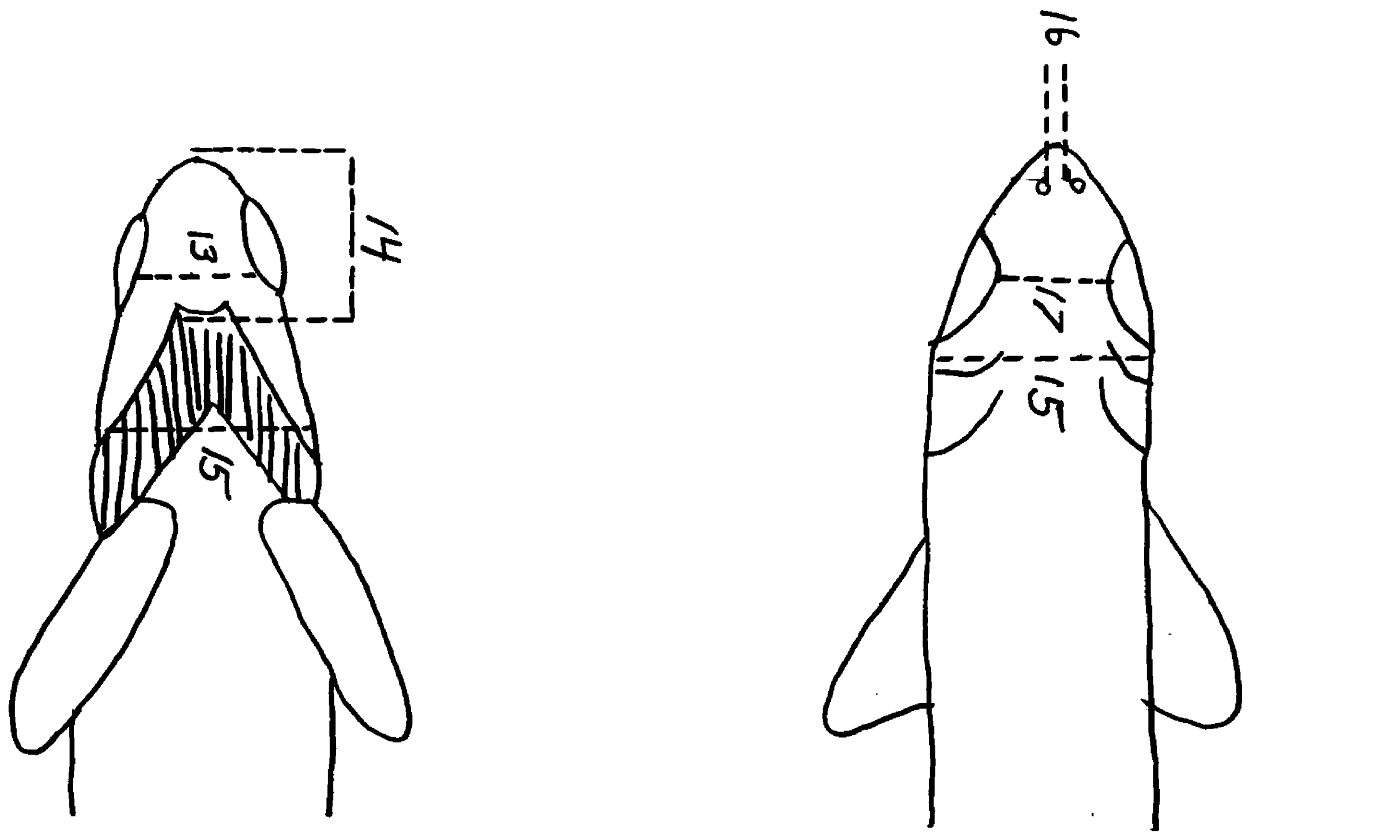


Figure 2. Measurement Locations.

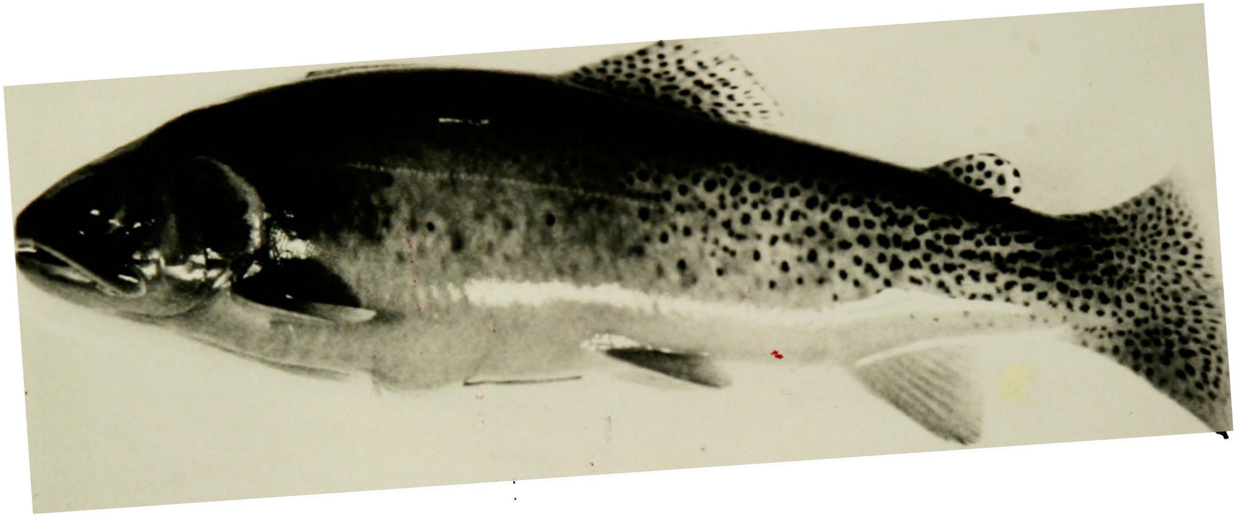


Figure 3. Typical Spotting of the Western Montana Cutthroat.
Specimen from Dirty Ike Creek.

