11.—RESULTS OF EXPLORATIONS IN WESTERN CANADA AND THE NORTH-WESTERN UNITED STATES.

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INTRODUCTION.

During August and part of September, 1892, I made a series of collections of fishes between Winnipeg and Vancouver in Canada, and between Umatilla, Oregon, and Poplar, Montana, in the United States. Collections were made at 25 different places distributed as follows: 5 stations in the basin of the Red River of the North, 1 in the basin of Lake Manitoba, 6 in the Saskatchewan basin, 7 in the Columbia basin, 4 in the Fraser basin, and 2 in the Missouri basin. I thus collected material for a comparison of the fish faunas of the streams flowing into Hudson Bay and into the Gulf of Mexico on the Atlantic slope, and into Puget Sound and into the Columbia on the Pacific slope. The conclusions based on my observations are, of course, merely tentative, for many other species will probably be found in the streams examined.

Nineteen stops were made in Canada along a line which runs nearly west from Winnipeg, *i. e.*, along the Canadian Pacific railway. On the Atlantic slope I collected from an elevation of 700 feet at Winnipeg to an elevation of 4,500 feet at Banff, in the Rocky Mountains Park, and on the Pacific slope from an elevation of 4,050 feet at Field to 300 feet at Umatilla on the Columbia system, and from 1,900 feet at Griffin Lake to tide water at Mission in the Fraser system.

The streams on the Atlantic side in Canada belong to one river system, since the Red River and the Saskatchewan are united in Lake Winnipeg and there is a direct communication between the Qu'Appelle River and the Saskatchewan.* I was informed that a similar relation exists between the headwaters of the Saskatchewan and the Milk River, thus connecting the Winnipeg system with the Mississippi system. The connection is said to lie in a marshy meadow to the west of the Cypress Hills; and should this be a fact, the Mississippi, Saskatchewan, and Columbia† would form one gigantic water system similar to that formed by the Orinoco, Amazon, and La Plata, with the difference that the Pacific slope is included in the North American system. The great similarity of the fauna of the Saskatchewan to that of the Missouri lends

* H. Youle Hind, Canadian Red River and Assiniboine and Saskatchewan Expedition (London, 1860), p. 355: "We soon found a pond from which we observed water flowing to the Saskatchewan and the Assiniboine. The pond is fed by a number of springs and small streams, a foot or two broad, issuing from the sand hills at right angles to the valley."

† For a full and interesting account of the connection between the headwaters of Snake River and the Yellowstone, see Evermann, Report of the Commissioner of Fish and Fisheries respecting the establishment of fish-cultural stations in the Rocky Mountain region and Gulf States, p. 22, 1892.

color to the claimed connection between these two systems. The connection between the Missouri and the Columbia has scarcely affected the distribution of fishes.

The region from Winnipeg to Calgary is very much like any section in the United States from the Mississippi to the Rockies. The slope for the most part is imperceptible and the country is level or slightly rolling. A large part is prairie, the rest is covered with low shrubs. The rivers have usually worn a narrow valley below the general surface, and their banks are nearly always quite abrupt and very muddy. From Calgary the ascent is rapid and the streams become mountain torrents.

On the Pacific slope the streams are all swift, and from Field to the Columbia the descent is very rapid. The Columbia is navigable from Golden up, but below Golden there are many rapids. This river makes a long horseshoe bend towards the north, and when the railway strikes it again at Revelstoke the river is 1,000 feet lower and again navigable.

I received much valuable information and many courtesies from Mr. McQueen, inspector of fisheries for Manitoba; from Mr. W. Hill, of Winnipeg; Mr. Amedée E. Forget, of the Canadian Indian department; Capt. Harper, of the Canadian mounted police, and Mr. G. A. Stewart, superintendent of the Rocky Mountains Park of Canada.

Finally, I must acknowledge my indebtedness to Dr. Albert Günther, of the British Museum, at whose suggestion and expense the explorations were undertaken.

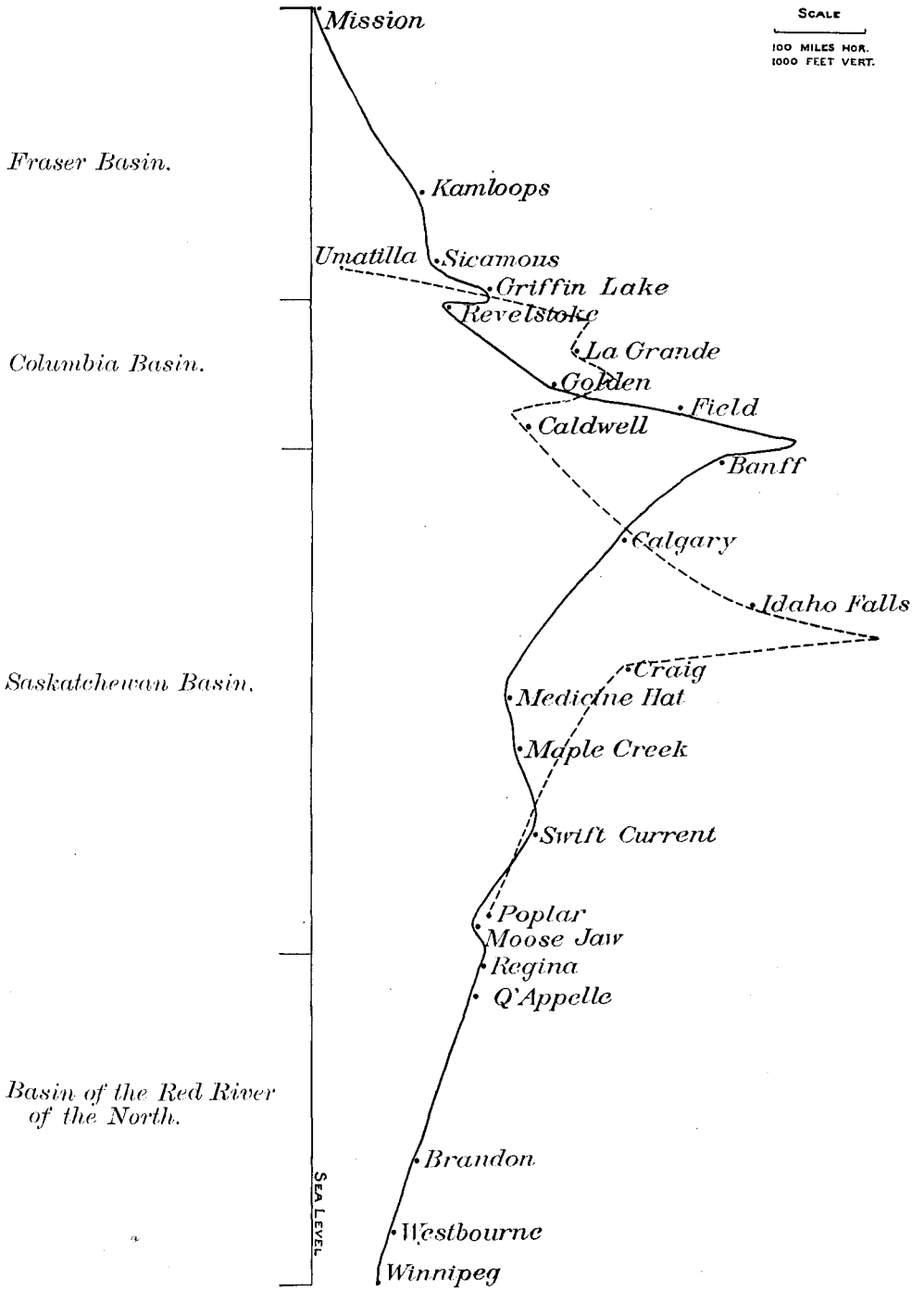
STATIONS WHERE COLLECTIONS WERE MADE.

In the following list I give the names of the places visited by me in their regular succession, the name of the river examined, the system to which it belongs, and, as far as I have been able to determine, the elevation of each locality. All the elevations of Canadian points have been taken from the levels of the Canadian Pacific Railroad. Plate 5 illustrates the relation of these stations to each other.

Station.	Elevation.	Stream.	River system.
Canada, Atlantic slope:			
Winnipeg	700	Red River of the North	
Westbourne	*750	White Mud	Manitoba Lake.
Brandon	1,150	Assiniboine	Red River.
Qu'Appelle	*1,700	Qu'Appelle	Do.
Regina	1,875	Lacawana Creek	Do.
Moose Jaw	1,725	Moose Jaw	Do.
Chaplin		Old Wives Lake	
Swift Current	2,400	Swift Current	Saskatchewan.
Maple Creek	(?) 3,800	Maple Creek	Do.
Medicine Hat	2,150	Saskatchewan	Do.
Calgary	3,388	Bow and Elbow	Do.
Banff	4,500	Bow and Vermillion	Do.
Canada, Pacific slope:			
Field	4,050	Kicking Horse	Columbia.
Golden	2,550	Kicking Horse and Columbia	Do.
Revelstoke	1,475	Columbia	Do.
Griffin Lake	1,900	Griffin Lake	Fraser.
Sicamous	1,300	Shushwap Lake	Do.
Kamloops	1,158	Thompson River	Do.
Mission	1	Fraser	Do.
United States:			
Umatilla	300	Umatilla Creek and Columbia	
La Grande	2,786	Grand Ronde	Columbia.
Caldwell	2,372	Boise	Do.
Idaho Falls	4,712	Snake River	Do.
Craig	†3,438	Missouri	Missouri.
Poplar	†1,960	Poplar River	Do.

* About.

† Elevations furnished by Great Northern Railroad through its general manager, Mr. D. L. Mohler.



RELATIVE LONGITUDINAL AND ALTITUDINAL POSITIONS OF THE POINTS WHERE COLLECTIONS WERE MADE.

The continuous line represents the Canadian points. The river basins to which these points belong are indicated beneath the sea-level line. The broken line connects the United States points. All those west of the highest point belong to the Columbia Basin; all those to the right belong to the Missouri Basin.

DESCRIPTION OF LOCALITIES IN THE ORDER OF EXPLORATION.

CANADA.

The region about Winnipeg is a flat prairie about 25 or 30 feet above the river. The bed and banks of the Red River of the North are muddy in the extreme and full of stumps and snags. In seining, where we did not sink into the mud beyond possibility to work, snags were sure to interfere. An old French fisherman has cleared the snags from a short stretch of bank, and here from morning till night he drags a seine over the same ground, making about 20 hauls during the day. The abundance of fishes is evident from the fact that a number are taken with every haul. The principal species are the gold-eye (*Hiodon*), which is smoked and dried; the various suckers and buffalo; the pickerel (here the species of *Stizostedion* go by this name); the pike (*Lucius*), sturgeon, and catfish. The last are extremely abundant, and are taken in quantity with hand lines.

