

XXX.—NOTES ON THE GRAYLING OF NORTH AMERICA.

BY JAMES W. MILNER.

The grayling has recently attracted a great deal of attention in the United States. The discovery, in accessible localities, of a fish of great beauty and fine game qualities, that hitherto was regarded as peculiar to the Arctic rivers of British America and to the Old World, gave it at once great prominence in the estimation of fish-culturists and anglers. These qualities are to be regarded as its special claim to attention rather than any likelihood that it is to become an extensive food-resource. As the latter purpose has been the only one so far recognized by the United States Commission, the propagation of this species is not likely to receive its attention. Yet, in view of the fact that the sport of angling is so generally popular, and that the presence of the game-fishes in the streams and rivers of a region are appreciated as no minor attraction, the possession of this beautiful fish is of sufficient consequence to deserve consideration under the State appropriations.*

A species inhabiting the headwaters of the Missouri River was observed in 1860 by Surgeon J. F. Head, U. S. A. In his correspondence, he called the attention of other naturalists to the fact, and asserted the tributaries of the Missouri west of Fort Benton to be its habitat. Specimens have since been obtained from Willow Creek and the Gallatin Fork of the Missouri by the United States Geological Survey,† and, through application made by Surgeon J. F. Head, others have been obtained from George Scott Oldmixon, acting assistant surgeon U. S. A., from the vicinity of Camp Baker, Mont., and from Dr. Charles A. Hart, acting assistant surgeon U. S. A., stationed at Fort Shaw, Mont., from the Sun River, tributary of the Missouri. A writer to Forest and Stream has found them plentiful in a tributary of the Yellowstone River near the Orow Indian agency.

In the particular of its being found in restricted, isolated areas, its habits resemble what is said to characterize *Thymallus vulgaris* of Eng-

* Fred Mather has advanced the argument, in "Forest and Stream," from the fact that they do not eat each other, that "cannibalism" does not prevail among them, they are likely to prove superior to the trout in their ability to produce a large stock of fishes.

† Preliminary Report of the Geological Survey of Montana and Portions of the Adjacent Territories, being a fourth annual report of progress, by F. V. Hayden, United States geologist, 1871, p. 469.

land. The grayling of Central Europe seems to have a more general distribution.

A species of this genus, on the continent of North America, was first noticed by Sir John Richardson, in the narrative* of Sir John Franklin's first journey to the Arctic Regions, where it was described and figured as *Coregonus signifer*, or Back's grayling. In his *Fauna Boreali-Americana*, 1836, is a colored plate of this species, under the name of *Thymallus signifer* Richardson. In both these works, another species is also described, the lesser grayling; in the former work under the genus *Coregonus*, in the latter as *Thymallus thymalloides*. In the *Fauna Boreali-Americana*, he suggests that it may be the young of *T. signifer*.

Richardson says that the range of Back's grayling is north of parallel 62°, and between the Welcome and Mackenzie Rivers, tributaries of the Arctic Sea.

A specimen of a grayling was in the possession of Valenciennes about 1847 or 1848, supposed to have come from Lake Ontario, which he named *Thymalus ontariensis*. As there is no subsequent record of its coming into the hands of any naturalist from the waters of the region, it has been thought probable that the locality affixed to the specimen was erroneous. Letters to Forest and Stream from correspondents have asserted the existence of a grayling in the waters of Canada in a stream near Quebec, where it had the local name of "spearing," and in the Northeastern United States near Derby Line, Vt., and in a stream at the headwaters of the Penobscot River in Maine. It has also been claimed, with but little evidence advanced, to inhabit a region of Wisconsin, and the vicinity of Pointe aux Pins, Canada, at the head of Saint Mary's River of Lake Superior.

During the winter of 1864 and 1865, Prof. Edward D. Cope, of Philadelphia, examined a large collection of fishes belonging to educational institutions of the State of Michigan, and, among them, found specimens of a grayling from the waters of the State, which he believed to differ from any species previously described, and gave the name of *Thymallus tricolor*.

In 1871, while visiting the Traverse Bay region of Michigan, in connection with my duties as assistant in the United States Fish Commission, a trip was made to the Jordan River for the purpose of procuring specimens; but, although a good many were seen in the clear, cold waters, they could not be induced to take the hook during the day spent on the river. Arrangements were made for the collection of specimens, and two were soon after sent to me at the Chicago Academy of Sciences. They were lost, with the rest of the collections, in the great fire of that year.