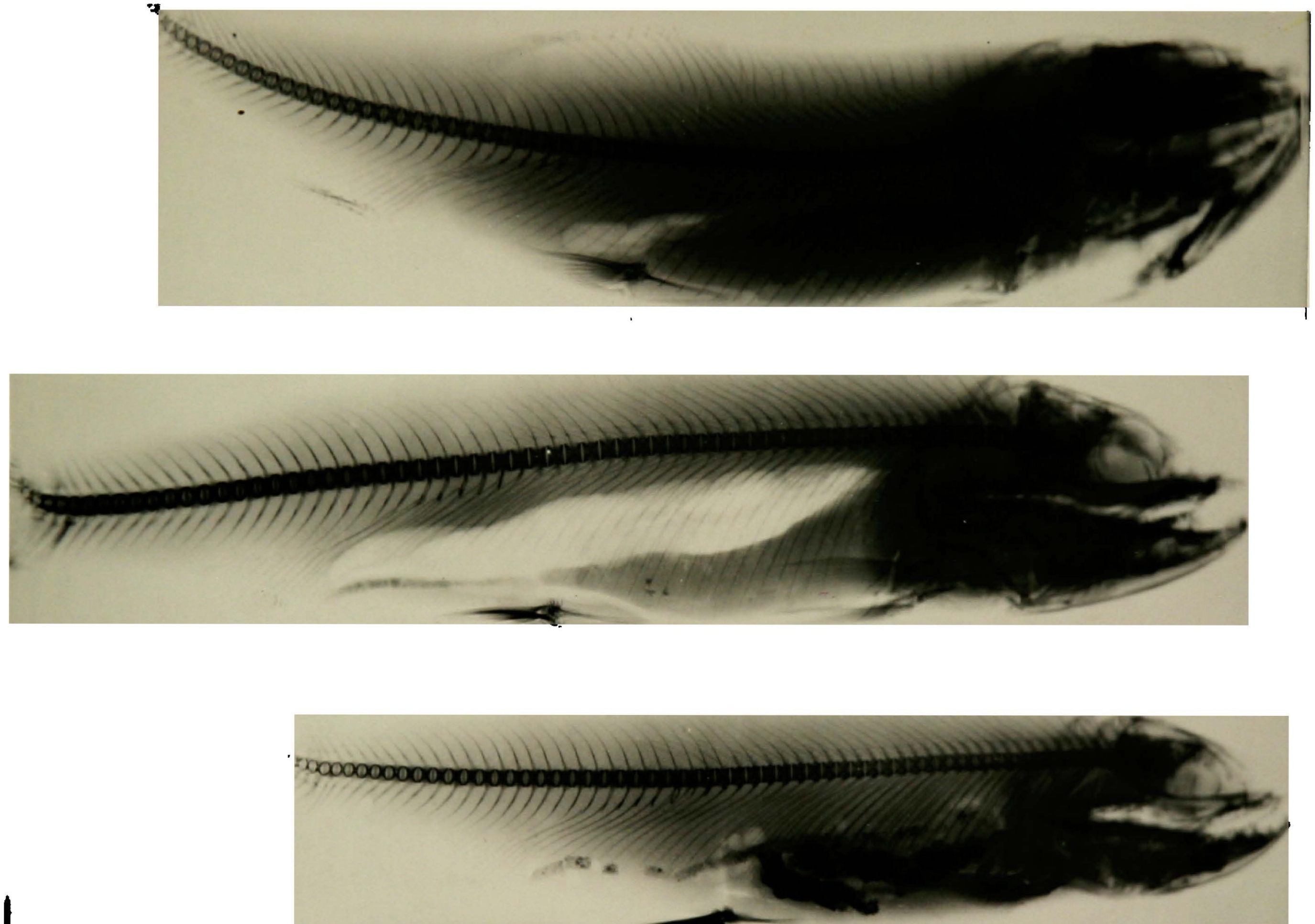


Figure 4. X-Ray Photograph of Cutthroat Vertebrae. Specimens from Lakelse, British Columbia. The standard lengths from top to bottom are 274, 280, and 238 mm.

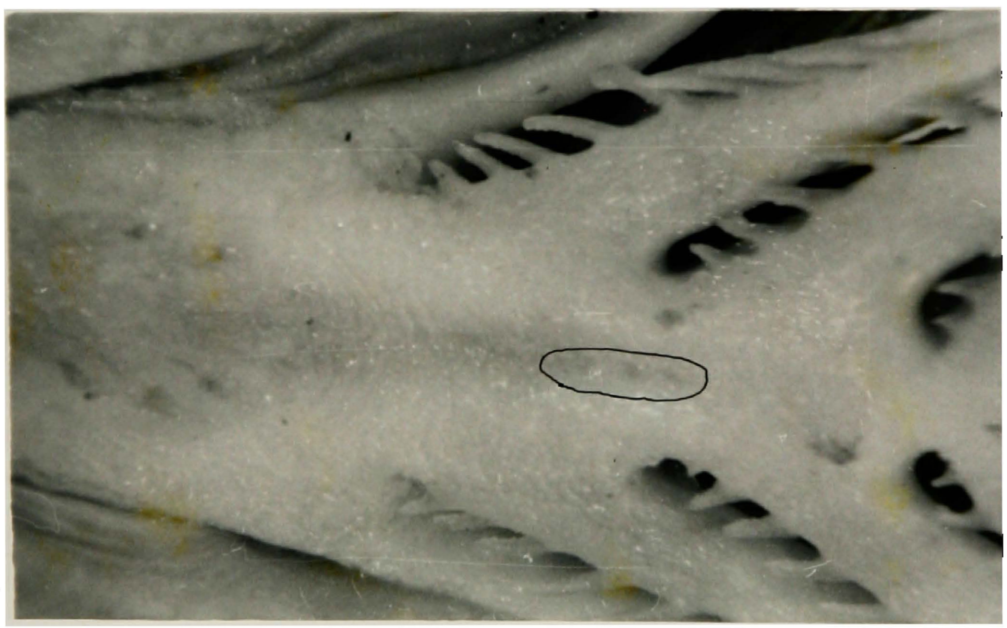
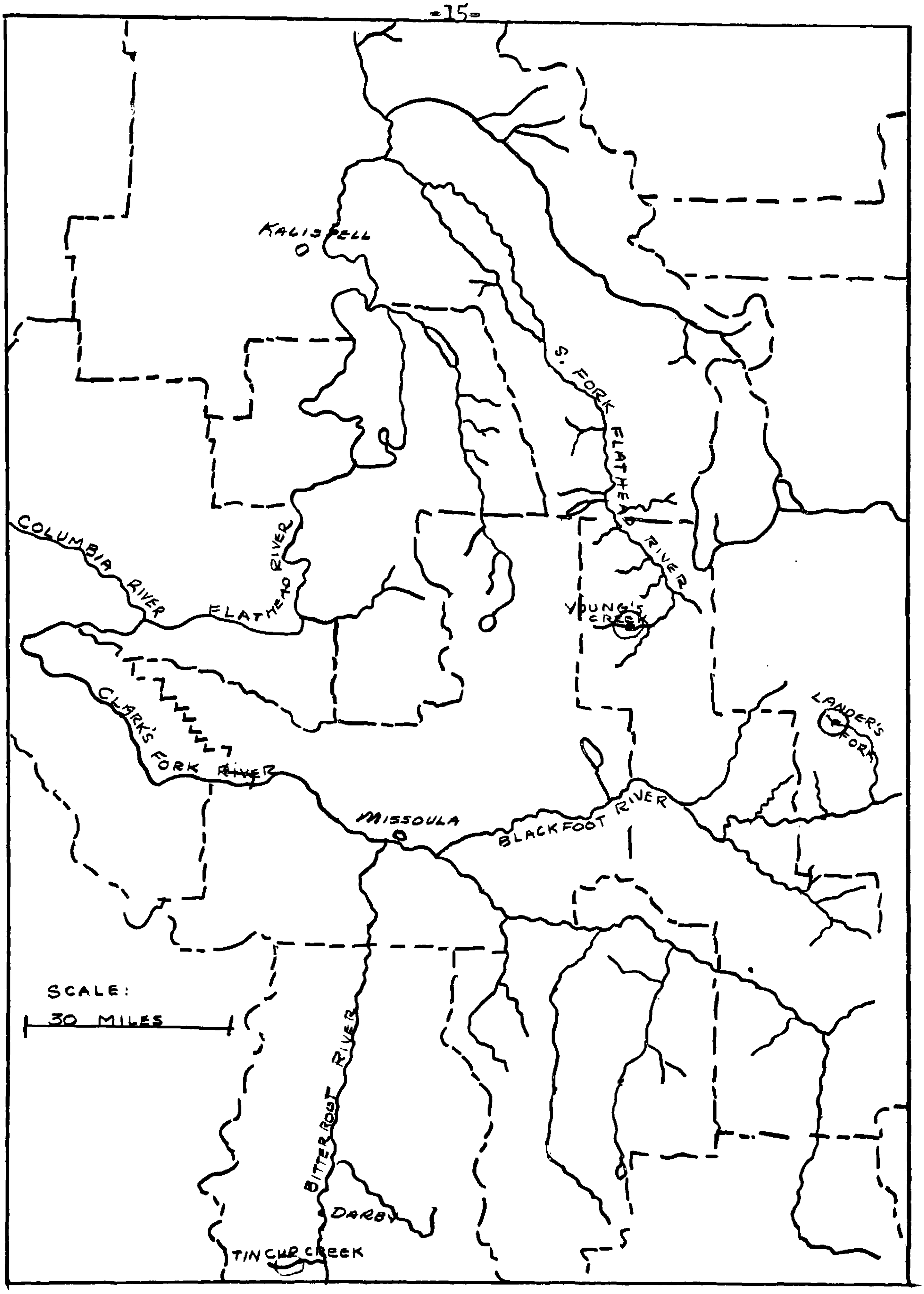


Figure 5. Location of Basibranchial Teeth. The teeth show as dark spots in right center of photograph between the first and second gill arches. X10.



...ion Western Montana Collection Sites

RESULTS

A comparison of the three populations of cutthroat trout from western Montana (Tin Cup Creek, Landers Fork of the Blackfoot, and Youngs Creek) for which large samples were available is presented in this section. In addition, trout from the geographic areas of Montana west of the Continental Divide, Montana east of the Divide, and coastal British Columbia are compared. In the following account the means are given in parenthesis following the ranges. This material is tabulated in Tables I to VIII.

The trout of western Montana have a dorsal fin ray range of 9 - 11 (9.95), those of eastern Montana have 9 - 10 (9.76), and those of British Columbia have 8 - 10 (9.29). Significant differences of .01 exist between the mean fin ray counts of British Columbia trout and those of western and eastern Montana. Trout from Tin Cup Creek, Youngs Creek, and Landers Fork have ranges of 9 - 11 (9.42), 9 - 10 (9.68), and 9 - 10 (9.79), respectively. These means are below the 9.95 mean for the combined 7 populations of western Montana.