The White Mud River at Westbourne is tributary to Lake Manitoba. It is a narrow stream, 60 to 80 feet wide, and swift. There are pebbly weed-covered stretches, alternating with deep muddy pools. The country about Westbourne seems to be low and swampy. *Lucius lucius* is reported to ascend in such numbers to spawn that they can be shoveled out.

The Assiniboine at Brandon meanders through a valley about a mile wide. The stream itself is swift and between 200 and 300 feet wide. The current changes with every bend, now approaching one side, now another. The bottom of the stream is gravelly in places, but for the greater part the soft mud is 2 or more feet deep. I did not learn of any fishing here for the market.

In order to reach the Qu'Appelle River it was necessary to ride nearly 20 miles by stage. The road is over a wind-swept prairie, with clumps of low shrubs. At longer or shorter intervals there are shallow depressions which resemble enormous sink holes of limestone countries. Nothing is seen of the Qu'Appelle Valley till one is at its brink, where, about 300 feet below the general level of the prairie, lies the valley of the Qu'Appelle, or "Who Calls" River. The valley is over a mile wide and is flanked by abrupt walls. It is occupied by a series of four lakes having an average depth of about 43 feet. The latter are connected by a swift, clear stream only 15 to 20 yards wide. They abound in fish. *Etheostoma nigrum* flourishes in perfection in the stream connecting the lakes. Two species of whitefish (*Coregonus*) are taken in these lakes, but I was unable to obtain any specimens.

The country about Regina is mostly a level prairie. Lacawana Creek is a small stream about 4 yards wide. Its bed is very muddy, so much so that it was almost impossible to draw a net. The banks are abundantly supplied with various water weeds. Near the town the stream has been dammed to form a reservoir for the city. The bank of the reservoir nearest the city has a strip of chara about 20 feet wide. These chara fields harbored thousands of *Pimephales* and a few *Eucalia*. Below the dam a single haul of the seine secured about a peck or more of *Eucalia*. Only four species were taken at this place. Suckers, and especially pike (*Lucius*), are said to be very abundant during their breeding season or in the early spring.

About Moose Jaw there are rolling hills. Above the town, Moose Jaw Creek flows through a narrow valley or gorge; near the station it joins Thunder Creek, a smaller stream. As is usual along the railroad, the stream is dammed near the station. Below the dam it forms a succession of deep pools and shallow riffles. The conditions seemed favorable for a large variety of fish life, but the number of species obtained was very small. The larger species are more abundant here than the smaller.

Old Wives Lake is alkaline, and as far as I could determine contains no fishes.

Swift Current is an ideal place for variety in fish life. The stream is narrow and on an average about 2 feet deep. It flows over gravel and, as the name implies, has a swift current. It is just such a stream as the darter delights in in more southern latitudes, and in fact one of their number, *Etheostoma iowæ*, is quite abundant here. This is the only darter, however, that I obtained in the waters of the Saskatchewan Basin. The stream is dammed above the railway, and it is just below the dam that the most favorable locality for fishing was found.

At the time I visited Maple Creek it consisted of a succession of slimy pools in a moderately deep channel. There was an almost incessant cold rain that prevented much work, but although 1½ inches of water fell during my stay, no impression whatever was made on the quantity of water in the pools. Maple Creek empties into Big Stick Lake which, in high water, overflows into a tributary of the Saskatchewan.

The Saskatchewan River at Medicine Hat is a navigable stream with a swift current. The water is cold and cloudy. Many of the larger species of fish were reported to me here, although I obtained but few. The river bed is said to be 1,600 feet lower than that at Maple Creek, the descent during the last few miles before reaching the river being considerable. The bed of this river lies in a level valley of varying width. At Medicine Hat the low hills approach almost to the edge of the river.

Calgary lies in the V formed by the junction of the Elbow with the Bow River. Both of the rivers are swift, clear, cold mountain streams, the former being the shallower. Trout, *Salmo* and *Salvelinus*, are abundant. Seining in the Bow River proper was impossible, and it was confined to the sloughs of that river and to the Elbow. The country is hilly and devoid of timber. The Rockies are seen from here.

From Calgary to Banff there is a steady ascent. Banff is located on the Bow River and in the Canadian Rocky Mountains Park.

The valley of the Bow is swampy for several miles above Banff, and the Bow River itself is a quiet deep stream. At Banff it becomes a torrent in which fishing with a net is impossible. The valley is everywhere quite narrow and flanked by high mountains. Vermillion Creek, the outlet of the Vermillion Lakes, which lie in the swamps of the Bow, enters the Bow at Banff, as also does Forty-Mile Creek. These tributaries are clear and icy cold. On the opposite side a small stream of warm water enters from the hot sulphur springs, and a much larger stream, the Spray River, which is, however, too swift for seining. The larger streams all abound in *Salmo mykiss*, *Salvelinus namaycush*, and *Coregonus williamsoni*.

From Banff the ascent is very rapid to the continental divide. The descent on the Pacific side is even more steep. My first station on the Pacific side was at Field, where the mountains rise 10,000 feet above the river. The river bed of the Kicking Horse, at Field, is a broad sandy stretch and the water flows in several channels. The main stream is too swift for seining, but the smaller branches are quieter in many

places. The icy water of the Kicking Horse is milky in appearance and full of a tough clayey substance. But two species of fishes were obtained here, *Coregonus coulteri* and *Cottus philonips*, both new to science.

At the mouth of the Kicking Horse, at Golden, other collections were made. The Columbia River above this place is navigable for small steamers. Below Golden it becomes a narrow torrent. Collections were made in a meadow overflowed by back water from the Columbia, and in the Columbia at the mouth of one of the branches of the Kicking Horse. The valley of the Columbia here slopes up to a range of low pine-clad mountains extending parallel with the stream. Salmon (*Oncorhynchus*) ascend to this point.

At Revelstoke the Columbia is a much larger stream and very swift. To the west a series of high mountains are seen which form the watershed between the Columbia and the Fraser. On the east the ascent is more gradual.

Griffin Lake is the last of a series of small lakes beginning just beyond the divide between the Columbia and the Fraser. It is a very clear lake, shallow near the shores. It is about a mile wide and about 2 miles long. All sticks lying in it are covered with a bright green sponge. Great clusters of the same sponge, a foot high and about the same width, are seen on the bottom in shallow water. Fish life is not abundant. From its banks low mountains rise. The stream flowing from it is swift and full of young *Salmo*. A rudimentary dam has been constructed at its outlet to keep timber from floating down against the railway bridge. As a consequence the lake is full of snags. The outlet of Griffin Lake empties into Eagle River, which in its turn empties into Shushwap Lake.

Sicamous is a station on an arm of Shushwap Lake near the mouth of the Eagle River. Low mountains covered with pines ascend from all the shores of the lake. The water of the lake is much warmer than that of the Eagle River. The bottom is overgrown with water weeds which seem in some places to be 20 feet or more in height. Fish are very abundant and schools of them swim below the surface, frequently a whole school poking their heads up together, like schools of frightened anchovies.

At Kamloops the North Thompson River empties into Thompson River, forming together a stream nearly a mile wide. The current is moderate, and formerly steamboats plied on the river. The margins of the stream are full of waterweeds, through which it is impossible to draw a net. Salmon are taken here by the Shushwap Indians. The valley is skirted by rounded hills which, with the exception of scattered pines, are devoid of trees. The water is much warmer than in the mountain streams, though the exact temperature was not obtained.

Soon after leaving Kamloops the descent again becomes very steep and continues so along the Fraser to Mission, where the river is affected by high tides. The country south of Mission is marshy, a few hills rising on the north. The Fraser is here a slow, broad stream, and salmon and sturgeon abound in it.

UNITED STATES.

The region about Umatilla is a rolling prairie. The banks of the Columbia River are sandy and gravelly. The Umatilla River is small and empties into the Columbia. About its mouth is an estuary with a soft mud bottom and with from 2 to 3 feet depth of water. The mud and some waterweeds usually filled the net so that it was difficult to pick out the fish, especially as it was necessary to collect after dark. The most important discovery of the season was made at this point. *Columbia transmontana* shows in a striking way the modification of the fins of the Pacific slope fishes. In this case it has found expression in the strong spines at the origin of the anal and the dorsal fins.

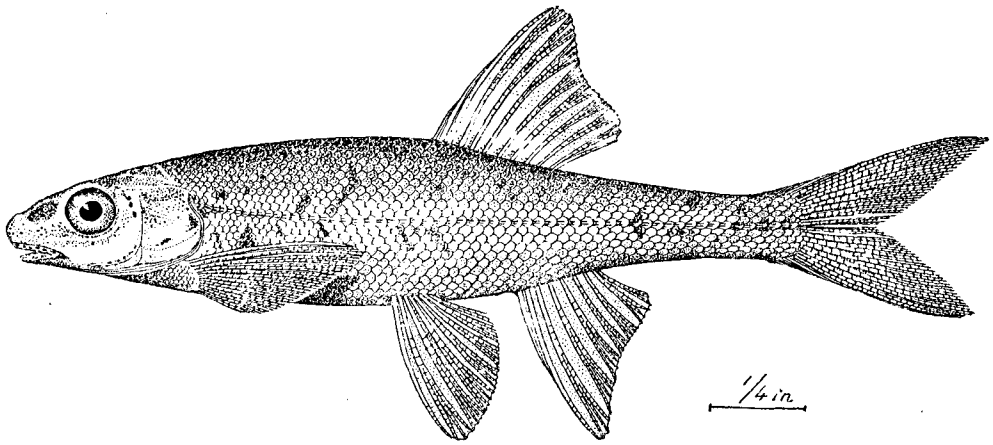
The Grand Ronde River is a tributary of the Snake. At La Grande it is a small stream with a few deep holes. It is dammed near the town for milling purposes, is full of angular pieces of lava, and seining is almost impossible. Below the dam large numbers of *Ammocœtes* were found dead.

About Caldwell the country is a level plateau, treeless except along the river banks. The Boise River, which is a swift stream about 100 feet or less in width, is dammed at various places to divert the water into irrigating ditches. There are level stretches in the river, alternating with swift riffles.