In the winter of 1872-'73, Mr. D. H. Fitzhugh, of Bay City, Michigan,

* Narrative of a Journey to the Shores of the Polar Sea in the years 1819, '20, '21, '22. By John Franklin, Capt. R. N., F. R. S. With an appendix on various subjects, including science and natural history. 4to. London, 1823. p. 711.

sent specimens to Mr. Charles Hallock, of New York, who placed them on exhibition at the restaurant of Mr. John Sutherland. Some of these, Mr. Sutherland transmitted to Professor Agassiz, and the receipt was acknowledged in a letter published in the New York Times. Subsequently, at the request of Mr. Hallock, specimens were sent, by Mr. Fitzhugh, to the National Museum at Washington, where they were received on the 19th of February of 1873.

Mr. Hallock makes reference in his book, the *Fishing Tourist*, and in the first number of his paper,* to the habits of the fish. In subsequent numbers, he published short notes from Mr. Fitzhugh, and in the paper of October 2 appeared a quite full account of its habits and localities from notes received from Mr. Fitzhugh and other correspondents. Since that time, the references to the species have been numerous in different journals.

In September, 1873, while engaged in investigations on Lake Huron, I made a trip with Mr. Fitzhugh to the Ausable River, for the purpose of obtaining specimens of the grayling, a knowledge of its habits, and the facilities for obtaining spawn in the proper season.

The experience of the two days on the river proved them to be free, strong biters, eagerly taking the fly, and with all the gaminess in resisting the effort to take them from the water with a hook, that is the special quality demanded by the anglers. They were decided to be quite equal to the brook-trout on the table; and for grace of form and beauty of color on the body and the great dorsal fin that is the peculiar mark of the genus, they surpassed all of the so-termed game-fishes. One hundred and forty-three were taken with two rods in the portion of two days occupied on the river.

Like that of the brook-trout, their natural food consists of the insects that fall or light upon the surface of the stream. Their stomachs were found to contain broken and partially-digested specimens of *Coleoptera*, *Neuroptera*, as well as the larvæ of species of the dragon-flies. There were also found in their stomachs the leaves of the white cedar, (*Thuja occidentalis*,) which drop continually on the surface of the stream, and are probably taken because the fish in their quick darts to the surface mistake them for insects falling upon the water. It is not at all probable that they select them as food.

The upper tributaries of the Muskegon and Manistee Rivers, the Boardman River and the Jordan River, emptying through Pine Lake, all tributary to Lake Michigan, the Ausable, the Rifle, the Marquette, and the Au Grès, all tributary to Lake Huron, are the streams in which the grayling have thus far been found. The only character that these waters have, differing from adjacent streams, is their exceeding coldness. Of the Jordan and Ausable Rivers only, I can speak from personal observation; but inquiry from those who have visited the portion of the other rivers inhabited by the grayling elicited similar observation of temperature in

* Forest and Stream, August 14, 1873, p. 13.

the waters. In the two rivers referred to, the temperature was nearly as low as the ordinary temperature of the springs of the region; the result probably of the very numerous springs along the banks and in the beds of the rivers. The temperature of the Ausable during the two days we were in the region, late in September, varied from 45° in the morning to 49°·3 in the evening. The Jordan River, visited in August, 1871, though not tested with a thermometer, was observed to be much colder than the waters of Pine Lake and River, into which it flows.

Mr. Fitzhugh says, of the Ausable, "The south branch of the Ausable is fed by a swampy lake at its source, and there are no grayling in it until you get nearly to its mouth, where it receives large springs, and the water becomes pure and cold."

If this low temperature be the controlling influence in the distribution of the species, there will be a considerably more limited area suitable for its propagation than for that of the brook-trout.

The *Thymalli* of Europe are spring-spawners. Heckel and Kner say of *T. vulgaris* of Central Europe* that it spawns at the breaking-up of the ice in spring usually in March, and the young brood come out in June. They, like the trout, excavate a hole in the gravel, in which they deposit the eggs, and according to these authors cover them over with gravel after the male has impregnated them. They are said to grow very rapidly, attaining a mature size in two years.

Siebold says of the grayling of this region† that the spawning-season begins in March and may last over into April. He says that, in spawning fishes, the nervous activity of the skin greatly increases, and the under surface of the scale becomes adherent to the skin throughout its length; probably a similar process to that observed in the California salmon by Livingston Stone during the spawning season, where the scales became imbedded in the epidermal sheathings.‡

Pallas says, of the species of Eastern Siberia and Kamtchatka, that it deposits the spawn about the time the ice is breaking up in the rivers. The Indians informed Sir John Richardson that *T. signifer* spawned in the spring months.

All of the species whose habits have been observed are spring-spawners.

In this particular, the species in the United States are similar.

This apparent anomaly in the habits of the salmon-family is peculiar to the *Salmo hucho* of Europe and the *Thymalli*. It is probably to be considered rather as a habit of late spawning, when compared with that of the other species, than as earlier.