The ranges and means of anal fin rays for the fish of western Montana, eastern Montana, and British Columbia are 8 - 11 (9.22), 8 - 9 (8.98), and 8 - 10 (9.02), respectively. Trout from Tin Cup Creek possess a range of 8 - 10 (9.20), whereas those from Landers Fork and Youngs Creek have the same range but means of 9.22 and 9.37. The fish of Youngs Creek have the only mean above the 9.22 mean for the 7 populations of western Montana. T-tests reveal significant differences between the means for the trout of western Montana and those of the other two areas.

The total range of caudal fin ray counts is 18 - 22. The majority possess 19 rays with means of 19.51 for the fish of western Montana, 19.00 for those of eastern Montana, and 18.93 for those of British Columbia. The trout of Tin Cup Creek have a range of 19 - 20 (19.01), those from Youngs Creek have 18 - 22 (19.72), and those of Landers Fork have 18 - 20 (18.97). Significant differences in caudal fin ray means appear between the trout of western Montana and those of eastern Montana and British Columbia. An almost significant difference approaching .05 was obtained between the means of trout from eastern Montana and British Columbia.

Vertebral counts reveal a marked similarity in trout from the 3 geographic areas. The total range was 59 - 64, with identical means of 61.20 for trout from western Montana and eastern Montana and 61.74 for those of British Columbia. T-tests show the mean is distinct for fish from British Columbia. The means for trout from Tin Cup Creek, Landers Fork, and Youngs Creek are above the 61.20 mean for the 7 populations of western Montana.

Oblique lateral scale row counts are distinct for the cutthroat of western and eastern Montana and British Columbia. The t-test is significant at .01. Fish from Weatherwax Creek possess a higher mean than the other stream populations. The means for the trout of Tin Cup and Youngs Creeks are higher than the combined mean for the fish of western Montana.

The ranges and means of lateral line scale counts are too closely related to make group separation possible. Western Montana trout have a range of 113 - 150 (124.16), those of British Columbia have 118 - 142 (124.76), and those of eastern Montana have 115 - 139 (127.61). However, t-tests show a significant difference in means between specimens from eastern Montana and the other two areas. No distinction could be made between the means of fish from western Montana and British Columbia. Tin Cup Creek trout have a range of 115 - 128 (122.68), while the Youngs Creek trout show a range of 116 - 142 (125.16) and Landers Fork trout have a range of 113 - 132 (122.28). The mean of those from Youngs Creek is higher than that of the combined western Montana populations.

The eye diameter is least in trout from eastern Montana and greatest in trout from British Columbia. However, t-tests show the mean difference is significant at the .05 level between the cutthroat of British Columbia and those of the other two areas. The eye diameter of trout from Tin Cup Creek is 5.5 - 10.0 (7.93), those from Landers Fork have 5.2 - 12.0 (8.24), and those from Youngs Creek have 8.0 - 14.5 (9.67). The trout of Landers Fork and Youngs Creek possess means well above that of the 7 western Montana populations.

Similarity in the size of the fish from the different populations is indicated by the standard length measurements which range from 59.0 - 278 mm. (143.24) for western Montana trout, 80.0 - 293.0 mm. (146.06) for British Columbia trout, and 68.0 - 210.0 mm. (148.06) for eastern Montana trout. T- and analysis of covariance tests reveal no significant differences in these means. The three large collections from western Montana have ranges of 79.0 - 195.0 mm. (136.60) for Tin Cup Creek trout, 66.0 - 245.0 mm. (146.69) for Landers Fork trout, and 160.0 - 278.0 mm. (212.84) for the Youngs Creek trout.

Measurements of the caudal peduncle depth is not considered to be accurate because those specimens preserved in alcohol exhibit marked shrinkage when compared to those fixed in formalin.

The mean of the number of parr marks for cutthroat from western Montana is slightly higher than the others. These means are: western Montana, 10.81; eastern Montana, 10.59; and British Columbia, 9.68. The means for trout from Tin Cup Creek and Landers Fork are 11.09 and 9.75, respectively. None of the trout from Youngs Creek possess parr marks. The specimens from this stream are larger than the others.

The means of counts of head spots are distinct in populations from eastern Montana, western Montana, and British Columbia. The difference between the means for trout from western Montana and British Columbia is significant at .01, between trout from eastern Montana and British Columbia it is .025, and between eastern Montana and western Montana trout it is .05.

Proportional measurements reveal that eastern Montana, western Montana, and British Columbia cutthroat are similar in snout to anal origin and snout to adipose lengths. T-tests show highly significant differences between the means of trout from western Montana and British Columbia for maxillary and preopercle lengths and internasal width. Analysis of covariance tests show that mean differences are not related to standard length.

Sixty-eight per cent of all cutthroat in this study possess basibranchial teeth. The collection from Pilgrim Creek is the only one in which the majority of fish do not possess these teeth. Of 125 specimens from western Montana, 93 have teeth. Nineteen out of 30 fish from eastern Montana have teeth. Seventeen cutthroat from British Columbia have teeth and 15 do not. Of 28 specimens from Tin Cup Creek, 18 have teeth and of 27 from Landers Fork, 15 have teeth. Trout from Youngs Creek have the highest percentage with teeth. They are present in 29 of 37 specimens.

Gill raker counts range from 13 - 21. The population means are: western Montana, 16.48; eastern Montana, 17.10; and British Columbia, 17.03. Trout from Tin Cup Creek have a range of 14 - 20 (16.29), from Landers Fork a range of 13 - 19 (16.33), and from Youngs Creek a range of 13 - 21 (17.18). T-tests reveal significant mean differences between the cutthroat of western Montana and the other two areas at the .01 level.

Pyloric caeca counts range from 19 - 39 (33) for 16 specimens from Youngs Creek. No specimens from other areas were examined.

T-tests show all geographic populations to have highly significant mean differences for chin length and oblique lateral scale rows. Chin length is greatest for the fish of British Columbia, intermediate for those of western Montana, and least for those of eastern Montana. Oblique lateral row counts are greatest for the fish of eastern Montana, intermediate for those of western Montana, and least for those of British Columbia. Distinct differences between the populations of eastern Montana and British Columbia reveal that those from eastern Montana possess higher lateral line and dorsal fin ray counts, a lower vertebral count, and shorter snout and preopercle lengths. The trout of western Montana are distinctly different from those of British Columbia in higher dorsal, anal, and caudal fin ray counts but shorter snout, maxillary, preopercle, and head lengths, and smaller internasal width, and eye diameter. The fish of western Montana differ significantly from those of eastern Montana in having higher anal, caudal, and dorsal fin ray counts, greater eye diameter, and lower gill raker and lateral line counts.

The fish from British Columbia have a distinctly longer snout length than those from eastern or western Montana. This difference between the means of populations from British Columbia and western Montana is significant at .025. The difference between the means for cutthroat from British Columbia and eastern Montana is significant at .05.

Chin length is distinct in the 3 geographic populations with the mean difference of the two Montana populations the least significant at .05.

The only significant mean difference in maxillary length exists between trout from western Montana and British Columbia. However, an almost significant difference approaching .05 exists between fish from eastern Montana and British Columbia. No dependence upon standard length was revealed by the covariance test.

Preopercle and head lengths show distinct differences at .01 for cutthroat from western Montana and British Columbia. The mean difference of the preopercle length for eastern Montana and British Columbia trout is significant at .05.

Internasal width displays a significant difference of .025 between the cutthroat from western Montana and British Columbia. The mean difference is almost .05 for the cutthroat of eastern Montana and British Columbia.

Analysis of covariance substantiates results of the t-test in all cases. Therefore, standard length differences do not influence the means obtained.

The only two characters showing a close relationship between fishes from coastal British Columbia and fishes from east of the Continental Divide in Montana is in gill raker and fin ray counts.

