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## CULTURE OF THE MONTANA GRAYLING

By JAMES A. HENSHALL

*Superintendent U. S. Fisheries Station at Bozeman, Montana*

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# CULTURE OF THE MONTANA GRAYLING.

By JAMES ALEXANDER HENSHALL,  
Superintendent U. S. Fisheries Station at Bozeman, Mont.

## CHARACTERIZATION OF THE SPECIES.

The Montana grayling originally existed only in the tributaries of the Missouri River above Great Falls, and was first noticed by Lewis and Clark, during their remarkable journey to the Pacific coast. They described it from fish taken near the headwaters of the Jefferson River, but did not name it, alluding to it as a new kind of white or silvery trout. It was rediscovered by James W. Milner, of the U. S. Fish Commission, in 1872, in a tributary of the Missouri near Camp Baker, Montana. He described it, and named it *Thymallus montanus*. At first it was said to be a variety of the Michigan grayling, but it is now given specific rank. In its affinities it is really more nearly related to the Arctic grayling (*T. signifer*), as may be seen from the following characterizations:

## SPECIFIC CHARACTERS OF THE GRAYLINGS.

Species.	Head in length.	Depth in length.	Eye in head.	Maxillary in head.	Scales.	Gill rakers.	Dorsal rays.	Height of dorsal fin in length.	Spots on body.
<i>T. signifer</i> .....	5 $\frac{1}{2}$	4 $\frac{1}{2}$	3	2 $\frac{1}{2}$	8-88 to 90-11	12 below angle	20-24	3 $\frac{1}{2}$	Anterior.
<i>T. tricolor</i> .....	5 $\frac{1}{2}$	5 $\frac{1}{2}$	4	2 $\frac{1}{2}$	93-98	7+12	21-22	5 $\frac{1}{2}$	Posterior.
<i>T. montanus</i> .....	5	4 $\frac{1}{2}$	3 $\frac{1}{2}$	2 $\frac{1}{2}$	8-82 to 85-10	5+12	18-21	4 $\frac{1}{2}$	Anterior.

a To orbit.

*Description.*—From the examination of a large series of fresh specimens the following detailed description of the Montana grayling may be given:

Head moderate, subconic, its length contained 5 times in length of body, curving regularly from snout to dorsal line, and continuous with it. Mouth moderate, oblique, terminal, the maxillary extending to the anterior border of the eye, its length 3 times in head; jaws equal. Eye large, 3 $\frac{1}{2}$  in head, nearly equal to interorbital space, and longer than snout, the pupil pyriform or pear-shaped, with the apex anterior. Teeth feeble, sparse, and uniform in size; on jaws,

vomer, and palatines; none on tongue. Gill rakers 5+12. Scales moderate, 82 to 85 along lateral line, with 8 rows above and 10 rows below; lateral line nearly straight, curving upward slightly toward the head. Dorsal fin long and high, the height greater than depth of body; 18 to 21 rays. Caudal fin strongly forked. Coloration: Back bluish-gray with purplish reflections; sides and gill-covers lighter, with purple and silvery reflections, beautifully iridescent; scales with a pearly luster; belly pure white; a few V-shaped black spots between the head and middle of dorsal fin, but none posteriorly; two oblong, bluish black blotches in cleft between opercle and branchiostegals, more pronounced in the male; a line on upper border of belly from ventral to pectoral fins, dark and heavy in the male, very faint in female. Dorsal fin edged with a red or rosy border; four to seven vertical rows of red or rosy roundish spots, ocellated with white between the dorsal rays; dark blotches forming lines between the rows of red spots. Ventral fins with three rose-colored, branching stripes along the rays, darker between. Pectoral and anal fins plain, with dark border.

*Origin.*—It is very probable that the Arctic grayling was the parent stock from which the Michigan and Montana graylings descended; and from the fact that the habitats of the three species are so widely separated, it is not unreasonable to suppose that the Michigan and Montana forms were conveyed thence from the Arctic regions during the Glacial period. This theory is strengthened by the fact that Elk Lake, a half mile from the Montana grayling station, is abundantly inhabited by both grayling and the lake trout (*Cristivomer namaycush*), which latter fish is found nowhere else west of Lake Michigan.