The spawning time of the different-species varies considerably as to

* Die Süßwasserfische der österreichischen Monarchie bearbeitet von Jacob Heckel und Dr. Rudolf Kner, Leipzig, Verlag von Wilhelm Engelmann, 1858. p. 245.

† Die Süßwasserfische von Mittel-Europa, bearbeitet von C. Th. E. v. Siebold, Professor der Zoologie und vergleichenden Anatomie in München. Mit 64 Holzschnitten und 2 farbigen Tafeln. Leipzig, Verlag von Wilhelm Engelmann, 1863. p. 270.

‡ See pages 182, 190, in Mr. Stone's article.

the time of year.* The Sacramento salmon (*Salmo quinnat?*) spawns from July until September and even October; the siscowet of Lake Superior (*Salmo siscowet*) in August and September. This also seems to be the season for the peculiar species (*S. Kennerleyi*) of the Pacific coast; the *S. oguassa*, similar in habit to the charrs of Europe, has a very well defined season, between about October 10 and the middle of November. The salmon-trout (*S. namaycush*) also spawns in October, while the speckled trout (*S. fontinalis*) begins about this time and extends its season in some localities well into the winter. In November, the white-fish of the great lakes spawns; and, in the latter part of the month and in December, the lake-herring (*Argyrosomus clupeiformis*) in the vicinity of Sandusky, Ohio, on Lake Erie, was found to begin emission of spawn late in November, and continue it into December. The brook-trout of the Pacific slope (*S. irideus*) is said to begin spawning after Christmas; the *S. umbla* of Europe spawns in January and February; a species, *S. scouleri*, of the Pacific coast, is found far up the brooks in January, February, and March; the *S. hucho* and the *Thymalli* spawn in March and April. The species of the family not here referred to spawn contemporaneously with some one of those mentioned. As the reduction of the water to a certain condition of coolness seems to have relation to the spawning-season of the larger portion of the species, rather than an increase of temperature, it would seem to be more correct to speak of those spawning in late summer as the earlier spawners, and those in the spring as the later spawners.

The *Thymallus tricolor*, though observed only during one season, evidently spawns in the month of April. A letter from D. H. Fitzhugh, of Bay City, who has been identified so much with the efforts to attain a knowledge of the habits of the species, says that "April is undoubtedly the spawning-season, as Fred Mather and I were there on the 1st of April and found no ripe fish; Seth Green and I reached there May 1, and found all spawned out."

The period between the deposition of the eggs and the hatching in the English species, according to Frank Buckland, is fourteen days. Heckel and Kner state that the eggs are deposited in March and April, and the young fish appear in June; though this statement very likely refers to the time when the young fish first attract attention.

The only experience in grayling-hatching thus far in the United States is that of a few eggs procured by Seth Green from the bed of the Ausable River, and placed under the care of A. S. Collins, in the troughs at Caledonia Springs near Rochester, N. Y.†

* There is evidence with relation to certain species of fishes that the season is earlier in a southern warmer latitude than farther north.

† Mr. Collins, in *Forest and Stream*, publishes notes of his experience as follows: May 5, eggs arrived from Michigan; 8, first egg hatched; all eggs hatched out; 12, first fish began to rise and out; 15, all swimming; the sac lasts about six days; the eggs are nearly as large as trout-eggs, but of less specific gravity; the fry resemble the young of the white-fish, (*Coregonus albus*.)

In the letter quoted previously from D. H. Fitzhugh it is stated: "I do not know any fish-culturists who have grayling except Seth Green and Fred Mather, who obtained them last spring. Mr. Green collected about one hundred eggs in the Ausable early in May, and informs me he hatched nearly all at Caledonia, and that the fry are thriving. George H. Jerome, one of our commissioners, had some on exhibition at the Michigan State fair. I do not know how many are in his possession."

Fred Mather, in a letter to Forest and Stream, quotes the statement from a letter from A. S. Collins, in whose hatching-house at Caledonia the grayling eggs were cared for, that "the young fishes were larger at six months old than the brook-trout at the same age."

This is a like fact with that stated by Heckel and Kner with reference to the grayling of Central Europe, that they grew very rapidly, and attained mature size when two years old.

The average size of the grayling in the Ausable River is not more than ten or eleven inches in length. It rarely attains the length of sixteen inches, and the largest recorded weighed less than two pounds; the average weight is not more than a half-pound.