TABLE I

RANGES AND MEANS OF ALL MEASUREMENTS AND COUNTS

Stream	Dorsal Fin	Anal Fin	Caudal Fin	Vertebrae	Oblique Lateral Rows	Lateral Line Scales
Pattee Canyon	9 - 10 9.80	9 9.00	19 19.00	59 - 61 60.00	140 - 160 149.38	116 - 124 120.79
Miller Creek	9 - 11 10.28	9 - 11 10.10	19 - 22 20.88	60 - 63 61.70	139 - 160 149.15	117 - 139 127.80
Marshall Creek	9 - 11 10.20	9 - 11 9.79	18 - 22 19.97	60 - 63 60.82	141 - 171 153.52	116 - 130 122.92
Dirty Ike Creek	10 - 11 10.09	9 - 11 9.72	18 - 21 19.41	59 - 62 60.48	125 - 168 147.19	117 - 150 127.50
Youngs Creek	9 - 10 9.68	8 - 10 9.37	18 - 22 19.72	60 - 63 61.57	145 - 182 161.48	116 - 144 125.16
Landers Fork	9 - 10 9.79	8 - 10 9.22	18 - 20 18.97	60 - 64 61.70	128 - 179 145.33	113 - 132 122.28
Tin Cup Creek	9 - 11 9.42	8 - 10 9.20	19 - 20 19.01	59 - 63 62.10	132 - 169 153.37	115 - 128 122.68
British Columbia	8 - 10 9.45	8 - 10 9.26	18 - 19 18.93	60 - 64 61.74	132 - 167 143.33	118 - 142 124.76
Weatherwax Creek	9 - 10 9.71	9 9.00	19 19.00	59 - 62 60.77	161 - 188 174.34	123 - 139 129.85
Pilgrim Creek	9 - 10 9.71	8 - 9 8.95	19 19.00	59 - 62 60.55	137 - 179 154.64	115 - 132 122.55
Bozeman Area	9 - 10 9.69	8 - 9 8.98	19 19.00	60 - 62 62.28	124 - 196 160.33	124 - 138 130.44
Total Mean	9.76	9.39	19.31	61.17	152.05	124.53

TABLE I (Continued)

RANGES AND MEANS OF ALL MEASUREMENTS AND COUNTS

Stream	Head Spots	Eye Diameter	Head Width	Head Depth	Peduncle Depth	Body Depth at Vent
Pattee Canyon	21 - 24	5.2 - 6.9	8.8 - 15.2	12.3 - 21.2	7.3 - 10.4	12.0 - 22.0
	21.87	5.49	11.36	15.04	8.74	15.85
Miller Creek	12 - 30	5.1 - 9.2	8.2 - 19.3	12.1 - 26.3	7.8 - 16.2	12.5 - 30.4
	19.11	6.85	13.03	17.31	10.92	18.63
Marshall Creek	13 - 25	5.5 - 7.6	8.0 - 15.0	10.9 - 21.0	7.0 - 12.0	11.0 - 23.0
	17.88	6.31	10.18	14.85	9.02	14.87
Dirty Ike Creek	14 - 30	4.8 - 10.5	8.2 - 27.5	10.2 - 37.5	6.0 - 21.0	8.7 - 35.5
	17.67	7.18	14.78	19.91	12.16	20.46
Youngs Creek	37 - 89	8.0 - 14.5	15.6 - 29.8	23.5 - 44.5	15.0 - 28.0	27.2 - 52.5
	51.82	9.67	22.34	31.15	21.54	39.66
Landers Fork	8 - 100	5.2 - 12.0	8.1 - 35.5	10.6 - 41.2	6.5 - 23.5	11.0 - 42.5
	36.22	8.24	15.88	21.80	14.14	25.59
Tin Cup Creek	13 - 91	5.5 - 10.0	7.1 - 22.5	11.0 - 31.0	7.5 - 19.5	12.5 - 36.8
	38.77	7.93	14.21	19.99	12.90	22.58
British Columbia	24 - 76	5.9 - 14.9	7.9 - 43.0	11.7 - 55.5	6.2 - 29.0	10.1 - 60.5
	41.12	8.65	16.78	22.06	13.17	24.23
Weatherwax Creek	18 - 74	8.0 - 9.9	13.3 - 19.8	20.0 - 30.5	12.4 - 18.8	22.9 - 32.5
	37.36	8.64	17.15	23.47	14.99	26.09
Pilgrim Creek	22 - 51	6.2 - 10.4	10.3 - 22.0	14.3 - 33.5	9.2 - 19.0	16.2 - 36.9
	33.49	7.96	14.88	21.75	13.54	24.65
Bozeman Area	13	5.1 - 9.0	7.5 - 20.2	11.0 - 28.5	5.5 - 18.0	10.0 - 30.5
	13.00	6.82	13.31	19.34	12.24	21.65
Total Mean	36.42	7.61	15.84	21.84	13.98	25.01

TABLE I (Continued)

RANGES AND MEANS OF ALL MEASUREMENTS AND COUNTS

Stream	Parr Marks	Gill Rakers	Snout Length	Chin Length	Maxillary Length	Preopercle Length
Pattee Canyon	9 - 12	13 - 16	3.9 - 8.8	8.2 - 13.9	10.2 - 18.8	15.0 - 25.2
	10.87	14.50	5.74	10.19	13.27	20.06
Miller Creek	9 - 12	14 - 20	4.0 - 9.2	6.2 - 16.0	10.0 - 20.0	15.4 - 29.3
	10.50	17.29	6.23	9.89	13.86	20.43
Marshall Creek	10 - 13	15 - 19	4.0 - 9.0	6.2 - 15.2	10.1 - 19.5	14.0 - 27.7
	11.33	17.13	5.27	9.34	12.82	18.88
Dirty Ike Creek	10 - 13	14 - 19	3.6 - 13.0	7.0 - 20.5	8.5 - 27.0	13.0 - 38.7
	11.30	16.69	7.40	11.59	15.35	22.48
Youngs Creek		13 - 21	8.5 - 18.0	13.5 - 25.5	20.0 - 36.0	27.0 - 50.8
		17.18	12.22	18.65	25.81	38.38
Landers Fork	7 - 14	13 - 19	4.0 - 17.0	7.2 - 24.5	10.5 - 36.0	14.6 - 52.0
	9.75	16.33	8.51	13.20	19.77	28.82
Tin Cup Creek	8 - 14	14 - 20	3.9 - 12.2	5.6 - 19.0	10.5 - 28.0	15.2 - 39.2
	11.09	16.24	6.93	11.30	17.86	25.54
British Columbia	8 - 12	14 - 20	4.9 - 22.0	7.4 - 35.0	12.3 - 48.9	17.4 - 68.9
	9.68	17.03	9.67	15.01	21.88	31.95
Weatherwax Creek	9 - 12	15 - 20	6.4 - 10.8	9.1 - 16.6	16.4 - 26.5	24.2 - 36.0
	10.14	17.30	8.62	12.95	20.91	29.31
Pilgrim Creek	10 - 13	14 - 19	5.0 - 11.6	6.9 - 17.0	12.1 - 26.3	18.5 - 37.5
	11.33	16.33	7.39	10.85	18.33	26.17
Bozeman Area	9 - 12	15 - 20	3.0 - 10.2	5.5 - 18.0	9.2 - 25.5	14.5 - 32.8
	10.29	17.66	6.57	10.69	16.18	22.29
Total Mean	10.63	16.70	8.36	13.12	19.16	27.86

TABLE I (Continued)

RANGES AND MEANS OF ALL MEASUREMENTS AND COUNTS

Stream	Head Length	Mouth Width	Interorbital Width	Internasal Width	Snout to Dorsal Origin	Snout to Anal Origin
Pattee Canyon	20.8 - 33.0 26.10	7.5 - 12.5 10.83	6.0 - 10.5 8.15	2.5 - 5.5 3.79	40.0 - 66.0 56.04	58.2 - 90.9 81.55
Miller Creek	20.1 - 37.3 27.23	7.5 - 16.1 10.68	5.5 - 10.8 7.66	2.5 - 6.0 3.90	42.0 - 83.0 56.45	60.0 - 124.6 83.56
Marshall Creek	19.5 - 34.2 24.37	7.2 - 13.7 8.68	5.2 - 9.0 6.76	2.3 - 4.5 3.11	38.2 - 65.0 48.07	49.6 - 94.6 66.76
Dirty Ike Creek	16.5 - 48.5 29.75	6.8 - 22.0 12.14	4.5 - 14.5 8.53	2.3 - 6.5 4.17	34.0 - 98.0 60.79	46.0 - 143.5 87.49
Youngs Creek	38.7 - 67.0 37.50	13.2 - 27.9 18.55	10.0 - 20.5 15.06	5.2 - 10.0 7.51	80.0 - 138.0 105.19	120.0 - 211.0 163.12
Landers Fork	20.1 - 64.5 49.69	7.3 - 28.0 13.92	5.5 - 18.5 10.32	2.5 - 9.7 5.22	41.0 - 128.5 74.54	62.9 - 188.0 112.76
Tin Cup Creek	20.5 - 50.0 33.07	6.5 - 20.5 12.16	4.7 - 14.6 8.64	2.0 - 7.5 4.01	38.8 - 98.0 66.49	58.6 - 143.0 100.44
British Columbia	22.5 - 89.8 41.33	6.7 - 38.5 14.45	5.6 - 26.3 11.44	2.9 - 14.2 5.97	42.0 - 152.0 74.04	59.2 - 224.0 113.08
Weatherwax Creek	31.3 - 44.5 37.22	11.1 - 16.0 13.98	8.5 - 12.7 10.73	4.5 - 7.1 5.61	65.0 - 91.0 75.99	98.5 - 143.0 116.99
Pilgrim Creek	24.0 - 48.6 34.34	8.1 - 18.2 12.40	6.5 - 14.7 9.46	3.0 - 7.5 4.52	51.0 - 102.0 72.70	79.5 - 161.0 109.87
Bozeman Area	19.1 - 48.6 32.02	6.0 - 17.0 11.26	4.3 - 13.6 8.83	2.2 - 6.5 4.25	34.0 - 103.0 65.43	48.0 - 153.5 99.37
Total Mean	36.30	13.42	10.26	5.09	72.76	109.83