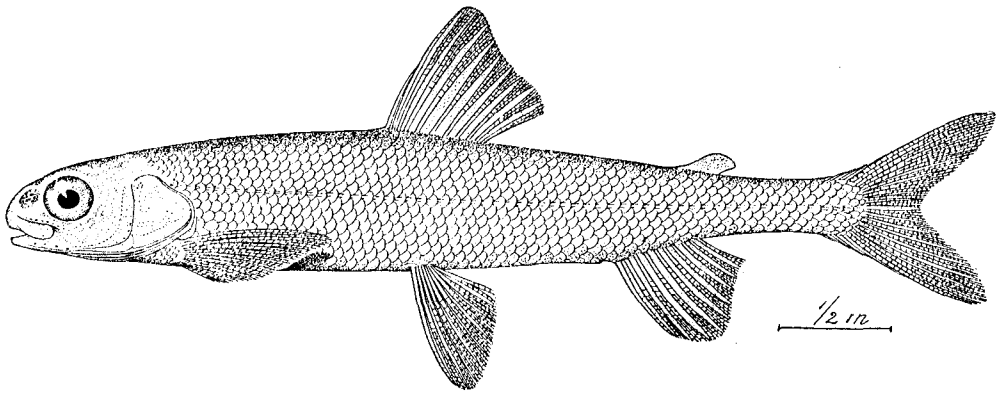
At Idaho Falls the Snake River has worn a narrow gorge through the lava, and is a fierce torrent in which seining was out of the question. Fortunately a small stream has been diverted for a mill, and in this I obtained probably a complete series of the fishes of this region. The country is still a level valley with mountain ranges at a distance on either side.

Soon after leaving Idaho Falls the continental divide is crossed. The first station at which I made collections was Craig, Mont., on the Missouri. This river is here about 150 feet wide, a clear, cold, rapid stream with gravel bottom and full of *Coregonus williamsoni* and *Platygobio gracilis*. Fishing was confined chiefly to the slough formed at the mouth of a small creek entering from the eastern side.

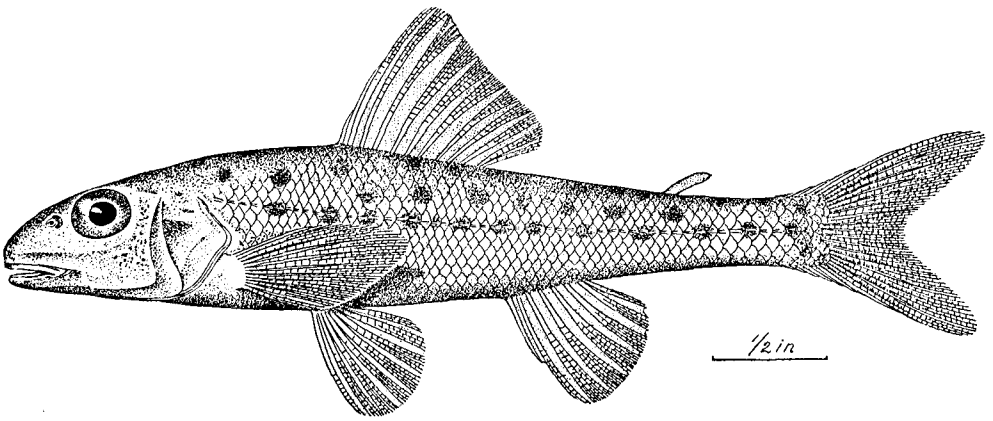
At Poplar the Missouri is a swift, muddy stream, probably 200 yards or more wide. Poplar River is also muddy and partakes of the nature of the prairie streams near Winnipeg; that is, its banks are composed of soft mud. It seemed nowhere over 5 feet deep, and in many places it was only a foot deep.



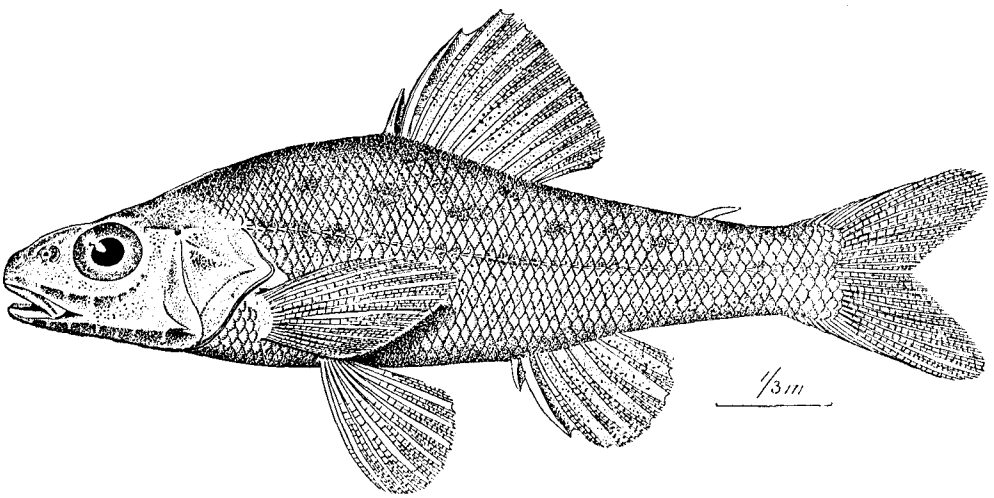
AGOSIA FALCATA Eigenmann & Eigenmann.



COREGONUS COULTERI Eigenmann & Eigenmann.



PERCOPSIS GUTTATUS Agassiz.



COLUMBIA TRANSMONTANA Eigenmann & Eigenmann.

NOTES ON THE FISHES COLLECTED.

1. **Ammocœtes tridentatus** (Gairdner). This species ascends the rivers to spawn. At La Grande the Grand Ronde, a small stream 5 or 6 yards wide, is dammed for milling purposes. Just below the dam a large number of this species were noticed in all stages of decay. Some had evidently died the preceding night. The ovaries of those taken at this place were large, but the eggs were quite small. Whether the "eels" had spawned and died, or whether the specimens were left stranded, I am unable to state. All the specimens were about 600 mm. long. At Caldwell I secured a large number of the young of this species. The largest of these measured 60 mm. In their habits the young very much resemble *Branchiostoma*. They burrow in the sand near the margin of the stream. If they are disturbed they will come out of the sand a few centimeters from the place of disturbance. The small ones were procured by throwing the sand on the banks, whereupon they would squirm out and could be secured.
2. **Acipenser sturio** Linnæus. This species is common at Winnipeg and in the lakes to the north. I procured a single specimen 96 mm. long. It has the upper part of the snout black, a black spot on the sides above the posterior third of pectorals, and another below the dorsal; a narrower dusky band connects these and extends to the tip of the tail.
3. **Noturus flavus** Rafinesque. A number of specimens of this species (150 to 250 mm. long) were obtained with hook and line at night in the Missouri River at Craig, Mont. This seems to be the most western record for any members of the *Siluridæ*. They were reported to me at Medicine Hat, but I did not procure any specimens at that place. Prof. Evermann reports none in his explorations in Montana and Wyoming. It has hitherto been supposed that the members of this family do not ascend to the mountains. None have been found indigenous to the Pacific slope. In the larger specimens the two maxillary barbels reach the base of the pectorals. There is uniformly a white spot on the back just at the base of and behind the last dorsal ray.
4. **Ictalurus punctatus** Rafinesque. Winnipeg. Exceedingly abundant in the Red River, where it is caught in great numbers, especially at night. It frequently reaches a length of about 750 mm. It was reported to me at Brandon, but it can not be abundant at that place, since none were said to have been caught there since 1883. A catfish was also called to my attention at Medicine Hat, but from the description it must be a *Noturus*.
5. **Ictiobus cyprinella** (Cuvier & Valenciennes). Winnipeg. Two specimens, the largest 760 mm. long.
6. **Carpiodes velifer** (Rafinesque). Winnipeg, Brandon, Medicine Hat, Poplar. I can detect no differences between the specimens from Winnipeg and some taken in the Ohio River at Cincinnati.
7. **Pantosteus jordani** Evermann.

   (*Pantosteus columbianus* Eigenmann & Eigenmann, Am. Nat., Feb., 1893.)

   Three specimens, 92 to 100 mm. long, Boise River, Caldwell, Oreg. Very closely related to *P. generosus*, the eye slightly larger, the caudal much longer. Head, $4\frac{2}{3}$–$4\frac{3}{5}$; depth, $4\frac{1}{2}$–5; D. II, $11\frac{1}{2}$–$12\frac{1}{2}$ (in two); A. I, $8\frac{1}{2}$ ($7\frac{1}{2}$ in *generosus*). Scales, 16 to 19–80 to 100–15. Eye, $1\frac{1}{2}$–2 in snout, $1\frac{2}{3}$–$1\frac{2}{3}$ in interorbital, $3\frac{3}{4}$ to little more than 4 in head ($2\frac{1}{2}$; $3\frac{2}{3}$; $4\frac{1}{2}$ in *generosus* of same size). All the fins more pointed than in *generosus*, the caudal lobes considerably longer than the head (shorter than head in *generosus*), $3\frac{2}{3}$–$4\frac{1}{2}$ in the length (5–$5\frac{1}{2}$). Light brown with indistinct clouds of darker.
8. **Catostomus catostomus** (Forster). Winnipeg, Swift Current, Medicine Hat, Calgary, Banff, Golden, and Revelstoke. Ascends streams to spawn. Is said to be very abundant at Winnipeg during the winter. Only a single specimen, the first of the season, was taken during my stay. As will be seen from the above localities, the species extends across the Rockies. A specimen of *catostomus* 290 mm. long, from Golden, on the Columbia River, differs in only a few minor details from a specimen of *Catostomus catostomus* of about the same size, the origin of which is not known. A series of larger specimens will probably show perfect intergradation. In the Golden specimen the eye is more anterior than in the other; and this feature changes all the proportions of the head. The size of the eye is the same in both; $6\frac{1}{2}$ in the length of the head, 2 in the postorbital portion in the Golden specimen ($2\frac{1}{8}$–3 in the other), about $2\frac{3}{4}$ in the snout ($3\frac{1}{4}$); middle of head behind anterior margin of pupil (at anterior

margin of eye); depth of head greater than length of snout plus eye (depth of head less than snout plus eye); scales of breast obscure, imbedded forward (scales of breast regularly imbricated, not imbedded); margins of lower fins all well rounded, all of them shorter than in typical *catostomus* (margins of lower fins all more angular, some of the rays being longer than others). Distance of end of superciliary mucous canal from transverse nuchal canal twice as great as in the typical form. Such differences would be considered of no value for purposes of classification in specimens from the same river system, and indeed I am not able to find any tangible differences between specimens 190 mm. long from the Columbia at Revelstoke and the Bow at Calgary or the Swift Current. The larger specimen has the back and sides quite dark, centers of the scales toward the belly white; belly entirely white. A reddish band along the lateral line. The young from all localities are mottled gray.