*Game and food qualities.*—The Montana grayling is a most graceful and beautiful fish, whose dainty and lovely proportions and exquisite coloration must be viewed fresh from its native waters to be appreciated properly. As a food fish it is fully as good as the trout, and to my taste better. Its flesh is firm and flaky, very white, and of a delicate flavor, as might be expected. As a game fish it is the equal of its congener, the red-throat trout, and when hooked breaks water repeatedly in its efforts to escape, which the trout seldom does. It takes the artificial fly eagerly, and if missed at the first cast will rise again and again from the depths of the pool, whereas the trout will seldom rise the second time to the same fly without a rest.

*Habits.*—The Montana grayling prefers swift, clear streams of pure water, with gravelly or sandy bottom. It is quite gregarious, lying in schools in the deeper pools, in plain sight, and not, like the trout, concealed under bushes or overhanging banks. In search of food, which consists principally of insects and their larvæ, it occasionally

extends its range to streams strewn. The fry subsists on minute crustacea; seizing the minute organisms is its fry, with two sharp, retrorse teeth in

Unlike the Rocky Mountain trout salmon, the grayling will go long distance spawning grounds. The auxiliary of Fisheries is on Elk Creek, one of the head of the Jefferson River. A season many grayling go up the Jefferson Red Rock rivers, to Red Rock Lake, 1 lake to the inlets at its head. After a lake to the streams below, none stop able, being shallow and with an alk Elk Creek is fairly alive with gray where their large and beautiful dorsal so many banners, clear of the water, a flood tide. In the North Fork of water is comparatively warm, come Yellowstone Park, the grayling spawn waters of Montana.

#### METHOD OF ARTIFICIAL

*Stripping and incubation.*—One fish eggs, which are about one-seventh of from 750 to 850 in number to a fluid fish lie loose in the abdominal cavity is quite as easily stripped—the eggs 1 but afterward flowing freely. They ess, and fully 95 per cent are fecund washing than trout eggs, to free them otherwise would cause them to bunch

When first extruded the eggs are of the presence of a large oil drop, which buoyant; but after a few days of incubation glass color, and as clear as crystal. eyed in hatching jars with a good protection from bunching and fungus. flat trays, touching each other, and water, they adhere in bunches, fungus entailed in picking, ending in a great spots show the eggs may be placed on being then much heavier and not light becomes very active before the eyes about a week or ten days at a temper

longue. Gill rakers 5+12. Scales line, with 8 rows above and 10 rows below, curving upward slightly toward the head, the height greater than depth. Dorsal fin strongly forked. Coloration: silvery reflections; sides and gill-covers iridescent; belly pure white; a few V-shaped black spots on dorsal fin, but none posteriorly; dark blotches in cleft between opercle and head in the male; a line on upper border of dorsal fins, dark and heavy in the male, anal fins edged with a red or rosy border; red or rosy roundish spots, ocellated rays; dark blotches forming lines on the sides. Ventral fins with three rose-colored, darker between. Pectoral and anal

that the Arctic grayling was the parent of the Montana graylings descended; the habitats of the three species are so different that it is reasonable to suppose that the Michigan grayling descended thence from the Arctic regions. This theory is strengthened by the fact that the Montana grayling station, is the same as the lake trout (*Cristi*), and the lake trout is found nowhere else west of

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the lake trout prefers swift, clear streams of pure water. It is quite gregarious, lying in large schools, and not, like the trout, hanging about the banks. In search of food, insects and their larvæ, it occasionally

extends its range to streams strewn with bowlders and broken rocks. The fry subsists on minute crustaceans, as Entomostraca, and for catching the minute organisms is furnished, like the lake whitefish fry, with two sharp, retrorse teeth in the upper jaw.

Unlike the Rocky Mountain trout (*Salmo clarkii*), but like the salmon, the grayling will go long distances, if necessary, to find suitable spawning grounds. The auxiliary grayling station of the Bureau of Fisheries is on Elk Creek, one of the feeders of Red Rock Lake, at the head of the Jefferson River. At the beginning of the breeding season many grayling go up the Jefferson, through Beaverhead and Red Rock rivers, to Red Rock Lake, 14 miles in length, and through the lake to the inlets at its head. After spawning they return through the lake to the streams below, none stopping in the lake, as it is unsuitable, being shallow and with an alkali bottom. At spawning time Elk Creek is fairly alive with grayling on the gravelly shallows, where their large and beautiful dorsal fins are to be seen waving like so many banners, clear of the water, in the manner of shark fins on a flood tide. In the North Fork of the Madison River, where the water is comparatively warm, coming from the Firehole River in Yellowstone Park, the grayling spawns a month earlier than in other waters of Montana.