TABLE I (Continued)

RANGES AND MEANS OF ALL MEASUREMENTS AND COUNTS

Stream	Snout to Adipose	Standard Length
Pattee Canyon	65.7 - 103.3 89.17	76.8 - 120.0 104.02
Miller Creek	67.2 - 140.2 92.24	80.7 - 162.0 112.62
Marshall Creek	58.2 - 106.0 75.66	70.0 - 126.0 88.54
Dirty Ike Creek	50.0 - 158.0 99.07	59.0 - 193.0 117.60
Youngs Creek	133.0 - 228.0 175.02	160.0 - 278.0 212.84
Landers Fork	62.9 - 201.0 123.58	66.0 - 245.0 146.69
Tin Cup Creek	63.5 - 160.5 110.69	79.0 - 195.0 136.60
British Columbia	65.0 - 245.0 121.70	80.0 - 293.0 141.06
Weatherwax Creek	110.0 - 156.0 127.91	133.0 - 189.0 157.67
Pilgrim Creek	87.2 - 171.0 120.12	104.0 - 210.0 144.53
Bozeman Area	55.8 - 167.5 111.37	68.0 - 210.0 133.82
Total Mean	119.84	143.82

TABLE II

RANGES AND MEANS OF RATIOS OBTAINED BY DIVIDING ALL HEAD MEASUREMENTS INTO THE HEAD LENGTH AND ALL BODY MEASUREMENTS INTO THE STANDARD LENGTH

Stream	Eye Diameter	Head Width	Head Depth	Peduncle Depth	Body Depth at Vent	Snout Length
Pattee Canyon	3.38-4.85 4.02	2.09-2.36 2.21	5.66-7.00 6.45	9.37-11.79 10.87	5.45-6.67 6.17	3.75-5.38 4.46
Miller Creek	3.41-4.23 3.92	1.93-2.38 2.14	5.79-7.47 6.34	8.48-11.91 10.13	5.08-7.00 5.85	3.97-5.17 4.46
Marshall Creek	3.28-4.62 3.82	2.19-2.61 2.39	5.76-7.41 6.24	8.89-11.96 10.16	5.48-6.56 6.00	3.80-5.12 4.58
Dirty Ike Creek	3.44-5.39 4.10	1.62-2.41 2.05	5.07-7.08 5.94	8.85-11.98 9.88	4.97-6.92 5.68	3.73-4.93 4.32
Youngs Creek	4.64-6.38 5.18	1.93-2.58 2.26	5.19-7.56 6.82	9.28-10.68 9.96	4.21-5.94 5.36	3.72-4.63 4.16
Landers Fork	3.71-5.86 4.43	2.01-2.76 2.40	5.76-8.36 6.86	8.97-12.46 10.62	4.54-7.36 5.90	3.62-5.03 4.48
Tin Cup Creek	3.42-5.00 4.19	2.13-2.89 2.38	6.29-7.72 6.90	9.70-12.09 10.85	5.30-6.49 6.00	4.14-5.70 4.87
British Columbia	3.66-6.55 4.53	1.89-3.10 2.60	4.20-7.44 6.42	10.00-14.03 11.50	4.14-8.61 6.47	3.60-5.42 4.45
Weatherwax Creek	3.85-4.88 4.36	2.07-2.41 2.27	6.30-7.05 6.63	9.78-12.08 10.71	5.76-6.54 6.06	4.03-4.89 4.43
Pilgrim Creek	3.99-4.75 4.30	2.22-2.72 2.35	6.11-7.27 6.63	9.78-11.57 10.78	5.66-6.54 5.90	4.07-5.17 4.71
Bozeman Area	3.89-5.65 4.75	2.36-2.58 2.47	6.18-7.80 6.98	10.38-12.36 11.24	5.82-6.80 6.24	4.57-6.37 5.10

TABLE II (Continued)

RANGES AND MEANS OF RATIOS OBTAINED BY DIVIDING ALL HEAD MEASUREMENTS INTO THE HEAD LENGTH AND ALL BODY MEASUREMENTS INTO THE STANDARD LENGTH

Stream	Chin Length	Maxillary Length	Preopercle Length	Mouth Width	Interorbital Width	Internasal Width
Pattee Canyon	2.33-2.70 2.48	1.76-2.06 1.92	1.31-1.39 1.34	1.27-1.50 1.37	3.14-3.50 3.33	6.00-8.40 7.19
Miller Creek	2.33-3.26 2.71	1.84-2.16 1.99	1.27-1.38 1.33	1.22-1.46 1.31	3.19-3.89 3.54	6.22-8.48 7.02
Marshall Creek	2.19-3.26 2.67	1.75-2.02 1.92	1.23-1.44 1.31	1.06-1.67 1.41	3.37-4.10 3.63	6.00-8.78 7.52
Dirty Ike Creek	2.34-3.08 2.66	1.79-2.11 1.96	1.23-1.40 1.32	1.11-1.46 1.29	3.07-3.83 3.42	6.04-7.76 7.20
Youngs Creek	2.33-2.99 2.70	1.79-2.09 1.95	1.29-1.79 1.32	1.16-1.60 1.38	2.85-3.87 3.34	5.84-7.59 6.70
Landers Fork	2.40-3.35 2.90	1.69-2.14 1.91	1.26-1.38 1.31	1.22-1.65 1.41	3.22-4.45 3.66	6.25-8.46 7.19
Tin Cup Creek	2.63-3.66 3.04	1.65-2.06 1.90	1.22-1.36 1.30	1.24-1.74 1.48	3.28-4.36 3.87	6.09-10.25 8.22
British Columbia	2.48-3.35 2.80	1.69-2.16 1.89	1.20-1.43 1.29	1.19-1.89 1.61	3.09-4.39 3.77	5.50-9.06 7.23
Weatherwax Creek	2.45-3.69 2.97	1.68-1.91 1.81	1.24-1.33 1.29	1.28-1.66 1.49	3.37-3.99 3.59	6.05-7.18 6.67
Pilgrim Creek	2.79-3.68 3.24	1.74-2.07 1.91	1.26-1.37 1.32	1.33-1.60 1.46	3.24-4.03 3.66	6.48-9.16 7.55
Bozeman Area	2.70-3.47 3.17	1.91-2.13 2.02	1.31-1.38 1.34	1.36-1.55 1.46	3.44-4.44 3.73	6.89-8.68 7.66

TABLE II (Continued)

RANGES AND MEANS OF RATIOS OBTAINED BY DIVIDING ALL HEAD MEASUREMENTS INTO THE HEAD LENGTH AND ALL BODY MEASUREMENTS INTO THE STANDARD LENGTH

Stream	Snout to Dorsal Origin	Snout to Anal Origin	Snout to Adipose
Pattee Canyon	1.81-1.93 1.88	1.28-1.35 1.32	1.16-1.20 1.17
Miller Creek	1.80-1.95 1.88	1.25-1.36 1.30	1.10-1.22 1.16
Marshall Creek	1.81-1.97 1.90	1.27-1.41 1.32	1.14-1.22 1.18
Dirty Ike Creek	1.75-2.10 1.93	1.25-1.34 1.31	1.09-1.22 1.18
Youngs Creek	1.79-2.12 2.01	1.24-1.35 1.30	1.17-1.24 1.21
Landers Fork	1.83-2.13 1.97	1.23-1.46 1.32	1.14-1.24 1.20
Tin Cup Creek	1.88-2.25 2.02	1.28-1.40 1.33	1.16-1.28 1.22
British Columbia	1.78-2.12 1.92	1.22-1.37 1.31	1.13-1.24 1.20
Weatherwax Creek	1.96-2.20 2.06	1.29-1.36 1.34	1.21-1.25 1.22
Pilgrim Creek	1.89-2.06 1.99	1.28-1.38 1.33	1.16-1.24 1.20
Bozeman Area	1.94-2.11 2.00	1.31-1.42 1.36	1.19-1.24 1.21