9. **Catostomus griseus** (Girard). Swift Current, Medicine Hat, Craig. One specimen, 116 mm. long, was taken at Swift Current. Caudal as long as head, 4⅘ in the length. D. II, 10½. Sides to ventral surface dark-grayish, variously mottled. Lower surfaces, white. A number of specimens were taken at Medicine Hat, the largest 90 mm. long. These smaller specimens can readily be distinguished from *C. catostomus* of the same size by their much larger mouth, which very much resembles that of *Pantosteus*. The jaws are provided with horny or cartilaginous sheaths, making the resemblance to *Pantosteus* still greater.

10. **Catostomus macrocheilus** Girard. Sicamous, Kamloops, Umatilla, La Grande, Caldwell, and Idaho Falls. I saw a species of this genus in Griffin Lake, but was unable to secure it. In all probability it was *C. macrocheilus*, since this species was obtained a few miles farther west, at the mouth of the outlet of this lake. The largest specimen was obtained at La Grande, and measured 380 mm. It is quite dark to below the lateral line, where, from a line from just above the upper lip to the lower part of the caudal, the color abruptly changes to white. The pectorals, ventrals, and part of the anal are dusky, and a dusky bar extends upward from the base of the pectoral. The local variation in dorsal rays is well marked. Aside from the two undivided rays at the beginning of the fin the rays are as follows:

Locality.	Dorsal rays.					
	11½	12½	13½	14½	15½	16½
Sicamous	.....	1	1	3	.....	.....
Kamloops	.....	.....	2	3	.....	.....
Umatilla	.....	.....	4	34	8	1
La Grande	.....	2	2	1	.....	.....
Caldwell	.....	.....	3	3	.....	.....
Idaho Falls	1	3	.....	.....	.....	.....

These last specimens approach *Catostomus ardens*.

11. **Catostomus commersoni** (Lacépède). Winnipeg, Westbourne, Qu'Appelle, Regina, Moose Jaw, Swift Current, Maple Creek, Medicine Hat, Calgary, Poplar. Very abundant everywhere. Scales, 55–69.

12. **Moxostoma aureolum** (Le Sueur). Winnipeg, Westbourne, Brandon, Poplar. Lower fins, and especially the caudal, red. D. 14½ to 16½. Specimens 240 mm., from Winnipeg, have the head 5 in the length.

13. **Moxostoma anisurum** Rafinesque. Winnipeg, Brandon. This species is much less abundant at Winnipeg than the preceding. The specimens measure from 90 to 285 mm. Head, 3½ to 4. D. 16½ or 17½, counting all the rays. A. 8½. Upper caudal lobe little longer than lower in the largest specimen. The largest specimen differs little from one obtained at Toledo, Ohio. Scales, 6-39 to 43-5. Color lighter than in the preceding species, no red on the fins.

14. **Hybognathus placita** Girard. Abundant at Poplar, but not seen elsewhere.

15. **Acrocheilus alutaceus** Agassiz & Pickering. Umatilla, Caldwell.

16. **Pimephales promelas** Rafinesque. Winnipeg, Westbourne, Brandon, Qu'Appelle, Regina, Swift Current, Maple Creek, Medicine Hat. Very abundant everywhere, especially so at Regina and Swift Current; least so at Qu'Appelle.

17 **Notropis jordani** Eigenmann & Eigenmann.

Notropis albeolus E. & E., Am. Nat., Feb., 1893; not *N. albeolus* Jordan=*N. megalops*.

A single specimen, 73 mm. long, obtained at Medicine Hat. This species is most closely related to *N. maculatus* and *N. heterodon*. In color it differs strikingly from the latter, agreeing in this respect with *maculatus*, except that it lacks a caudal spot and is less profusely spotted. The lateral line is much less complete than in *heterolepis*, and better developed than in *maculatus*. Head, 4; depth, 4½; D. 9½; A. 8½; scales, 4-35-4; 15 scales before the dorsal; teeth, 4-4, 1, 2. Two of the teeth feebly hooked, the two others with narrow imperfect grinding surfaces. The teeth on the right side are evidently abnormal, being arranged in three rows. Elongate compressed, more slender than *heterolepis*. Head much as in *heterolepis*, less convex above. Jaws equal; mouth oblique, the premaxillary on the level or lower margin of the pupil. Maxillary extending to anterior margin of orbit. Snout pointed, not decurved. Eye 3¾ in head, 1⅓ in interorbital. Fins all small; origin of the dorsal over ventral, equidistant from base of middle caudal rays and nares, highest ray extending a little past end of the last ray when the fin is depressed, equal to head less snout; anal similar to dorsal, its highest ray equal to snout and eye; ventral equal to highest anal ray; pectorals longer, equal to head less opercle. Scales closely imbricated, the exposed edges little higher than long. Lateral line decurved, the tubes developed on less than 10 scales (some of those of the middle of the body are removed). General color silvery, no distinct markings. Ventral surface entirely white, a plumbeous lateral band overlaid with silvery. A dark vertebral line from occiput to caudal. Sides with a few dark specks, dorsal surface more densely specked, the margins of the scales darker.

18. **Notropis heterolepis** Eigenmann & Eigenmann. A specimen, 35 mm. long, taken at Qu'Appelle. This species is evidently closely related to *N. heterodon*, *N. anogenus*, etc. It differs from them strikingly in having tubes developed in but one or two scales of the lateral line, while all the scales along the lateral line on one side and all but one or two on the other are deeply notched on their posterior margins. Head, 4; depth, 4¼; D. 9½; scales, 5-35-4; 15 scales in front of dorsal. Teeth feeble, 4-4; grinding surface well developed on three teeth. Head subconical, little compressed, the snout rounded, little obtuse; the lower jaw included. Mouth little oblique, the premaxillary below the level of the lower margin of pupil. Maxillary almost reaching eye. Eye large, 1 in snout, 3⅜ in head, 1⅓ in interorbital. Dorsal inserted equidistant from base of upper caudal rays and anterior margin of eye, behind the last ray of the ventrals. Tips of the first rays much projecting beyond tips of last when depressed, the longest ray about equal to head less snout. Anal similar to dorsal, the longest ray about 1⅜ in head; ventrals reaching vent, equal to highest anal ray; pectorals equal to length of head less opercles. Scales loosely imbricated, almost imbedded in front of the dorsal. Scales along the median line (lateral line) with a deep notch near the middle of the posterior margins, the line nearly straight. A few black specks along base of anal; a dark line along lower margin of tail from anal to caudal. A dark band from tip of snout along the sides to the caudal; on the tail the band coincides in position with the scales of the lateral line. On the body it is placed a little higher. A conspicuous black curved line at the base of each scale of the lateral line. All the scales above the lateral band dotted with black. A narrow vertebral line from occiput to dorsal, a broad dusky band on the back between the dorsal and caudal, between which and the lateral band is a lighter band. Scales of the back with dark margins. Series of minute black dots along each ray of the dorsal, anal, and outer portion of pectoral; the dorsal and caudal quite dusky.

19. **Notropis (Minnilus) reticulatus** Eigenmann & Eigenmann.* Brandon, Qu'Appelle. This species is closely related to *N. spectrunculus*, *fretensis*, *nitidus*, and *topeka*, and may prove identical with one or the other. It approaches nearest *N. fretensis* and *topeka*. From the former it differs chiefly in the larger scales in front of the dorsal, and from the latter in the naked breast. Head, 4; depth, 4–4½; D. 9½ or 10½ (I or II, 8½); A. 9½ (II, 7½); scales, 4 or 5-34-3 or 4; 12-14 scales in front of the dorsal; teeth, 4–4, hooked, with evident grinding surface. Head pointed, broad above and slightly convex. Snout decurved, pointed, the lower jaw included. Mouth oblique, the premaxillary on a level with the lower margin of the pupil or somewhat lower.

*A larger series of specimens collected by Mr. A. J. Woolman in the headwaters of the Red River make it probable that this species is *N. deliciosus*.

Maxillary reaching front of orbit. Eye large, considerably longer than snout, 3 in head, greater than interorbital. Origin of dorsal over ventrals, equidistant from tip of snout and from base of upper caudal rays; longest ray scarcely extending beyond tip of last when depressed. Anal low, the longest ray not extending past tip of last ray when the fin is depressed, equal to snout and eye. Ventrals reaching vent, slightly longer than the highest anal ray. Pectorals little longer than head less opercle. Scales closely imbricated, the exposed edges considerably deeper than long in the largest specimens. Lateral line decurved, complete. Breast naked (scaled in *N. topeka*). A dark streak from anal to caudal, lower parts otherwise plain. A dark vertebral line, a plumbeous band along the sides, a faint spot at the base of the caudal about as large as the pupil. A series of spots along each side of the lateral line. Upper parts of sides and the back profusely spotted, the edges of the scales black, giving the whole part a reticulated appearance. The specimens from Qu'Appelle are darker than those from Brandon.

20. **Notropis deliciosus** (Girard). Three specimens of this species were taken at Winnipeg.

21. **Notropis megalops** (Rafinesque). A number of specimens of this species were obtained at Brandon. None were seen elsewhere.

22. **Notropis scopiferus** Eigenmann & Eigenmann. This species is evidently closely related to *N. luciodus*, from which it differs in the scaling and in having a conspicuous jet-black spot about as large as the pupil at the base of the caudal fin. Numerous specimens were obtained at Winnipeg, Brandon, Fort Qu'Appelle, and Medicine Hat. The species is most abundant at Fort Qu'Appelle, where the largest specimens (112 mm.) were obtained. Head, 4–4½ (longest in young); depth, 4¼; D. 9½; A. 10½ (the first two rays minute, unsegmented, and unbranched); scales, 6-36 to 42-4; 14 to 18 scales in front of the dorsal; teeth, 2, 4-4, 2; grinding surface very narrow, on two teeth. Compressed fusiform, the dorsal and ventral outlines about equally arched; highest point of back at first dorsal ray. Head heavy, compressed, flat above; snout blunt, much decurved. Mouth small, little oblique; the premaxillary below the level of the lower margin of the pupil; maxillary extending to anterior margin of eye. Eye large, longer than snout, 3 in head, little less than interorbital width. Origin of dorsal about equidistant from tip of snout and base of caudal; the highest ray extending much beyond tip of last when the fin is depressed, equal to the length of the head; caudal deeply forked, the lobes equal, longer than head. Anal similar to dorsal, but much lower, the highest ray about equal to the head less the snout; ventrals below the dorsal, reaching vent; pectorals about equal to the highest anal ray. Scales closely imbricated, but not notably deeper than long. Lateral line complete, and each scale with a well-developed tube. The line evenly and gently decurved to above origin of anal. All specimens, from the smallest (about 25 mm. long) to the largest, have a conspicuous black spot at the base of the middle caudal rays, a silvery lateral band, its dorsal margin distinct, its lower margin not distinct. Color otherwise variable; those from muddy water (Red River at Winnipeg) are bright silvery with very little dusky, the chromatophores being not less numerous, but contracted. The other extreme is found in the clear water of the Qu'Appelle. In these specimens there is a conspicuous vertebral band, and all the scales above the lateral line are most profusely dotted with black, the dots being largest at the margins of the scales. Top of head and upper parts of its sides similarly dotted. Dorsal, caudal, and upper parts of pectorals dusky. Specimens from Little Traverse Bay, Lake Michigan, seem to represent a variety of the species above described; the snout is more slender, the eye perceptibly smaller, and the caudal peduncle more slender. The difference is more marked in young examples, the form being much more slender than in *scopiferus* and the caudal spot notably smaller.