The Old World species have attracted attention from a very early period; the impression that the fish possessed the odor of thyme suggesting the name of *Θύμαλλος* to the Greeks.*

Linnaeus called the grayling of Europe and Siberia *Salmo thymalus*. Artedi placed it as No. 3 of his genus *Coregonus*. The names *Salmo thymallus* and *Coregonus thymallus* were applied to all species known until Richardson described a species from Northern British America, collected by Lieutenant Back during Sir John Franklin's first Arctic journey, as *Coregonus signifer*; stating that the specific name "standard-bearer" applied to the character of the great dorsal fin. At the same time, a supposed second species was described, which he called *Coregonus thymalloides*, and which, in the *Fauna Boreali-Americana*, published later, he suggests to be the young of *T. signifer*, and, at the same time, changes the generic name to *Thymallus*.

After this, additional names were made, supposed to represent species of the Old World, until the list was increased to the number of ten. Nilsson gave the name of *Thymallus vulgaris* to a grayling found in Norway and in Lapland. Agassiz named the grayling of Central Europe *Thymallus vexillifer*; a *T. thymallus* from Denmark was named by Kroyer; Valenciennes gave the names of *Thymalus gymnothorax* to one from Berlin, Germany; *T. gymnogaster* to one from the Neva near St. Petersburg; *T. Æliana* to one from Lake Geneva; *T. Pallasii* to one from Russia; *T. ontariensis* to one supposed to have come from the vicinity of Lake

* The grayling, in Northern Italy, is still said to have the common name of *Temolo*. In Germany, it has the name of *Aesch*, referring to its gray or ash-colored tint, a derivation similar to that of its English name grayling, which is said to have been first used by Willughby, who published a history of fishes in 1686.

Ontario, North America; *T. Mertensii* described from a drawing of a grayling from Kamtchatka. In 1869, B. N. Dybowsky named a grayling, from Southern Siberia, *T. Grubii*.

Siebold, in his work on the fresh-water fishes of Central Europe, under *Thymallus vulgaris*, includes, *T. vexillifer*, *T. thymallus*, and *T. gymnothorax* of all authors, and, in a foot-note, is inclined to refer *T. gymnogaster* to the same species.

Günther believes that *Thymallus vexillifer*, *T. thymallus*, and *T. gymnothorax* as referred to by all authors are one and the same species with the first-named *T. vulgaris* of Nilsson. *T. ontariensis* and *T. Mertensii* he casts aside as invaluable; the latter probably because it was described from a drawing more or less inaccurate of the species it was intended to represent.

The genus has a wide range in the northern latitudes from Lapland through England and Northern and Central Europe to Italy; throughout Siberia and Kamtchatka; in the northern fresh waters of Alaska and British America; and in at least two localities in the United States, that of a portion of Michigan and some of the upper tributaries of the Missouri River.

A very fine specimen of the grayling from the region where Richardson procured his specimens is in the possession of the National Museum collection, which corresponds quite nearly with his original description.

It measures, in extreme length, seventeen and a half inches; and the dorsal fin exceeds in dimensions everything that has been described or figured, except the original figure* of Richardson's type of the species *T. signifer*, in the appendix to the narrative of Sir John Franklin's first journey to the Arctic Sea.

A comparison of the proportions of the specimen in hand with those which have been compiled from the figure† published in the *Fauna Boreali-Americana* of a specimen from Great Bear Lake affords very close similarity of characters. The most marked variations in the two series of measurements are the greater height of body in the drawing and slightly greater length in the maxillary. The description and figure of Richardson make the number of scales in the lateral line to be 87, while in the Fort Simpson specimen there are 98.

In the description of *T. signifer*, it is stated that there are no teeth upon the tongue, while they are present in the specimen.

In the description, especially in the measurement of the head on its lateral and superior surfaces, and the length of the snout, the differences are much more marked. But these differences are of such extent when com-

* Richardson states that this figure is not correct.

† Richardson says of this figure, "I much regret that that specimen, [alluding to the type specimen of the species obtained from Winter Lake,] having gone to decay, I cannot compare it with the one brought by the last expedition from Great Bear Lake, of which the figure in the present work is an exact representation, drawn on a scale of half the natural size."

pared with a large number of specimens of four species from seven widely-separated localities in North America and Europe, that an error is naturally supposed. To support this suspicion, the figure which is referred to as "an exact representation" does not at all corroborate the proportions given in the description, but does approach the proportions for like measurements in other species of the genus.

To illustrate this statement, the length of the head compared to the length of the fish, excluding the caudal in twenty individuals of different species, showed the different proportions of $19\frac{1}{4}$ hundredths to $22\frac{1}{2}$. Calculated from the measurements given in Richardson's description, the length of head is only $15\frac{1}{2}$ hundredths, while in the figure it is found to be 17. The distance from snout to edge of orbit, compared to the length of head in seventeen specimens, had a range of from 22 hundredths to $26\frac{2}{3}$, while in the description it is $14\frac{1}{2}$ hundredths, and in the drawing 26.