TABLE III

COMPARISON OF SALMO CLARKI STUDIES
Selected Counts and Measurements

(WM): Montana west of Continental Divide; (EM): Montana east of Continental Divide; (BC): British Columbia

Investigator	Lateral Line	Oblique Lateral Rows	Dorsal Fin	Anal Fin	Pyloric Caeca	Gill Rakers	Parr Marks
Carl, *et al.* 1959 *Salmo c. clarki*		120-180	8-11	8-12	27-57	15-22	10
Hartman, G. F. *Salmo c. clarki*		121-159 141.05	Mean 13.19	Mean 13.47	27-57 42.6		
Roundsfell, G. A. *Salmo clarki*	116-123 123	146-177 166	10-13	11-16	27-40 33*	14-21 19.34	
Shapovalvo, Leo *Salmo clarki*		120-180 150	8-11	No more than 12		14-21	
Schultz, L. P. *Salmo c. clarki*	120-180		9-11	9-11		15-22	
Schultz, L. P. *Salmo c. lewisi*	156-190 170		9-11	9-11			
Zimmerman, G. D. *Salmo c. lewisi* (WM)	113-150 124.16	125-182 151.34	9-11 9.95	8-11 9.22	19-39 33	13-21 16.48	7-14 10.81
Zimmerman, G. D. *Salmo c. lewisi* (EM)	115-138 127.61	124-196 163.07	9-10 9.76	8-9 8.98		14-20 17.10	9-13 10.59
Zimmerman, G. D. *Salmo c. clarki* (BC)	118-142 124.76	132-167 143.33	8-10 9.29	8-10 9.02		14-20 17.03	8-12 9.68

*From Townsend (1944).

TABLE IV

BASIBRANCHIAL TEETH

Stream	Present	Absent	Not checked
Pattee Canyon	3	1	2
Miller Creek	6	5	3
Marshall Creek	11	1	11
Dirty Ike Creek	11	2	4
Youngs Creek	29	8	1
Landers Fork	15	12	16
Tin Cup Creek	18	3	7
British Columbia	17	15	5
Weatherwax Creek	6	2	2
Pilgrim Creek	5	9	1
Bozeman Area	8	0	0

TABLE V

RANGES AND MEANS OF AVERAGES FOR THE CUTTHROAT OF MONTANA WEST OF CONTINENTAL DIVIDE (WM), MONTANA EAST OF CONTINENTAL DIVIDE (EM), AND BRITISH COLUMBIA (BC)

Identity		(DF)	(AF)	(CF)	(VC)	(OBLR)
Salmo clarki	Range	9.68-10.10	9.20-10.10	18.97-20.88	60.00-62.10	145.33-161.48
lewisi (WM)	Mean	9.95	9.22	19.51	61.20	151.34
Salmo clarki	Range	9.69-9.77	8.95-9.00	19.00	60.55-62.28	154.64-174.34
lewisi (EM)	Mean	9.76	8.98	19.00	61.20	163.07
Salmo clarki	Range	8.00-10.00	8.00-10.00	18.00-19.00	60.00-64.00	132.00-167.00
clarki (BC)	Mean	9.29	9.02	18.93	61.74	143.33

Identity		(L-L)	(HS)	(ED)	(HW)	(HD)
Salmo clarki	Range	120.79-127.80	17.67-51.82	5.49-9.67	10.18-22.34	15.04-31.15
lewisi (WM)	Mean	124.16	29.05	7.92	15.71	21.78
Salmo clarki	Range	122.55-130.44	13.00-37.36	6.82-8.64	13.31-17.15	19.34-23.47
lewisi (EM)	Mean	127.61	27.95	7.86	14.94	21.84
Salmo clarki	Range	118.00-142.00	24.00-76.00	5.90-14.90	7.90-43.00	11.70-55.50
clarki (BC)	Mean	124.76	41.12	8.60	16.74	23.68

Identity		(PD)	(BDV)	(PM)	(GR)	(SL)
Salmo clarki	Range	8.74-21.54	14.87-39.66	9.75-11.33	14.50-17.29	5.27-12.22
lewisi (WM)	Mean	14.03	25.49	10.81	16.48	8.21
Salmo clarki	Range	12.24-14.99	21.65-26.09	10.29-11.33	16.33-17.66	6.57-8.62
lewisi (EM)	Mean	13.59	24.46	10.59	17.10	7.62
Salmo clarki	Range	6.20-29.00	10.10-60.50	8.0-12.0	14.00-20.00	4.80-22.00
clarki (BC)	Mean	13.02	24.38	9.68	17.03	9.67

Key: DF, Dorsal fin; AF, Anal fin; CF, Caudal fin; VC, Vertebral count; OBLR, Oblique lateral rows; L-L, Lateral line scales; HS, Head spots; ED, Eye diameter; HW, Head width; HD, Head depth; PD, Peduncle depth; BDV, Body depth at vent; PM, Parr marks; GR, gill rakers; SL, Snout length.

TABLE V (Continued)

RANGES AND MEANS OF AVERAGES FOR THE CUTTHROAT OF MONTANA WEST OF CONTINENTAL DIVIDE (WM), MONTANA EAST OF CONTINENTAL DIVIDE (EM), AND BRITISH COLUMBIA (BC)

Identity		(CL)	(ML)	(PL)	(HL)	(MW)
Salmo clarki	Range	9.34-18.65	12.82-25.81	18.88-38.38	24.37-46.69	8.68-13.92
lewisi (WM)	Mean	12.97	18.61	27.34	35.72	13.36
Salmo clarki	Range	10.69-12.95	16.18-20.91	22.29-29.31	32.02-37.22	11.26-13.98
lewisi (EM)	Mean	11.45	18.57	26.28	35.11	12.70
Salmo clarki	Range	7.40-35.00	12.30-48.90	17.40-68.90	22.50-89.80	6.70-38.50
clarki (BC)	Mean	15.01	21.90	31.95	41.53	14.57

Identity		(IOW)	(INW)	(S-DO)	(S-AO)	(S-AD)
Salmo clarki	Range	6.76-15.06	3.11-7.51	48.07-105.19	66.76-163.12	75.66-175.02
lewisi (WM)	Mean	10.11	4.99	72.65	109.66	119.82
Salmo clarki	Range	8.83-10.73	4.25-5.61	65.43-75.99	99.37-116.99	111.37-127.81
lewisi (EM)	Mean	9.74	4.93	72.64	109.80	120.60
Salmo clarki	Range	5.60-26.30	2.90-14.20	42.00-152.00	59.20-224.00	65.00-245.00
clarki (BC)	Mean	11.39	5.97	75.92	112.30	122.92

Identity		(St-L)
Salmo clarki	Range	88.54-212.84
lewisi (WM)	Mean	143.24
Salmo clarki	Range	133.82-157.67
lewisi (EM)	Mean	148.06
Salmo clarki	Range	80.00-293.00
clarki (BC)	Mean	146.61

Key: CL, Chin length; ML, Maxillary length; PL, Precopercle length; HL, Head length; MW, Mouth width; IOW, Interorbital width; INW, Internasal width; S-DO, Snout to dorsal origin; S-AO, Snout to anal origin; S-AD, Snout to adipose; St-L, Standard length.

TABLE VI

POPULATION COMPARISON TABLE

Key: ---- indicates statistically distinct at .01%.
**** indicates statistically distinct at .05%.
indicates mean relationship.