23. **Notropis jejunus** (Forbes). This species was found to be abundant at Winnipeg, Brandon, and Medicine Hat. The teeth are quite variable, being in different specimens 4–4; 1, 4–4, 2; and 2, 4–4, 2; otherwise there is little or no variation. It is not unlikely that some of the species described as having teeth 4–4, or 1, 4–4, 2 are identical with this species.

24. **Notropis atherinoides** (Rafinesque). Winnipeg, Medicine Hat, Poplar. The specimens from Winnipeg are slightly deeper than those from other localities, and all of the northern specimens have slightly larger eyes and correspondingly shorter snouts

25. **Rhinichthys dulcis** (Girard). Swift Current, very abundant; Medicine Hat, few; Calgary, few; origin of dorsal equidistant from nostril and base of middle caudal rays. Banff, common in Bow River. One specimen has very much larger fins than the others, the pectoral quite reaching the anal. Also in hot sulphur springs, Banff, very abundant. Poplar, one specimen. Craig, abundant.

26. **Agosia nubila** (Girard). Idaho Falls, abundant.

27. **Agosia falcata** Eigenmann & Eigenmann. Abundant in the Boise River at Caldwell, Idaho; two specimens from Umatilla. In the following description the statements and figures given in parentheses refer to *A. nubila*. Head, 3⅔–4⅕ (4⅕–4⅓); depth, 4½–5¼ (4–4¾); D. 11½ (8½–11½); A. 9½ (7½–9½). Scales, 53–60 (59–67). Teeth, 1, 4–4, 1 or 2. Elongate, slender, head longer than in *nubila*. Eye much larger than in *nubila*, about 1⅓ in snout, 3½–4¼ in head in larger specimens. The head being longer the proportional numbers do not differ from those of *nubila*. Scales much larger than in *nubila*, about 10 above the lateral line (14 in *nubila*). Dorsal usually inserted directly over the origin of the ventrals, the fin large, its anterior rays prolonged. Origin of dorsal equidistant from base of middle caudal rays and from nares. Caudal deeply forked, the lobes acute, 3⅖ to 3¾ in the length. Anal very obliquely truncate, the anterior rays very high, 4⅛–4¾ (5–5½) in the length. Ventrals always more posterior in position than in *nubila*, about equidistant from base of middle caudal rays and from nares, their tips extending to or past middle of base of anal, 4¾–5 (5–6) in the length (reaching to vent, very rarely to origin of anal). Pectorals not reaching ventrals. A dark band forward from eye; dark, lateral band scarcely evident; silvery below; sides and back with numerous, irregular, well-defined blotches. Anal and sometimes ventrals with a dusky spot near base in front. Dorsal and caudal faintly mottled; crimson spots on mandible, axil of ventrals, and along base of anal. (Plate 6.)

28. **Agosia falcata shuswap** Eigenmann & Eigenmann. This variety seems well established by four specimens from Shushwap Lake at Sicamous. It is not at all improbable, however, that intergradations will be found. The specimens differ constantly in the more posterior position of the dorsal and ventrals; otherwise there is no difference of any note. Head, 3⅔–4⅕; depth, 4–4¾; D. 10½–11½; A. 9½. Scales, 10–55–8. Teeth, 1, 4–4, 2 in two specimens; 2, 4–4, 1 in another; and 2, 4–4, 0 in the fourth. Head pointed, the snout scarcely projecting beyond the mouth. Eye large, equidistant from tip of snout and from upper angle of gill-opening, the orbit about equal to the snout, 3½–3⅔ in the head. Dorsal inserted directly over origin of ventrals, equidistant from base of middle caudal rays and from posterior half of eye. Its first two developed rays elongate, the margin of the fin strongly concave. Highest dorsal ray equal to distance from tip of snout to upper angle of opercle. Caudal long, deeply forked, the lobes finely pointed, the middle rays half as long as the lobes, at least as long as the head. Structure of anal similar to that of dorsal. Ventrals inserted equidistant between base of middle caudal rays and posterior half of eye, pointed, extending to middle of base of anal, equal to head less opercle. Pectorals less pointed than the other fins, as long as head or a little shorter. Light brown with numerous well-defined blotches, a dark band from tip of snout to base of caudal. All the fins with dark points along the rays collected in places, giving the fins a faintly mottled appearance.

29. **Hybopsis storerianus** (Kirtland). A number of small specimens from Winnipeg are probably to be referred to this species.

30. **Couesius dissimilis** (Girard). Very abundant at Swift Current, Medicine Hat, Calgary, Poplar. The specimens from Medicine Hat and from Poplar are quite light in color. Those from Calgary and from Swift Current are darker, the lateral band being well defined. Scales along the lateral line 58–62.

31. **Platygobio gracilis** (Richardson). Craig, Poplar, Brandon, Medicine Hat. This species is extremely abundant in the Missouri River at Craig, and in its tributary, Poplar Creek. A number were obtained with hook and line in the main stream at Craig, where the current is too swift for seining. In the slough at the same place none were seen. One was obtained at Brandon, and I was told that it is abundant at that place. Their projecting snout and frosted silvery color make them a striking species. The largest obtained measures 20 mm. There is a dusky vertebral band and a brown lateral one.

32. **Mylocheilus caurinus** (Richardson). Mission, Kamloops, Sicamous, Revelstoke, Golden, and Umatilla.

33. **Ptychocheilus oregonensis** (Richardson). Kamloops, Sicamous, Umatilla, La Grande, and Caldwell. Teeth usually 2, 4–4, 2. Dorsal with nine well-developed rays (I, 9½).

Leuciscus and Richardsonius. The genus *Richardsonius* was proposed by Girard in 1856. It was said to bear some resemblance to *Squalius*, from which it could "be distinguished by the smooth edge of the dental ridge and the long anal, together with the peculiar position of the latter in reference to the dorsal. The dorsal is also much deeper than long, which is not the the case in *Squalius*." Species discovered since Girard's description was written have shown that no such differences between *Squalius* (*Leuciscus*) and *Richardsonius* exist. Dr. Günther classed the only two species of the genus *Richardsonius* with his *Abramis*, characterized by the elongate anal and compressed ventral ridge behind the ventrals. Jordan and Gilbert also separated the genus *Richardsonius* from *Leuciscus*, etc., on the basis of the compressed ventral ridge and elongate anal. I have examined a very large series of specimens and find that the ventral ridge is very variable, especially with age, and is of no worth whatever to separate *Richardsonius* even subgenerically from *Leuciscus*. In one specimen, which might have served Girard's artist when he drew *R. balteatus*, there is the merest vestige of a ventral ridge. The ridge seems best developed in specimens about medium size (75 mm.). The characters selected to separate the species of the old genus *Richardsonius* from each other seem no more fortunate. Neither the teeth nor the scales are of any value whatever in this respect. The anal fin is by no means an absolute guide, as will be seen later. In fact, I have been unable to detect a single character which will always separate the two forms, each of which is variable in the extreme. All those species of *Leuciscus* with increased number of anal rays, *montanus, hydrophlox, gilli, balteatus,* and *lateralis* may be classed under the subgeneric name *Richardsonius*. I find in examining 41 specimens of *Leuciscus montanus*, collected by Jordan at Provo, that in some the ventral ridge is much more developed than in typical specimens of *Richardsonius*. The anal rays are: 28 with 12½; 12 with 13½; 1 with 14½.

34. Leuciscus atrarius (Girard). This species is quite abundant in the Snake River at Idaho Falls. It readily takes the hook. The lateral line is not developed until late in life; in specimens 2 inches long the pores are formed on but few scales.

35. Leuciscus hydrophlox (Cope). Abundant in the Snake River at Idaho Falls. The anal rays in a number of specimens examined vary from 12½ to 14½. Two specimens have 12½ rays, fourteen have 13½, and four have 14½. The dorsal rays vary from 10½ to 11½, and the scales of the lateral line from 51 to 58. There is present a slight median keel behind the ventrals. These specimens agree very closely with specimens of *L. montanus* collected by Jordan at Provo, Utah, except that a larger percentage have 13 and 14 anal rays, and a smaller percentage have 12 rays.

36. Leuciscus balteatus (Richardson).

Cyprinus (*Abramis*) *balteatus* Richardson, Fauna Bor. Amer., III, 301, 1836; Storer, Synopsis Fish. N. A., 160, 1846.

Richardsonius balteatus Girard, Proc. Acad. Nat. Sci. Phila., VIII, 1856, 202; id., U. S. P. R. R. Exp. & Surveys, x, 278, pl. LX, figs. 1-4, 1859 (Fort Dalles, Oreg., Fort Vancouver, Oreg.?); Bean, Proc. U. S. Nat. Mus. 1882, 93 (Garrison Creek, Wash.); Jordan & Gilbert, Syn. Fish. N. A., 251, 1882 (Columbia River and northward); Jordan, Cat. Fish. N. A., 33, 1885.

Abramis (*Blicca*) *balteatus* Günther, Cat. Fish. Brit. Mus., VII, 309, 1868.

Of this species I obtained two unquestionable specimens at Kamloops. There is a distinct median ridge behind the ventrals, and the anal has 20½ and 22½ (II, 18½–20½) rays. Teeth, 2, 5-4, 2. At Mission this species is abundant, the largest individuals measuring 140 mm. In the larger specimens the postventral keel is very variable and frequently not at all distinguishable; it is best developed in medium-sized specimens (80 mm.). The teeth are usually 2, 5-4, 2, when normally developed. Of these, the anterior tooth on the left is thicker and shorter than the others, dagger-shaped, and remote from them. I have made detailed counts and measurements of over 20 specimens, and have counted the rays of all the rest. The anal rays are as follows: 16½ in two specimens; 17½ in seven; 18½ in thirteen; 19½ in twenty-five; 20½ in eighteen; 21½ in eight; 22½ in two; 23½ in two; 24½ in two. The usual number, then, is 19½ or 20½. The dorsal varies from 11½–13½. I have found no coördination of variations whatever. Each character varies independently. The scales vary from 11 to 13–53 to 63–5 to 7. According to the Mission specimens the normal number of anal rays is 19½ or 20½, and the variation is three or four rays in both directions.