#### METHOD OF ARTIFICIAL PROPAGATION.

*Stripping and incubation.*—One fish produces from 2,000 to 4,000 eggs, which are about one-seventh of an inch in diameter, running from 750 to 850 in number to a fluid ounce. The eggs in the ripe fish lie loose in the abdominal cavity, as in the trout, and the fish is quite as easily stripped—the eggs perhaps a little harder to start, but afterward flowing freely. They are fertilized by the dry process, and fully 95 per cent are fecundated. They require much more washing than trout eggs, to free them of a glutinous substance that otherwise would cause them to bunch.

When first extruded the eggs are of a rich amber color, owing to the presence of a large oil drop, which renders them almost semi-buoyant; but after a few days of incubation they become hyaline or glass color, and as clear as crystal. It is imperative that they be eyed in hatching jars with a good pressure of water, to obviate all danger from bunching and fungus. If they are placed on ordinary flat trays, touching each other, and exposed to a lateral current of water, they adhere in bunches, fungus appears, and much labor is entailed in picking, ending in a great loss of eggs. After the eye-spots show the eggs may be placed on the ordinary hatching tray, being then much heavier and not likely to float off. The embryo becomes very active before the eye-spot appears, which occurs in about a week or ten days at a temperature of 50° F. Incubation

is then complete within two weeks. If the water is much colder the period will be several days longer.

The fry is hatched with a very small yolk sac, smaller than the egg, and this sac is absorbed in a week or ten days, the fry then becoming a free swimming animal about half an inch long, quite slender and delicate, resembling somewhat the fry of whitefish or shad.

*Transportation of eggs.*—The usual method of packing and shipping salmon and trout eggs will not answer for grayling eggs. They will not bear crowding or pressure, and must be kept at a very low temperature. The period of incubation being so brief, there is a possibility of their hatching in transit if they are several days en route and the temperature rises above 42°. This was demonstrated the first season at the Bozeman station, when the eggs were shipped in ordinary trout-egg cases, and even with the precaution of packing ice with the moss about the stack of egg trays. Before the next season I devised the refrigerator case, with double wall, by means of which the temperature can be kept at 40° or below for any length of time if properly re-iced, and the eggs will reach their destination in excellent condition.

For the better aeration of the eggs was devised also a special egg tray but one-half inch in depth, with cheese-cloth bottom. No moss is placed over the eggs on the tray, for, as before stated, they will not bear any pressure, and a piece of mosquito netting is all that is required to keep them in position. A space of 2½ to 3 inches is left between the inner wall of the refrigerator case and the stack of egg trays, and this, as well as the hopper on top of the trays, should be kept constantly filled with ice. The hopper has perpendicular sides instead of the flaring sides usual in trout-egg cases, to facilitate re-icing of the space surrounding the stack of trays during transportation. The frames of the egg trays are 1 inch wide, so that when placed in a stack they form a wall 1 inch thick to separate the eggs from the ice, and there is no possible danger of freezing the eggs; this was demonstrated by experiment. For grayling egg-case labels the precaution "Do not expose to freezing temperature" is always erased, as unnecessary, and moreover, useless when considered in connection with the notice to express messengers to re-ice en route and to keep as cold as possible.

*Feeding the fry.*—If stream water containing the minute crustaceans that furnish suitable food for the fry, as most streams do, can be supplied to the fry in the hatchery from the first, no artificial feeding will be necessary for a month or six weeks. If, however, only spring water can be had, great care must be exercised and the ingenuity and intelligence of the fish-culturist brought into requisition to discover the best means of feeding. It was found that fresh blood supplied

before the yolk sac is entirely absorbed. Liver emulsion rendered as fluid as possible, ordinary muslin, will serve to tide the fry until they are a month or six weeks old, same as trout fry; but during the first six weeks closely and fed much more frequently than can be procured and stirred until it becomes free from clots, it can advantageously be mixed with the strained liver emulsion. Small size of the grayling fry, artificial feedstuffs quite a problem. At the Bozeman reared to maturity in the manner mentioned 70 per cent; and the mature fish have been hatched and fry planted. This has been done only a portion of the females yielded good fry not in good breeding condition, possibly from food and from being kept in spring water.