It has seemed to me that these discrepancies invalidate to a great extent the value of the differences between Richardson's specimens as described in his later work and the specimen from Fort Simpson.

The geographical region from which the type of *T. signifer* was obtained, from which the original of the figure and description in *Fauna Boreali-Americana* came, as well as the specimen in the National Museum is the valley of the McKenzie River, from whose tributary waters all were taken.

After consideration of these facts, I have decided to determine the specimen before me to be a true *Thymallus signifer*, notwithstanding the points of difference from Richardson's description, before referred to, in the number of scales in the lateral line, and the presence or absence of teeth upon the tongue.

Three specimens are in the collection from the Yukon River of Alaska, which arrived in too bad condition to be of value. The heads afford some characters for comparison, and, in all particulars, correspond well with *T. signifer*.

The width of the head and of the operculum in two specimens of a grayling from Alaska—skins—labeled "St. Michael's, Norton Sound, H. M. Bannister"—but which, it is believed, were brought to that point from some stream at a distance—does not resemble *T. signifer*.

These have greater width in the interorbital area, and a much greater length in the operculum than in the other specimens from the far north as well as south; the proportions of these measurements to the length of the head exceeding the maximum in all of the other graylings examined, except in the first-mentioned character in one specimen of the Michigan species. In other particulars they correspond.

The bones of the head in the northern specimens are heavier and more compact. A foramen situated in the frontal suture in the graylings from Michigan and Montana was not found in the northern specimens.

The length of the maxillary is greater in the southern forms, and the distances from snout to dorsal and anal fins are greater.

The northern specimens differ from *T. tricolor* in having a maxillary of less length and less distance from the snout to the insertions of the dorsal and the ventrals, and smaller diameter of orbit. Teeth are present on the tongue.

Specimens of the Montana grayling, sent from tributaries of the Missouri by George Scott Oldmixon, acting assistant surgeon U. S. A., and by Professor Hayden, to the National Museum collection, have greater height of body than in the Michigan species. Of the latter, out of seven specimens measured, the maximum height was $22\frac{1}{2}$ hundredths of the length, the minimum being .20; the mean height was .21. Out of six good specimens of the former, the maximum was $.24\frac{1}{2}$ of the length, and the minimum was $.23\frac{1}{2}$, which was more than the greatest height found in the eastern specimens. This character was confirmed in the evident slenderness of all the individuals in a collection of seventy-five specimens from Ausable River, Michigan.

A comparison of measurements of least height of tail also evinced similar differences. The maximum in the six Montana specimens was 9 hundredths of the length, and the minimum was $.08\frac{1}{2}$; the average being $.08\frac{3}{4}$. The average in the seven Ausable specimens was $.07\frac{1}{2}$; the maximum being $.08\frac{1}{2}$, and the minimum only .07.

The width of the head affords another character of similar import. In six specimens examined, the width of the head is much greater than in any of the specimens from Michigan. The maximum shown by the callipers was $.48\frac{1}{2}$ of the length of the head, and the minimum $.45\frac{1}{2}$; while out of seven Michigan specimens, the greatest was $.44\frac{3}{4}$, and the least $.41\frac{3}{4}$. The width of the interorbital areas corresponded with the differences of the thickness of the head.

The maximum and average lengths of the maxillary and the mandible, and also of the distance from tip of snout to orbit, are greater in the Michigan species; though individuals from each locality were found in which they formed an equal proportion of the length of the head.

The diameter of orbit is greater in the Michigan fish. The maximum in seven fishes is $.31\frac{1}{4}$ of the length of the head, while the minimum is $.28\frac{3}{4}$. In six Montana specimens, the maximum is $.28\frac{3}{4}$, and the minimum is .24.

In twenty-five or thirty specimens of the Michigan species examined, no matured specimen was found that had the least vestige of a tooth upon the tongue. Three young individuals out of seven or eight were found to have teeth in this position, from one to three very minute ones being found present.

Out of nine specimens from Montana, partly grown and matured, every one had a distinct patch of teeth upon the tongue, from seven to ten in number.

The length of the head from snout to edge of opercle, and from snout
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to edge of occiput, the width of operculum, the distances from snout to the insertion of the fins, excepting the dorsal, the lengths of the bases of the fins, the number of rays, the number of branchiostegals, the number of scales in the lateral line, and the number of transverse rows of scales above and below the lateral line, and the number of caecal appendages, agree quite closely in a comparison of these species.

From a comparison of notes furnished by Assistant Surgeon Oldmixon, made from a fresh specimen in Montana, with my own notes, made on the banks of the Ausable River, from fresh specimens from its waters, the coloration is found to differ somewhat.