Measurement	Western Montana		Eastern Montana		British Columbia		Western Montana
Eye Diameter	4.8-14.5	****	5.1-10.4		5.9-14.9		4.8-14.5
	7.92	######	7.86		8.60	******	7.92
Head Width	7.1-35.5		7.5-22.0		7.0-43.0		7.1-35.5
	15.71		14.94		16.74		15.71
Head Depth	10.2-44.5		11.0-33.5		11.7-55.5		10.2-44.5
	21.78	#####	21.84		23.68		21.78
Peduncle Depth	6.0-28.5		5.5-19.0		6.2-29.0		6.0-28.5
	14.03		13.58	#####	13.02		14.03
Body Depth at Vent	8.7-52.5		10.0-36.9		10.1-60.5		8.7-52.5
	25.49		24.46	#####	24.38		25.49
Snout Length	3.6-18.0		3.0-11.6		4.8-22.0		3.6-18.0
	8.21	######	7.62	******	9.66	******	8.21
Chin Length	6.2-24.5	****	5.5-18.0		7.4-35.0		6.2-24.5
	12.97	#####	11.45	*****	15.00	*****	12.97
Maxillary Length	8.5-36.0		9.2-26.5		12.3-48.9		8.5-36.0
	18.61	#####	18.57		21.90	*****	18.61
Preopercle Length	13.0-52.0		14.5-37.5		17.4-68.9		13.0-52.0
	27.34	#####	26.28	*****	31.98	-----	27.34
Head Length	16.5-67.0		19.1-48.6		22.5-89.8		16.5-67.0
	35.72	#####	35.11		41.53		35.72
Mouth Width	6.8-28.0		6.0-18.2		6.7-38.5		6.8-28.0
	13.36	#####	12.70		14.57		13.36
Interorbital Width	4.5-20.5		4.3-14.7		5.6-26.3		4.5-20.5
	10.11	######	9.74		11.39		10.11
Internasal Width	2.3-10.0		2.2-7.5		2.9-14.2		2.3-10.0
	4.99	#####	4.93		5.98	******	4.99

TABLE VI (Continued)

Measurement	Western Montana		Eastern Montana		British Columbia		Western Montana
Snout-dorsal Origin	34.0-138.0		34.0-103.0		42.0-152.0		34.0-138.0
	72.65	#####	72.64		75.92		72.65
Snout-anal Origin	49.6-211.0		48.0-161.0		59.2-224.0		49.6-211.0
	109.16	####	109.80		112.30		109.16
Snout to Adipose	50.0-228.0		55.8-171.0		65.0-245.0		50.0-228.0
	119.82	####	120.60		122.92		119.82
Standard Length	59.0-278.0		68.0-210.0		80.0-293.0		59.0-278.0
	143.24		148.06	####	146.06		143.24
Dorsal Fin	9 - 11		9 - 10		8 - 10		9 - 11
	9.95	######	9.76	------	9.29	------	9.95
Anal Fin	8 - 11		8 - 9		8 - 10		8 - 11
	9.22	-------	8.98	######	9.02	------	9.22
Caudal Fin	18 - 22		19.00		18 - 19		18 - 22
	19.51	---	19.00	#######	18.93	-----	19.51
Vertebrae	59 - 64		59 - 62		60 - 64		59 - 64
	61.20	#####	61.20	-----	61.74		61.20
Oblique Lateral Rows	125 - 182		124 - 196		132 - 167		125 - 182
	151.34	----	163.07	----	143.33	----	151.34
Lateral Line scales	113 - 150		124 - 139		118 - 142		113 - 150
	124.16	----	127.61	****	124.76	####	124.16
Head Spots	8 - 100		13 - 74		24 - 76		8 - 100
	29.05	#####	27.95		41.12		29.05
Parr Marks	8 - 14		9 - 13		8 - 12		8 - 14
	10.81	#####	10.59		9.68		10.81
Gill Rakers	13 - 21		14 - 20		14 - 20		13 - 21
	16.48	-----	17.10	#####	17.03	-----	16.48

TABLE VII

RANGES AND MEANS OF HEAD AND STANDARD LENGTH RATIOS FOR CUTTHROAT FROM MONTANA WEST OF CONTINENTAL DIVIDE (WM), MONTANA EAST OF CONTINENTAL DIVIDE (EM), AND BRITISH COLUMBIA (BC)

Identity		(ED)	(HW)	(HD)	(PD)	(BDV)	(SL)
Salmo clarki	Range	3.82-5.18	2.05-2.40	5.94-6.90	9.88-10.87	5.36-6.17	4.16-4.87
lewisi (WM)	Mean	4.24	2.26	6.51	10.35	5.85	4.48
Salmo clarki	Range	4.30-4.75	2.27-2.47	6.63-6.98	10.71-11.24	5.90-6.24	4.43-5.10
lewisi (EM)	Mean	4.47	2.36	6.76	10.91	6.07	4.75
Salmo clarki	Range	3.66-6.55	2.07-2.41	6.30-7.05	10.00-14.03	4.14-8.61	3.60-5.42
clarki (BC)	Mean	4.53	2.27	6.63	11.50	6.47	4.45

Identity		(CL)	(ML)	(PL)	(MW)	(IOW)	(INW)
Salmo clarki	Range	2.48-3.04	1.90-1.99	1.30-1.34	1.29-1.48	3.33-3.87	6.70-8.22
lewisi (WM)	Mean	2.74	1.94	1.32	1.38	3.54	7.29
Salmo clarki	Range	2.97-3.24	1.81-2.02	1.29-1.34	1.46-1.49	3.59-3.73	6.67-7.66
lewisi (EM)	Mean	3.13	1.91	1.32	1.47	3.66	7.29
Salmo clarki	Range	2.48-3.35	1.69-2.16	1.20-1.43	1.19-1.89	3.09-4.39	5.50-9.06
clarki (BC)	Mean	2.80	1.89	1.29	1.61	3.77	7.23

Identity		(S-DO)	(S-AO)	(S-AD)
Salmo clarki	Range	1.88-2.02	1.30-1.33	1.16-1.22
lewisi (WM)	Mean	1.94	1.31	1.19
Salmo clarki	Range	1.90-2.06	1.33-1.36	1.20-1.22
lewisi (EM)	Mean	2.02	1.34	1.21
Salmo clarki	Range	1.78-2.12	1.22-1.37	1.13-1.24
clarki (BC)	Mean	1.92	1.31	1.20

Key: ED, Eye diameter; HW, Head width; HD, Head depth; PD, Peduncle depth; BDV, Body depth at vent; SL, Snout length; CL, Chin length; ML, Maxillary length; PL, Preopercle length; MW, Mouth width; IOW, Interorbital width; INW, Internasal width; S-DO, Snout to dorsal origin; S-AO, Snout to anal origin; S-AD, Snout to adipose.

TABLE VIII

T-TEST AND ANALYSIS OF COVARIANCE

XXX indicates distinct significance at .01%
XX indicates distinct significance at .025%
X indicates distinct significance at .05%

*** indicates an almost significant value
--- indicates a nonsignificant value

Measurement	Comparison	T-test	Significance	Covariance
Gill rakers	WM - EM	2.510	XXX	
	WM - BC	2.310	XXX	no test
	EM - BC	.2287	---	
Snout length	WM - EM	.972	---	
	WM - BC	2.067	XX	26.3880
	EM - BC	1.844	X	
Chin length	WM - EM	1.775	X	
	WM - BC	1.975	XX	20.3542
	EM - BC	2.219	XX	
Maxillary length	WM - EM	.039	---	
	WM - BC	2.347	XXX	30.2156
	EM - BC	1.485	***	
Preopercle length	WM - EM	.563	---	
	WM - BC	2.389	XXX	39.6532
	EM - BC	1.824	X	
Head length	WM - EM	.223	---	
	WM - BC	2.317	XXX	62.6873
	EM - BC	1.567	***	
Dorsal fin	WM - EM	.548	---	
	WM - BC	3.619	XXX	no test
	EM - BC	4.101	XXX	
Anal fin	WM - EM	3.718	XXX	
	WM - BC	2.485	XXX	no test
	EM - BC	1.019	---	
Caudal fin	WM - EM	2.966	XXX	
	WM - BC	3.344	XXX	
	EM - BC	1.478	***	

TABLE VIII (Continued)

Measurement	Comparison	T-test	Significance	Covariance
Vertebrae	WM - EM	.957	---	
	WM - BC	1.478	***	no test
	EM - BC	3.457	XXX	
Oblique lateral rows	WM - EM	4.883	XXX	
	WM - BC	3.903	XXX	no test
	EM - BC	6.581	XXX	
Lateral line scales	WM - EM	2.806	XXX	
	WM - BC	.842	---	no test
	EM - BC	1.654	X	
Eye diameter	WM - EM	1.735	X	
	WM - BC	2.006	X	3.3480
	EM - BC	.148	---	
Inter-nasal width	WM - EM	.199	---	
	WM - BC	2.278	XX	39.2906
	EM - BC	1.541	***	

No test because not a measurement.