The fry should be transferred to shallow, a good current of stream water, of a high temperature, if possible—say from 55° to 60°. The natural food as soon as placed in the pond, and industrious. If the water is found to contain their natural food, which can be determined by the microscope, they will do well. In order to feed the fry at least six times a day for they may begin to eat each other, being subject to this tendency it is, moreover, advisable to feed as many fry as it is desired to rear.

*Output of the government grayling hatcheries.* A statistical résumé of the results of grayling hatcheries in the last decade.

OUTPUT OF GRAYLING FROM THE U. S. FISHERIES  
1898-1907.

Year.	Eggs collected
1898.....	2,593.20
1899.....	5,745.00
1900.....	3,687.00
1901.....	2,400.00
1902.....	4,463.00
1903.....	3,045.00
1904.....	3,247.80
1905.....	1,010.00
1906.....	1,650.00
1907.....	2,370.00
Total.....	30,114.00

## MONTANA GRAYLING.

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Water containing the minute crustaceans for the fry, as most streams do, can be secured from the first, no artificial feeding is necessary for six weeks. If, however, only spring water must be exercised and the ingenuity and skill brought into requisition to discover it was found that fresh blood supplied

before the yolk sac is entirely absorbed answers a good purpose. Liver emulsion rendered as fluid as possible, and then strained through ordinary muslin, will serve to tide the fry over the precarious stage until they are a month or six weeks old, when they can be fed the same as trout fry; but during the first stages they must be watched closely and fed much more frequently than trout fry. If fresh blood can be procured and stirred until it becomes a homogeneous fluid, free from clots, it can advantageously be supplied either straight or mixed with the strained liver emulsion. But, owing to the very small size of the grayling fry, artificial feeding is under all circumstances quite a problem. At the Bozeman station they have been reared to maturity in the manner mentioned with a loss of from 50 to 70 per cent; and the mature fish have been stripped and the eggs hatched and fry planted. This has been done several seasons, though only a portion of the females yielded good eggs and many males were not in good breeding condition, possibly from a lack of their natural food and from being kept in spring water.

The fry should be transferred to shallow, sunny nursery ponds with a good current of stream water, of a higher temperature than spring water, if possible—say from 55° to 60°. They begin to forage for their natural food as soon as placed in the pond, and are exceedingly active and industrious. If the water is found to contain an abundance of their natural food, which can be determined by examination with the microscope, they will do well. In addition, however, it is well to feed the fry at least six times a day for several weeks; otherwise they may begin to eat each other, being very cannibalistic. Owing to this tendency it is, moreover, advisable to begin with two or three times as many fry as it is desired to rear.

*Output of the government grayling hatchery.*—The following table is a statistical résumé of the results of grayling propagation by the U. S. Bureau of Fisheries in the last decade.

OUTPUT OF GRAYLING FROM THE U. S. FISHERIES STATION AT BOZEMAN, MONT., 1898-1907.

Year.	Eggs collected.	Eggs shipped to other stations.	Fry and fingerlings distributed.	Adults and yearlings distributed.
1898.....	2,593,200	115,000	1,500,000	.....
1899.....	5,735,000	380,000	4,567,000	.....
1900.....	3,687,000	814,000	2,449,718	10,000
1901.....	2,490,000	390,000	1,453,461	11,721
1902.....	1,453,000	1,455,000	1,130,333	18,000
1903.....	3,045,000	645,000	974,114	368
1904.....	3,247,800	494,000	2,692,200	237
1905.....	1,010,000	400,000	400,000	.....
1906.....	1,650,000	642,000	800,000	70
1907.....	2,370,000	250,000	1,376,200	.....
Total.....	30,114,000	5,585,000	17,343,026	40,381

Mt Holmes is 9 mi E of Park boundary

From: Map To Accompany "A Reconnaissance of the Streams and Lakes of Yellowstone National Park" by David S. Jordan, 1889 (topography taken from map published in 1886 by U. S. Geological Survey)

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