Dr. Oldmixon says that the "red spots" upon the dorsal are "encircled by a thin border of bright emerald-green." The presence of green upon the ventrals, and the fact that the caudal is "plain" as to color, are all points of difference in examining the coloration.

These variations of characters found to exist in the graylings of different regions of North America warrant the recognition of three species at least, the descriptions of which are given in the following pages.

The probability of the existence of a grayling in Canada and the Northeastern United States, already referred to, involves the possibility that Valenciennes' *T. ontariensis* may again be found, which will at least be likely to revise the nomenclature of the species.

THYMALLUS Cuvier.

Fusiform. Mouth small, with small, needle-like teeth of uniform size; none on the pterygoid bones. Dorsal fin very largely developed; rays of anterior portion of fin simple; posterior rays bifurcated, and often unusually prolonged. Thoracic region with minute scales; sometimes naked.

THYMALLUS SIGNIFER Richardson.

Coregonus signifer Richardson, Nar. of Jour. to Polar Sea, Franklin, p. 711, pl. 26.

Coregonus thymalloides Rich., *op. cit.*, p. 714, [young.]

Salmo (Thymallus) signifer Rich., Back's grayling, Faun. Bor. Amer., part iii, p. 190, pl. 88.

Salmo (Thymallus) thymalloides Rich., lesser grayling, *op. cit.*, p. 194.

Thymalus signifer Cuv. and Val., vol. xxi, p. 450; Günth. Cat. Fishes, Brit. Mus., vi, p. 202.

Thymalis Pallasii, Dall, Alaska and its Resources, p. 579; Rept. Dept. Agric., [U. S.,] 1870, p.

The greatest height of body is more than the length of the head and much less than the base of the dorsal. The length of the snout is equal to the diameter of the orbit, and less than the interorbital area; the diameter of the orbit is equal to the length of the operculum. The anterior ray of the dorsal fin is in front of a point midway between the pectorals and the ventrals. The last ray of the anal fin is posterior to the insertion of the adipose fin.

The height is $21\frac{1}{4}$ hundredths of the length. The distance from the

snout to the dorsal fin is .31. The distance from the snout to the anal fin is .74. The distance from the snout to the origin of the ventrals is .47. The length* of the caudal peduncle is .16.

The length of the head is $.19\frac{1}{2}$ of the length without caudal; the distance from snout to nape is $.13\frac{1}{2}$ of the same. The width of the head is $.44\frac{1}{2}$ of the length of the head; the width of the interorbital area is $.26\frac{2}{3}$; the length of the maxillary is $.30\frac{2}{3}$; the length of the snout is $.24\frac{1}{2}$; the length of the operculum is $.25\frac{1}{4}$; the diameter of the orbit is .25.

Br., 9; D., 24; A., 3-11; C., 8-18-7; P., 15; V., 10; scales on lateral line, 98; transverse rows of scales above lateral line, 8; below lateral line, 11-4.

The distance from the snout to the dorsal is less than in *T. tricolor* and the adipose fin is more slender. The maxillary is shorter than in *T. tricolor* or *T. montanus*†. The thickness of the head is less than in *T. montanus*, and the mandible is longer.

Teeth are present upon the premaxillaries, maxillaries, vomer, palatines, mandible, pharyngeals, and tongue.

There is a small naked space on the branchial isthmus.

Length, 17.5 inches.

National Museum, No. 3333. Locality, Fort Simpson, British America. Collector, Bernard R. Ross.

The two skins labeled "St. Michael's, Norton Sound, Alaska," differ considerably from the species just described in the greater width of head and interorbital area, and markedly in the width of the operculum. In all other characters, they are apparently similar. Additional specimens are needed to determine its relation to this species.

THYMALLUS TRICOLOR Cope.‡

Thymallus tricolor Cope, Proc. Acad. Nat. Sci. Philadelphia, 1865, p. 80; Günther, Cat. British Museum, vol. 6, p. 201; Cope, Prelim. Rep. U. S. Geol. Surv. Montana and Portions of Adj. Terr., p. 469. §

Body elongate, subcompressed, highest at the anterior portion of dorsal fin. The greatest height of body equal to the length of head. The

* Measured from a point vertical to the last ray of the anal fin.

† Described on page 741.