The following table gives the measurements and some other variations found among the specimens of *Leuciscus balteatus* from Mission:

No.	Length in mm.	Dorsal.	Anal.	Scales.	Teeth.*	Depth.	Position of dorsal.	Sex.	Remarks.
1	140	13½	18½	12-59-6	.....	3½	(†)	♀	Keel scarcely evident.
2	120	12½	21½	11-53-5	‡2, 5-4, 1	3⅔	(§)	♂	Median keel scarcely evident.
3	110	13½	19½	12-60-6	2, 5-4, 2	3⅔	(‖)	♂	Median keel moderate.
4	105	12½	20½	12-58-6	2, 5-4, 2	3½	(‖)	♀	Median keel well developed.
5	100	12½	19½	11-57-6	2, 4-4, 2	3¾	(†)	♂	Keel typical.
6	102	12½	18½	12-60-6	2, 5-4, 2	3½	(§)	♂	Keel moderate.
7	91	11½	20½	12-57-5	2, 4-3, 1	3¾	(‖)	♀	Keel evident.
8	92	11½	19½	12-58-6	2, 5-4, 1	3¾	(‖)	.....	Keel distinct.
9	88	12½	19½	12-61-6	2, 5-4, 2	3⅔	(‖)	♂	Keel well developed.
10	92	12½	21½	12-63-6	2, 5-4, 1	3⅔	(§)	♀	Keel typical.
11	102	12½	20½	11-62-6	2, 5-4, 2	3¾	(§)	♂	Keel well developed.
12	87	12½	20½	13-59-6	1, 5-4, 2	3¾	(†)	♂	Keel moderate.
13	86	12½	20½	11-59-7	2, 5-4, 1	3½	(‖)	♂	Keel well developed.
14	83	12½	20½	12-61-7	2, 5-4, 1	3½	(†)	♂	Keel no more than in *montanus*.
15	80	11½	19½	12-61-6	2, 5-4, 1	3⅔	(†)	♂	Keel distinct.
16	95	12½	18½	13-59-7	2, 5-4, 2	3½	(‖)	♂	Keel evident.
17	90	12½	17½	13-58-7	2, 5-4, 2	3⅔	(†)	?	Keel moderate.
18	80	11½	17½	11-60-7	2, 5-4, 2	3½	(†)	♂	Keel typical.
19	77	12½	17½	57	2, 5-4, 2	3⅘	(†)	?	Keel well developed.
20	87	12½	16½	13-61-7	2, 5-3, 2	3⅔	(§)	.....	Do.
21	81	12½	22½	12-58-7	2, 5-4, 2	3⅔	(‖)	♀	Keel moderate.
22	80	13½	21½	61	2, 5-?	3⅔	(‖)	♀	Do.
23	74	11½	16½	.....	2, 5-4, 2	.....	.....	.....	Do.
24	60	13½	24½	.....	2, 5-4, 2	3½	†	.....	Keel evident.
25	68	13½	24½	.....	.....	.....	.....	.....	
26	64	12½	23½	.....	.....	.....	.....	.....	

* I have frequently observed that the largest individuals among the minnows usually have abnormal numbers of teeth.
† Equidistant from base of middle caudal rays and a point above middle of pupil.
‡ Anterior tooth of main row on left side is large, dagger-shaped, and remote from the others, and points inward.
§ Equidistant from base of middle caudal rays and upper angle of preopercle.
‖ Equidistant from base of middle caudal rays and posterior margin of eye.

Besides the above there are four with 17½ anal rays; eleven with 18½; twenty with 19½; eleven with 20½; five with 21½; one with 22½; one with 23½. The largest number of specimens with increased anal rays were small individuals, about 70 mm. long.

37. Leuciscus balteatus lateralis (Girard). The specimens of this subspecies from the different localities will be considered separately.

1. *Sicamous.* A number of the specimens contain large parasitic worms. Eight specimens examined show the following measurements:

No.	Length.	Dorsal.	Anal.	Scales.	Teeth.	Position of dorsal.	Depth.
	mm.						
1	82	12½	19½	11-60-6	2, 4-3, 1	(*)	4—
2	92	12½	16½	11-62-6	2, 5-4, 2	Keel indistinct (*) ..	.....
3	90	12½	14½	14-62-7	2, 5-4, 2	(†)	3⅜
4	87	12½	17½	12-60-5	2, 5-4	.....	4
5	85	12½	16½	10-62-5	2, 5-5, 3	(‡)	4⅛
6	80	12½	18½	11-60-6	2, 5-4, 1	(*)	4¼
7	85	12½	16½	11-59-5	2, 5-4, 2	(†)	4
8	77	12½	17½	11-61	2, 5-4, 1	(*)	4⅛

* Equidistant from base of middle caudal rays and upper angle of preopercle.
† Equidistant from base of middle caudal rays and a point above middle of pupil.
‡ Equidistant from base of middle caudal rays and occiput.

The total number of specimens collected at Sicamous was 58. They have the following number of anal rays: 1 has 14½; 3 have 15½; 13 have 16½; 28 have 17½; 8 have 18½; 5 have 19½. These specimens are a little more robust than those from Mission and are certainly more elongate, the depth in a number of them being 3¾–4¼ in the length. They are more coarsely and profusely punctate. There is a conspicuous black lateral band, above which there is in some specimens a narrow light line, above which there is another darker shade. The ventral keel is moderately developed. In all the normal pharyngeals examined the teeth in the main row were 5-4. In one case the teeth are 2, 5-5, 3 which may be a case of reversion. This is unquestionably the species figured by Girard as *R. lateralis*. The average size of the specimens is smaller than that of *balteatus*.

2. Specimens from *Griffin Lake*, also undoubtedly *lateralis*, are similar to those from Sicamous in color and proportions, being probably slightly more compressed and deeper. Many specimens of this genus are bright scarlet on the sides. There were taken in Griffin Lake 14 specimens with anal rays as follows: 3 with 14½; 7 with 15½; 3 with 16½; 1 with 17½; 75 mm. or less in length. The teeth in the main row are in all but one doubtful case, 5-4.

3. Two specimens from *Kamloops* have the keel moderately developed, the teeth 2, 5-4, 2 and 2, 5-3, 2; the anal rays, 17½ and 18½.

4. One specimen from *Revelstoke* has teeth 2, 5-4, 1; anal, 15½; depth 4 in length.

5. *Golden.* The position of the dorsal fin does not vary materially in any of the specimens enumerated above, nor in *balteatus*. In all the specimens examined this fin was equidistant from base of middle caudal and from a point from above the middle of the eye to nearly the occiput. At Golden I obtained a number of specimens in which there is very great variation in this point. The dorsal is equidistant from base of middle caudal rays and from posterior margin of the eye in one extreme and from behind the occiput in the other. The specimens living in a milky river instead of a clear lake, as those at Sicamous, are much lighter and more uniform in color. The average number of anal rays is less than in the Sicamous specimens, as may be seen from the following table:

Measurement of specimens from the Columbia River at Golden, British Columbia.

No.	Length.	Dorsal.	Anal.*	Scales.	Teeth.	Depth.	Head.	Position of dorsal.	Sex.	Remarks.
	mm.									
1	115	12½	15½	12-63-6	2, 5-4, 1	3⅜	4¼	(‡)	♀	Keel nil.
2	104	11½	16½	10-61-?	2, 5-4, 1	4	4⅓	(‡)	♀	Keel evident.
3	103	11½	18½	10-55-5	2, 5-4, 2	4	4¼	(‡)	♀	Do.
4	103	11½	17½	12-59-?	2, 4-5, 2	4⅕	4⅔	(‡)	♂	Do.
5	95	12½	15½	56	1, 5-4, 1	4	4⅓	(†)	♀	Keel well marked.
6	92	11½	15½	.....	.....	4½	4½	(§)	?	Keel well developed.
7	91	12½	17½	57	2, 4-3, 2	3¾	4⅕	(†)	.....	Keel nil.
8	85	11½	14½	.....	.....	4	4⅕	(†)	.....	Keel well developed.
9	85	12½	16½	.....	.....	4⅕	4⅔	(§)	.....	Keel scarcely evident.
10	82	11½	16½	.....	.....	4½	4½	(*)	.....	Keel evident.
11	83	11½	16½	.....	.....	3⅝	4	(‡)	.....	
12	77	11	15½	.....	.....	4¼	4½	(†)	.....	Keel evident.
13	73	12½	15½	.....	.....	4	.....	(†)	.....	Keel well developed.
14	72	10½	15½	.....	.....	4⅓	.....	(‡)	.....	Keel moderate.
15	68	11½	6½	.....	.....	4	.....	(*)	.....	Keel well developed.
16	67	12½	17½	.....	.....	3⅗	.....	(‡)	.....	Do.
17	65	12½	15½	.....	.....	4	.....	(§)	.....	Keel strong.
18	62	11½	17½	.....	.....	4⅕	.....	.....	.....	Do.

* Equidistant from base of middle caudal rays and occiput (beginning of scaled region).
† Dorsal nearer base of middle caudal rays than occiput.
‡ Equidistant from base of middle caudal rays and upper angle of preopercle.
§ Equidistant from base of middle caudal rays and posterior margin of eye.

The dorsal in this lot has one or two spines.

Twenty-three specimens taken at La Grande, in the Grand Ronde River, vary from 32 to 108 mm. in length. Two have anal rays 14½; six have 15½; eleven, 16½; four, 17½. Depth, 3⅜-4; teeth in one specimen examined, 2, 5-4, 2; general color dark, markings well defined.

Thirty-three specimens from Boise River at Caldwell show the greatest variation in anal rays without any great specialization in one number. They are as follows: one with 14½; two with 15½; six with 16½; seven with 17½; eight with 18½; seven with 19½; two with 20½; and one with 21½. These specimens are rather flat and deep (depth 3½ to 3¾), approaching *L. balteatus* in this respect as well as in the number of anal rays. They are rather pale in color with the markings not distinct. Some of these specimens may belong more properly to *balteatus*, but I am not able to detect any differences save those mentioned. The ventral keel in most of these specimens is no more evident than in specimens of *L. montanus*.

Of nine specimens from Umatilla, Oreg., two have the anal rays 17½, four have 18½, and three, 20½.