DISCUSSION

Water temperature has been shown to be one factor influencing the meristic characters of fish (Hubbs, 1922; Gabriel, 1944; Weisel, 1955; Lindsey, 1962). Optimum survival temperature produces low meristic counts (Lindsey, 1962). Colder water temperatures appear to increase fin ray, scale, and vertebral counts. Comparison of the mean annual temperatures for Missoula, Montana, and Prince Rupert, British Columbia, reveals the Missoula mean is lower than that of Prince Rupert. The means are 43.8° and 45.9° F, respectively. Light quality, intensity, and duration also influence meristic characters (Lindsey, 1958; McHugh, 1954). Increased periods of exposure decreases the number of anal fin rays and vertebrae. If the meristic differences between the trout of western Montana and British Columbia are not genetic but environmentally induced by temperature, this suggests that the meristic counts of the western Montana trout should be higher than those of the Prince Rupert area. This assumption is supported in this study by dorsal and caudal fin ray counts and oblique lateral rows but is refuted by the vertebral count.

The mean number of scales in the oblique lateral rows have highly significant differences between the 3 geographic populations. The trout of eastern Montana have the highest mean and those of British Columbia the least. In addition, this count indicates the variability of oblique lateral rows in geographically indigeneous populations. All trout from Weatherwax Creek possess higher oblique lateral row counts than those of

Pilgrim Creek. The mean for fish from Weatherwax Creek was 174.34, whereas those from Pilgrim Creek was 154.64. Both streams are located near White Sulphur Springs, Montana, east of the Continental Divide.

Average means for eye diameter; length of snout, chin, maxillary, preopercle, and head; width of head, internasal, and interorbital show an increasing trend from eastern Montana to British Columbia. The first assumption was that the presence of larger fish in the British Columbia collection was responsible. However, this was negated by analysis of covariance tests.

Standard deviations are large in the cases of oblique lateral scale rows, lengths of preopercle, head, snout to dorsal origin, snout to anal origin, snout to adipose, and standard lengths. The latter has a range of 59.0 - 293.0 mm. which accounts for the large deviation from the mean. This is especially true for small populations which do not fit the normal distribution curve.

Counts of pyloric caeca agree well with the report of Townsend (1944), who reported a mean of 33 which is identical to the mean for the cutthroat of Youngs Creek. The means and ranges found by other workers are given in Table III.

The range of 24 - 76 (41.12) for head spots on cutthroat from British Columbia agrees well with the 26 - 71 range reported by Snyder (1933) for the coastal cutthroat of California. The trout of western Montana possess a range of 8 - 100 (29.05), whereas those of eastern Montana have a range of 13 - 74 (27.95). The trout of western and eastern Montana have means considerably lower than those of British Columbia.

Considerable variations in color were noted. This indicates that a characteristic so variable should not be the primary means of taxonomic separation. All trout in this study possess the dark opercle spots and the typical hyoid slash. These are the best color characteristics for field identification of the western Montana cutthroat from other local trout species. Hybrids possess varying shades of hyoid color (Hartman, 1956) and, if present, is not well developed on rainbow trout.

The fish of western Montana have a significantly lower gill raker count than those from the other 2 geographic areas. The trout of British Columbia and eastern Montana appear closely related by this count.

The presence or absence of basibranchial teeth is not a reliable character. These teeth are deciduous, hard to detect, and not present in all cutthroat. Except in considering large series, this character should be disregarded as distinctive and certainly is not a good field character.

All 3 geographic populations appear to be closely related. There are only small mean differences in the following characteristics: number of vertebrae, lateral line counts, head and peduncle depths, body depth at vent; width of head, mouth, and interorbital; length of snout to anal origin, snout to dorsal origin, snout to adipose, and standard. T-tests and analysis of covariance tests verified no distinct differences in these means.

There are 15 mean similarities detected by small mean differences between the trout of eastern Montana and those of western Montana. Other similarities are more numerous spots posteriorly below the lateral line and the number of head spots (Table VII).

Maxillary and head lengths, anal and caudal fin ray counts, and eye diameter show mean relationships between the trout of eastern Montana and British Columbia. The only similarity observed between the cutthroat of western Montana and British Columbia is the number of lateral line scales.

A number of the apparent mean similarities are substantiated by t-tests. The cutthroat of western Montana are statistically similar to the cutthroat of eastern Montana in 7 characters, whereas those of western Montana and British Columbia and those of eastern Montana and British Columbia are statistically similar in only 1 instance.

The cutthroat of western Montana, geographically intermediate to the coastal cutthroat and the cutthroat east of the Continental Divide, are intermediate in length of snout, chin, maxillary, preopercle, and head; oblique lateral scale rows; and number of head spots. However, statistical analysis indicates a greater relationship of the western Montana cutthroat to *S. c. lewisi* from east of the Continental Divide in Montana, and is considered to be that sub-species.

SUMMARY

Two hundred and forty-one cutthroat trout were collected from the following 11 streams: Pattee Canyon Creek, Miller Creek, Marshall Creek, Dirty Ike Creek, Youngs Creek, Landers Fork of the Blackfoot, and Tin Cup Creek all in Montana west of the Continental Divide. Those from Montana east of the Continental Divide came from Weatherwax Creek, Pilgrim Creek, and the Bozeman area. Coastal cutthroat came from the Prince Rupert area of British Columbia.

Twenty-seven measurements and counts were made and their means tested for significant differences by t-tests and analysis of covariance tests in 3 combinations, western and eastern Montana, western Montana and British Columbia, and eastern Montana and British Columbia. Three levels of significance were accepted, .05, .025, and .01, with the latter the level of highest significance. Many of the ranges overlap but distinct mean differences appeared in 14 instances. A comparison of population means was made and verified statistically for 10 characters.

No distinct morphological characteristics were observed in collections from the 7 different streams of western Montana, although some of these are widely separated.

The cutthroat of western Montana are distinct from those of eastern Montana in 7 characters (number of gill rakers, anal rays, and caudal fin rays; counts of oblique lateral row scales and lateral line scales; chin length and eye diameter). All differences are significant

at .01 except chin length and eye diameter which are significant at .05. The remaining 7 characters indicate a relationship between these 2 cutthroat populations. These characters are length of snout, maxillary, preopercle, and head; counts of dorsal fin rays and vertebrae; and internasal width. Also, spotting posteriorly below the lateral line of the western Montana cutthroat resembles that of the eastern Montana cutthroat.

The cutthroat of western Montana are distinct from those of British Columbia in 12 characters. These are the number of gill rakers; length of snout, chin, maxillary, preopercle, and head; counts of dorsal, anal, and caudal fin rays, oblique lateral scale rows, eye diameter, and inter-nasal width. Those differences significant at .01 are length of maxillary, preopercle, and head; counts of dorsal, anal, and caudal fin rays, and oblique lateral scale rows. Those significant at .025 are the number of gill rakers, length of chin and snout, and internasal width. Eye diameter is significant at .05. The difference in vertebral counts was sufficient to nearly attain the .05 level of significance. Only 1 similarity, the lateral line scale count, appears between the cutthroat of western Montana and British Columbia.

The fish of eastern Montana and British Columbia possess distinct differences in 7 characters (length of snout, chin, and preopercle; counts of dorsal fin rays, vertebrae, oblique lateral rows, and lateral line scales). Those differences significant at .01 are counts of dorsal fin rays, vertebrae and oblique lateral scale rows. Those significant at .05 are the length of snout and preopercle, and lateral line scales. Chin length is significant at .025. The characters of maxillary and head length, caudal fin rays, and internasal width possess mean differences approaching..05. There are 3 similarities between the cutthroat of eastern Montana and British Columbia. These are gill raker and anal fin ray counts, and eye diameter.

Inasmuch as cutthroat trout from western Montana exhibit only slight differences from those of eastern Montana and greater differences with those of coastal British Columbia, they should be considered to be *Salmo clarki lewisi* rather than *S. c. clarki*.

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APPENDIX

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For statistical analysis the total sample of 241 fish was taken as a complete unit and the fish from each stream as sub-units. The streams were then combined into the three geographic populations of western Montana, eastern Montana, and British Columbia for the t-test and the analysis of covariance. In these two cases the hypothesis was that the means were equal and the hypothesis rejected if the mean differences proved significant. The distinct differences are those in which the means were not statistically similar and the similarities are those for which the hypothesis was accepted.

The t-test is utilized in this study to determine if the mean differences were significant. Results revealed that some observed differences were significant so an analysis of covariance test was completed to determine if the standard length was responsible for this difference.

F values in the analysis of covariance test are significant if the value is above 3.0. These values are significant at .05 per cent. If the first or second values were significant the remaining values are neglected; but if both the first and second values are not significant, the third value is always significant, and identifies the mean difference as dependent upon standard length.

The first F value if significant indicates the two lines of standard length and the measurement involved do not possess the same slope and the lines for the three populations are not parallel. Insignificant values at this point merely indicate similarity of slope.

The second F value if significant indicates the lines are not identical, whereas insignificant values give no evidence that the lines are not identical.