‡ The prominent characters of *T. vulgaris* are the straight profile of the head; the muzzle is prolonged and flattened, the lower jaw shutting easily within the premaxillaries; the maxillary is short and wide, reaching but little beyond the edge of the eye; the mandible is dilated at its anterior end; the orbital opening is acute forward; the dorsal fin is smaller; the scales are arranged in parallel linear rows; the striae are coarser; on the anterior of the thoracic region between the pectoral fins and for nearly half the distance to the insertion of the ventrals, the skin is naked. The scales in the vicinity of this region are very minute, and increase in size rather rapidly upon the sides and toward the ventral fins; the scales of the lateral line are larger; and the appendages to the ventrals are longer.

§ Popular descriptions have been given in the following journals: Mather, (quoted in editor's article,) Forest and Stream, (N. Y.,) vol. ii, June 4, 1874, p. 265, (with plate;) Mather, (quoted in editor's article,) American Agriculturist, (N. Y.,) vol. xxxiii, p. 333, Sept., 1874, (with plate;) Mather, Live Stock Journal, (Buffalo, N. Y.,) vol. v, p. 214, July, 1874, (with plate.)

length of the snout is about equal to the interorbital area. The diameter of the orbit is greater than the length of the operculum. The origin of the dorsal fin is vertical to a point midway between the insertions of the pectorals and the ventrals. The last ray of the anal fin is opposite to the anterior insertion of the adipose fin.

The greatest height is $.21\frac{1}{2}$ of the length without the caudal; the greatest width of body is .09; the least height of tail is $.07\frac{3}{4}$; the length of the caudal peduncle,* .16; the distance from the snout to the dorsal fin is $.35\frac{1}{2}$; the length of the base of dorsal is .23; the distance from the snout to the anal fin is .76; the distance from snout to ventrals is .51; the length of the median rays of caudal is $.07\frac{1}{4}$; the length of the external rays of the same is .20.

Head $.21\frac{1}{2}$ of the length without caudal; the distance from the snout to the nape is $.15\frac{1}{4}$; the width of the head is $.44\frac{1}{2}$ of the length of the head; the width of the interorbital area is $.24\frac{1}{2}$ of the same; the length of the maxillary is $.33\frac{3}{4}$; the length of the mandible is .51; the length of the snout is .25; the length of the operculum is $.25\frac{1}{2}$; the diameter of the orbit is $.27\frac{3}{4}$.

Br., 9; D., 24; A., 3-11; C., 8-19-7; P., 16; V., 10; scales in lateral line, 92; transverse rows of scales above lateral line, 8; below lateral line 11-4; cæcal appendages, 18.

The height of the body is less than in *T. montanus*; the length of the head is greater than in *T. signifer*; the distance from the snout to the dorsal fin is greater than in *T. montanus* or in *T. signifer*; the furcation of caudal is slightly more; and the adipose fin is larger.

The head is more compressed than in the two species mentioned; the maxillary is longer; and the diameter of orbit is greater.

There are teeth upon the premaxillaries, maxillaries, vomer, palatines, mandibles, and pharyngeals. In mature specimens, no teeth are found upon the tongue; and but rarely from one to three minute teeth are found in this position in young specimens.

The scales have less of the regular linear arrangement than is found in *T. vulgaris* and *T. montanus*.

Color: purplish gray, (in young specimens approaching silvery white on sides and belly;) darkest on back, and verging toward white on belly, with faint tendency to bluish tint. The premaxillary and tip of mandible have a bluish tinge; the same color shows strongly on the white of the inside of the lower jaw. The opercula have bronze-yellow, purplish, and dusky tints. The sides from the opercula to the middle of body have small, black, irregular spots. In young specimens, the spots continue much farther toward the tail.

The pectoral fins are light brown, with a yellowish cast. The outer ray is dark brown; the inner and inferior margin of the fin pale slate.

The ventral fin has the distal half of the outerray black; the proximal portion is lighter; diagonal lines of rose-color extend across the mem-

* Measured from the vertical of the posterior edge of the adipose fin to the caudal.

brane and rays; the first line begins in the middle of the anterior ray and extends diagonally across the membrane and the second ray; the second line has its origin at the proximal end of the first ray, and, extends across membranes and rays, to the outer end of the fourth ray; the third line begins near the body on the fifth ray, and extends along the intervening membrane between the fifth and sixth rays; the fourth line, beginning some distance from the body, upon the membrane between the seventh and eighth rays, extends in a broken line anteriorly, and terminates upon the membrane between the sixth and seventh rays, and upon the seventh ray. The lines sometime have flecks of yellow upon them. The rest of the fin is dusky, the first rays and membranes being darker than the others.

The dorsal along its insertion has a black line; next, one of faint rose-hue; then there is a blackish one; again one of rose-hue; then blackish again; then there is one of rose-hue, beginning at the sixth ray and extending to the middle of the fin, and continuing out as a row of spots in a dark ground; then there is a row of spots of dusky-green tint; then a row of minute spots of rose; then a broad dusky area. The middle portion of the margin of the fin is tipped with rose.