38. Hiodon alosoides (Rafinesque). *Gold eye.* Poplar, abundant; D. 11½ or 12½, counting all rays; lateral line about 60; depth, 3⅓ to 3½. This species is very abundant in the Red River at Winnipeg; the largest specimen seen measured 370 mm.; head, 4⅕-5 in largest specimens (4¼-4½, in smaller, 230 mm.); depth about 3; D. 11½; A. 31-37; lateral line, 61. This species is here dried for the market; also taken at Brandon and reported to me at Medicine Hat.

39. Hiodon tergisus Le Sueur. Winnipeg, Brandon.

40. Coregonus williamsoni Girard. This species is extremely abundant in the Missouri River at Craig. It was also taken at Idaho Falls in the Snake River, at La Grande in the Grand Ronde; at Golden, Revelstoke, and Umatilla in the Columbia River; at Caldwell in the Boise River; at Calgary and Banff in the Bow River, where it is called grayling, and at Sicamous in Shushwap Lake. There are minute differences between the specimens taken at different places, but I am unable to distinguish specific characters to separate them.

41. Coregonus coulteri Eigenmann & Eigenmann. Many specimens, the largest measuring 195 mm., from the Kicking Horse, at Field, British Columbia; one specimen from Golden. Head, 4½–5; depth, 4½–5½; D. 10½–11½; A. 12-13; scales 7, 60-63, 7 (to ventrals). Form rather heavy, little elevated, the snout broad, very blunt and decurved; greatest depth of head equals its length less the opercle. Mouth low, the snout but little projecting, maxillary reaching eye in largest specimen, further in the smaller ones. Eye equals snout, 4 in head. Supplemental bone a crescent. Gill-rakers much as in *williamsoni*. Dorsals and anal shorter and higher than in *williamsoni*. Scales large, dull silvery; the spots of the young not so conspicuous as in those of *williamsoni*. Length of largest specimen to origin of dorsal, 68 mm. (Plate 6.)

42. Oncorhynchus tschawytscha Walbaum. Golden, 11 specimens, the largest 120 mm. Revelstoke, a large number of specimens, the largest 120 mm. La Grande, 1 specimen. Mission, the largest 95 mm. Kamloops, 1 specimen.

43. Salmo mykiss Walbaum. Calgary, Banff, Griffin Lake, Sicamous, Kamloops, Idaho Falls, and Craig? The specimens from Calgary and Banff resemble very closely specimens in the collections of the Indiana University from the Rio Grande at Del Norte, Colorado. In one of the Rio Grande specimens I count 181 rows of scales; Dr. Jordan counted 155 to 160 in those he examined. In one of the Calgary specimens I find 156 rows. In the shape of the head and in color the specimens from Calgary and Banff are almost exact reproductions of the Rio Grande specimens. I therefore see no reason why the two should go under different names. The question of the number of species of trout does not appear settled as yet, nor is it probable that it will be until all the trout are caught. Specimens from Kamloops differ from those from Calgary in having slightly larger spots. Those from Griffin Lake have still larger and more numerous spots.

44. Thymallus signifer ontariensis Valenciennes. A single specimen, 212 mm. long; D. 21; A. 12; scales, 91. Craig, Montana. This specimen differs from the specimens obtained by Jordan in the Madison River and at Horsethief Springs, in the larger scales, being in this respect identical with the typical *signifer*, and in having the black spots extend quite to below the soft dorsal fin. The color of the dorsal is as described by Jordan.*

45. Salvelinus namaycush (Walbaum). Calgary, Banff, Devils Lake, Golden, and Revelstoke. A species of *Salvelinus*, probably to be referred to this species, reaches a large size, a meter and more in Devils Lake, in the Canadian Rocky Mountains Park. A photograph of one of these larger individuals shows it to be everywhere profusely spotted on head, sides, and back. The spots are slightly larger on lower parts of sides. Those of the head do not differ from those of the body. The dorsal, caudal, and to some extent the anal, ventrals, and pectorals, are also profusely spotted. The largest specimen obtained measures about 435 mm. The spots are much less numerous than in the photograph and those of the head show a tendency to unite, leaving a dark reticulation as a background. Dorsal, soft dorsal, and caudal well spotted; anal and inner surfaces of ventrals and pectorals also spotted. The anal margined in front and above with white. In this larger specimen the teeth of shaft of vomer are well developed.

In the Bow, into which Devils Lake has an outlet, and in the Elbow there are numerous small trout which are considered distinct from those in the lake. The largest of those obtained at Banff measured 300 mm. in length, the rest from Calgary are all smaller. In this largest specimen and in all the smaller ones no teeth are developed on the shaft of the vomer. In a specimen about 300 mm. long, from Lake Michigan, the shaft of the vomer has well-developed teeth. This would lend color to the popular belief that those of the river are different from those of the lake. The river specimens have smaller and much fewer spots, the dorsals and caudal and inner surface of pectorals are dusky without indications of spots; there are few or no spots on the head. A specimen 165 mm. long has these characters still more empha-

* Bull. U. S. Fish Com., IX, 50, pl. VIII, fig. 7.

sized. There seems to be nothing about these specimens that may not be taken as characters of the young. Other specimens from the Columbia at Golden and at Revelstoke show no differences from those from Calgary and Banff. A large head in the University's collections from 20 miles east of New Westminster, B. C., has teeth on the shaft of the vomer and is *S. namaycush* (Walbaum).

46. Percopsis guttatus Agassiz. Winnipeg, Brandon, Regina, Swift Current, Medicine Hat. This species is abundant in almost all streams from Winnipeg to Medicine Hat. They are more numerous and larger in the cool, clear streams. The genera of *Percopsidæ* may be distinguished as follows: (Plate 6.)

a. Dorsal, with two feeble, slender, unbranched rays; anal, with a single similar ray; scales most strongly ctenoid on caudal peduncle; posterior margin of preopercle entire or with feeble crenulations; form slender ..... PERCOPSIS.

aa. Dorsal and anal each with two very strong spines; scales most strongly ctenoid on anterior part of body; posterior margin of preopercle with a few short but strong spines; form heavy, deep ..... COLUMBIA.

47. Columbia transmontana Eigenmann & Eigenmann. Umatilla. (Plate 6.)

Columbia transmontana Eigenmann & Eigenmann, Science, 1892, 233 (Umatilla, Oregon).

Head, 3⅛–3½ (3 in the young); depth, 3½–3⅝ (4 in the young); D. II, 9½; A. II, 6½; scales, 7 to 9–44 to 46–7. Body comparatively deep, dorsal profile more arched than the ventral, making an angle at the origin of the dorsal fin; sides compressed, caudal peduncle most so. Head short and chubby, eye equal to snout, about 3½ in the head. First dorsal spine about equal to the pupil, second spine one-half length of head, recurved and very deeply grooved behind. Anal spines somewhat lower than the dorsal spines; ventrals reaching past vent. Nape, with the exception of occipital spine, scaled. Translucent in life. Color, generally smutty. Side with three rows of more or less oblong blackish spots, the middle and superior rows most noticeable. Back with a series of similar spots, one being more conspicuous at beginning and end of first dorsal. Dorsal mottled, caudal barred. Head smutty, a blue black spot on middle of opercle; a narrow, silvery, lateral band. Young translucent, with well-defined dark spots.

48. Lucius lucius Linnæus. Winnipeg, Brandon, Westbourne, Moose Jaw, Swift Current, Medicine Hat. This species is common throughout the North and is one of the most prominent game fishes. Usually called pike, the name pickerel being applied to the two species of *Stizostedion*.

49. Pygosteus pungitius Linnæus. This species was obtained in the clear waters of the Qu'Appelle River. It was not noticed elsewhere.

50. Eucalia inconstans Kirtland. Qu'Appelle, Regina, Swift Current, Maple Creek, Calgary, Poplar. This species is very abundant at Regina just below the dam.

51. Etheostoma güntheri Eigenmann & Eigenmann.

Etheostoma güntheri Eigenmann & Eigenmann, Am. Nat. 962, 1892. Winnipeg; Cedar Rapids, Iowa.

Types: Three specimens 50, 50, and 60 mm. long, Winnipeg, Manitoba.

Three specimens from near Cedar Rapids, Iowa, collected by Seth E. Meek.

Premaxillaries not protractile; gill-membranes scarcely connected; ventral line with the median scales enlarged; lateral line complete; palate with well-developed teeth; dorsal spines, 10; preopercle entire; nape and breast, except the median line, naked; cheeks and opercles each with about three series of large ctenoid scales. This species is very closely related to *E. aspro*, from which it differs in the uniform size of the scales on the cheeks and on the opercles, etc. Head, 3⅜; depth, 6⅛; D. X–13 or 14; A. II, 9½–11½; scales, 5–52 to 54–5. Form of *E. aspro*; mouth moderate, the maxillary not extending beyond anterior margin of eye, about 3 in head; eye, 3⅜ in head; cheeks with about 25 large, strongly ctenoid scales; opercle with similar scales; gill-membranes much more connected than in *E. aspro*, the connection not extending back beyond middle of cheeks. Outer series of teeth considerably enlarged in each jaw. Dorsal spines slender and high, slightly more than snout and eye in length; soft dorsal shorter and lower than the spinous. First anal spine but little longer than second; pectoral equals head less opercular spine; ventrals but little shorter than pectorals. Breast naked, a few scales along its median line, mid-ventral line naked, the scales when present probably little if any larger than those of the sides; nape naked, as in *E. aspro*.

Translucent in life; a dark stripe down and another down and forward from eyes. A black spot on humeral region. Sides with about eight dark spots, which are narrow, on anterior part of body, further apart and larger on tail; only the last three extending above the

lateral line; ventral surface plain; back tessellated, but much less regularly and distinctly than in *E. aspro*. Spinous dorsal with a black spot between the first two or three spines and another between the bases of the last three. The remainder of the fin, as well as the soft dorsal, regularly dotted; caudal faintly barred, a black spot at its base, the remaining fins plain.

A fourth specimen from Winnipeg may belong to the same species, but it is probably an immature specimen of *E. aspro*. It is but 19 mm. long. It has D. IX-11; A. 11, 7; scales about 46. Premaxillary not protractile; gill-membranes united to below middle of cheeks; nape, cheeks, and opercles naked; breast and ventral line naked. A black stripe forward from eye, not below it; a series of ten black spots along the sides; a series of six larger ones on the back; a black band through middle of spinous dorsal; about three oblique bands on soft dorsal and on the caudal. A black spot on base of caudal. No distinguishable lateral line.

The three specimens from Iowa differ in no essentials from the Winnipeg specimens. In the smallest (40 mm.) the blotches of the sides are larger and fewer in number, and there are rather broad dorsal blotches, intermediate in position to the lateral ones.