The anal and adipose fins are dusky with a faint bluish cast.

The central rays of caudal are purplish pink; the other rays are dusky brown. The outer margin of the caudal is tipped with lines of colors like a faint spectrum.

A very small naked space is found on the branchial isthmus.

Length, 11.83 inches.

National Museum, No. 11099. Locality, Ausable River, Michigan. Collector, D. H. Fitzhugh, jr.

THYMALLUS MONTANUS, *sp. nov.*

Form much less elongate than in *T. tricolor*. The greatest height of the body is more than the length of the head, and nearly equal to the base of the dorsal. The length of the snout is less than the width of the interorbital area. The diameter of the orbit equals the width of the operculum. The origin of the dorsal fin is anterior to a point midway between the pectorals and the ventrals.

The height is $.23\frac{1}{2}$ of the length without the caudal; the greatest width of the body is $.10\frac{1}{2}$; the least height of tail is $.09$; the length of the caudal peduncle is $.15\frac{1}{2}$; the distance from the snout to the dorsal fin is $.33\frac{1}{2}$; the length of the base of the dorsal is $.25$; the distance from the snout to the anal fin is $.75$; the distance from the snout to the ventrals is $.45\frac{1}{2}$; the length of the median rays of the caudal is $.07$; the length of the external rays is $.16\frac{1}{2}$.

The head is $.21\frac{1}{2}$ of the length without the caudal; the distance from the snout to the nape is $.15\frac{1}{2}$; the width of the head is $.45\frac{1}{2}$ of the length of the head; the width of the interorbital area is $.26\frac{3}{4}$; the length of the maxillary is $.32\frac{3}{4}$; the length of the mandible is $.47\frac{1}{2}$; the length of the

snout is .24 $\frac{3}{4}$; the length of the operculum is .24 $\frac{1}{2}$; the diameter of the orbit is .25 $\frac{3}{4}$.

Br., 9; D., 22; A., 3-11; C., 6-19-7; P., 16; V., 10; scales in lateral line, 95; transverse rows of scales above lateral line, 8; below lateral line, 10-5; caecal appendages, 18.

The height of the body is greater than in the other American species; the length of the head is greater than that of *T. signifer*. The distance from the snout to the dorsal is greater than in the latter species and slightly less than in *T. tricolor*. The falcation of the caudal is less than in *T. tricolor*; the adipose fin is more slender in form; the head is thicker; the length of the maxillary is less, as is also the diameter of the orbit.

Teeth are present on the premaxillaries, maxillaries, vomer, palatines, mandible, and pharyngeals, and a group of seven or eight are found upon the tongue.

The scales to some extent assume the linear arrangement characterizing *T. vulgaris* and not discernible in *T. tricolor*. The scales in the thoracic region are slightly smaller than in the latter species. A small naked space is to be seen on the branchial isthmus.

Length, 11.75 inches.

National Museum, No. 13090. Locality, Camp Baker, tributary of the Missouri River, Montana Territory. Collector, J. Scott Oldmixon, acting assistant surgeon, United States Army.

MATERIAL.

Thymallus vulgaris Nilss.—One specimen, 10 inches long, presented by H. Denny, Leeds, England; two specimens, 12 $\frac{3}{4}$ inches in length, from Rudolph Hessel, Offenbergl, Germany.

Thymallus signifer Rich.—One specimen,—carefully-stuffed skin, in excellent condition,—17 $\frac{1}{2}$ inches long, from B. R. Ross, Hudson Bay Company's factor, Fort Simpson, B. A.; one specimen, 7 $\frac{1}{2}$ inches long, in alcohol, from same locality and collector; three specimens, alcoholic, in bad condition, from Yukon River, Alaska, W. H. Dall; two specimens,—differing slightly from the others,—labeled "St. Michael's(?), Norton Sound, Alaska, H. M. Bannister."

Thymallus tricolor Cope.—Seventy-five specimens from Au Sable River, Michigan, from 6 to 14 inches in length; collected by D. H. Fitzhugh, jr., and James W. Milner.

Thymallus montanus, sp. nov.—Three specimens, collected for Smithsonian Institution, at solicitation of Surgeon J. F. Head, U. S. A., by Acting Assistant Surgeon George Scott Oldmixon, Camp Baker, Montana Territory; three specimens, (arrived in bad condition,) collected by C. A. Hart, acting assistant surgeon United States Army, at the request of Surgeon J. F. Head, from Fort Shaw, Montana Territory; three specimens, collected by Dr. F. V. Hayden, United States geologist, at Willow Creek, headwaters of Missouri River, Montana Territory.