52. Etheostoma aspro (Cope & Jordan). Four small specimens of this species were taken at Winnipeg and a number at Brandon, the largest of which is 70 mm. long. These do not differ in any essentials from specimens collected by Prof. S. E. Meek in Iowa.

53. Etheostoma nigrum Rafinesque. Specimens of this species taken at Westbourne, a tributary of Lake Winnipeg, in the Assiniboine at Brandon, and in the Qu'Appelle do not differ from specimens collected in Indiana and Iowa. I was informed by a half-breed that this species was very abundant in some small streams north of Qu'Appelle. The same information was given me by others at Brandon.

54. Etheostoma iowæ Jordan & Meek. Abundant at Swift Current. This is a very beautifully colored darter in life. The male has the base of the spinous dorsal dark blue, above which is a rusty band and then a narrower dark margin. A bright light-green spot above pectoral. Sides with about nine dark-green spots, the interspaces silvery with rusty and with green spots. Fins of the female nearly plain, the rusty spots of the sides wanting. In the alcoholic specimens the patterns of color are seen to be very varying. In smaller specimens there are about nine quite regular bands; in larger specimens the sides become much mottled by the addition of dark spots in the interspaces. Frequently there are eight or nine quadrate spots on the back. In one specimen there is a dark band along the sides from the head to the tail. The caudal is always more or less conspicuously barred, the soft dorsal less so, and the lower fins including the pectorals are plain. The lateral line is usually developed on more scales than in *E. quappelle*.

55. Etheostoma quappelle Eigenmann & Eigenmann.

Etheostoma quappelle Eigenmann & Eigenmann, Am. Nat. 963, 1892. Qu'Appelle.

Fort Qu'Appelle. A single specimen, 43 mm. This is the northernmost point at which darters have as yet been taken. Premaxillaries not protractile; gill-membranes scarcely connected; ventral line with the median scales not enlarged; lateral line straight, developed on 19 scales; palate without teeth; dorsal spines, 9; anal fin considerably smaller than soft dorsal; humeral region without black process; cheeks with a few small scales just below and behind eyes; opercle with a few scales on its upper angle. This species is closely related to *E. iowæ* and *E. jessiæ*, differing in the radial formula, scales, etc. In shape it approaches very nearly *E. iowæ*, being much slenderer than *jessiæ*. Head, 4; depth, 5½; D. IX-9; A. 11, 6½. Scales, 3-53-7; lateral line developed on 19 scales. Form similar to *E. iowæ*, its dorsal profile notably less arched, its head lower and less compressed, more truly conic. Snout rather blunt, the maxillary extending to anterior margin of pupil, about 3 in head. Eye moderate, 3½ in head. Teeth in very narrow bands, the outer series enlarged. Cheeks with about 10 small cycloid scales bordering the lower posterior portion of orbit; opercles with a few scales. Dorsal spines rather short and stiff, the highest equal to snout and orbit. Second dorsal shorter than first, base of anal much shorter than base of second dorsal, not equal to snout and eye. Pectoral and ventrals about equal in length, about equal to head less opercle. Nape and breast naked; mid-ventral line with small scales. General color dusky, the markings much less conspicuous than in *iowæ*. A dark shade downward from eye, another forward; a black spot behind eye; a dusky region on opercle and on shoulders. Sides with about 8 dark blue bars, alternating with rusty bars, the margins of these ill defined. No blotches on back. Basal half of spinous dorsal black, the remainder hyaline. Soft dorsal and caudal barred, anal and ventrals hyaline, pectorals dusky.

56. Perca flavescens Mitchill. Abundant at Fort Qu'Appelle; Brandon.

57. Stizostedion vitreum (Mitchill). Winnipeg, Moose Jaw, Fort Qu'Appelle. A single specimen from Moose Jaw has the sides and upper parts all quite dark with few yellow spots in streaks. Spinous dorsal dusky with the usual black spots. Soft dorsal, caudal, and pectoral colored like the sides; anal and ventrals yellow with many dark spots. D. XV–1, 21.

58. Stizostedion canadense griseum DeKay. Winnipeg, Brandon, Poplar.

59. Aplodinotus grunniens Rafinesque. Winnipeg, abundant.

60. Cottus asper (Richardson). Mission, Sicamous, Kamloops, Griffin Lake, and Umatilla. Very abundant in the Fraser system from tidewater to an altitude of 1,900 feet. This species varies greatly in color in different localities. At Mission I obtained a number in the turbid water of the Fraser. These are gray with the usual dark markings; I obtained two specimens from a little brook of clear water which were very much darker, the gray remaining as but narrow streaks and spots among the general ground color of black both on the sides and fins.

61. Cottus bairdi punctulatus Gill. Craig, Montana.

62. Cottus rhotheus (R. Smith). Two fine specimens of this species, 120 mm long, and a number of smaller ones were obtained at La Grande. Lateral line complete. D. VII or VIII, 17; A. 12½ or 13½. Soft dorsal adnate behind, the membrane extending to near caudal. Color of largest specimens: soft dorsal with oblique bars, most marked on the rays; caudal with about three large bars. The species is quite common at Idaho Falls.

63. Cottus philonips Eigenmann & Eigenmann.

Cottus philonips Eigenmann & Eigenmann, Am. Nat. 963, 1892. Field.

Seventeen specimens of a *Cottus* were taken in the icy waters of the Kicking Horse at Field, B. C. Head, about 4¾–4 in head. D. VIII or IX–16 to 18; A. II, 13; V. I, 4. Pectoral reaching anal or past vent even in largest specimens. Anal equidistant from tip of snout and base of caudal or nearer tip of snout. Ashy gray with blackish blotches. No well-defined crossbars except sometimes near the tail. Frequently a dusky blotch on anterior part of spinous dorsal and another near its posterior end; the fin sometimes wholly dusky, margined with white. Pectorals, soft dorsal, and caudal more or less barred.

64. Cottus onychus Eigenmann & Eigenmann.

Cottus onychus Eigenmann & Eigenmann, Am. Nat., 963, 1892. Calgary.

A single specimen 82 mm. long from Calgary. This species is evidently closely related to *C. pollicaris* (J. & G.), from which it differs chiefly in having many prickles. Head, 3¾; depth, 5½; D. VIII, 17; A. 13; ventrals, I, 4; pectorals, 13. Teeth on vomer, none on palatines. Width of head equals its length to end of preopercular spine, its depth 2 in its length. Preopercle with an upturned claw-like spine, below which are two others, much smaller, the anterior one having its point turned downward and forward. Eye 1⅓ in snout, ½ in interorbital, 5 in head. Maxillary not reaching orbit. Sides above the lateral line, which is complete, with stiff prickles from below first spine to below the last dorsal ray; prickles below the lateral line confined to the abdominal part of the sides. Dorsals connected by a low membrane, the rays much higher than the spines, 3½ in head. Pectorals reaching past vent, its rays not branched. A dusky spot on breast just behind anterior end of gill-slits; ventral surface, including the ventrals, otherwise plain. Anal with a few dusky specks on its rays; other fins barred; sides and upper surfaces olive with darker spots. Three dark bands below soft dorsal; a dark band just in front of the caudal.

65. Lota lota maculosa (LeSueur). Winnipeg, Craig. Abundant at Winnipeg. A single specimen was taken in the Missouri with hook and line. This species was reported to me at Calgary, where it is said to ascend the streams south of Calgary in great numbers. A species of "ling" was also reported to me at Golden* and again at Sicamous. From the description given it must be closely related to the species under consideration. It is said to reach a length of 1.50 m. At Sicamous they had this species for dinner just before I arrived, which is the nearest I came to securing it on the Pacific slope.

*I have recently received a specimen from this place through Mr. Green. It is identical with the Atlantic slope form.

Table showing the distribution of the different species collected.

Species.	Red River Basin.						Saskatchewan.						Columbia.			Fraser.				Columbia.				Mis-souri.	
	Winnipeg.	Westbourne.	Brandon.	Qu'Appelle.	Regina.	Moose Jaw.	Chaplin.	Swift Current.	Maple Creek.	Medicine Hat.	Calgary.	Banff.	Field.	Golden.	Revelstoke.	Griffin Lake.	Sicamous.	Kamloops.	Mission.	Umatilla.	La Grande.	Caldwell.	Idaho Falls.	Craig.	Poplar.
Ammocœtes tridentatus	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+	+	...	...	...
Acipenser sturio	+	...	?	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Acipenser transmontanus	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	??	??	...	...	...	...	...
Acipenser medirostris	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	??	??	...	...	...	...	...
Scaphirhynchus platyrhynchus	?	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+	...
Noturus flavus	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Ictalurus punctatus	+	...	?	...	...	...	...	...	...	?	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Ictiobus cyprinella	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Carpiodes velifer	+	...	+	...	...	...	...	...	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+
Catostomus catostomus	+	...	...	...	...	...	...	+	...	+	+	+	...	+	+	...	...	...	...	...	...	...	...	+	...
Catostomus griseus	...	...	...	...	...	...	...	+	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Catostomus macrocheilus	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	?	+	+	...	+	+	+	+	...	...
Catostomus commersoni	+	+	...	+	+	+	...	+	+	+	+	...	...	...	...	...	...	...	...	...	...	...	...	...	+
Pantosteus jordani	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+	...	...	...
Moxostoma aureolum	+	+	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+
Moxostoma anisurum	+	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Hybognathus placita	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+
Acrocheilus alutaceus	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+	...	+	...	...	...
Pimephales promelas	+	+	+	+	+	...	...	+	+	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Notropis jordani	...	...	...	...	...	...	...	...	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Notropis heterolepis	...	...	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Notropis reticulatus	...	...	+	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Notropis deliciosus	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Notropis megalops	...	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Notropis scopiferus	+	...	+	+	...	...	...	...	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Notropis jejunus	+	...	+	...	...	...	...	...	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Notropis atherinoides	+	...	...	...	...	...	...	...	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+
Rhinichthys dulcis	...	...	...	...	...	...	...	+	...	+	+	+	...	...	...	...	...	...	...	...	...	...	...	+	+
Agosia nubila	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+	...	...
Agosia falcata	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+	...	+	...	...	...
Agosia falcata shuswap	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+	...	...	...	...	...	...	...	...
Hybopsis storerianus	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Couesius dissimilis	...	...	...	...	...	...	...	+	...	+	+	...	...	...	...	...	...	...	...	...	...	...	...	...	+
Platygobio gracilis	...	...	+	...	...	...	...	...	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	+	+
Mylocheilus caurinus	...	...	...	...	...	...	...	...	...	...	...	...	...	+	+	...	+	+	+	+	...	...	...	...	...
Ptychocheilus oregonensis	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+	+	...	+	+	+	...	...	...
Leuciscus atrarius	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+	...	...
Leuciscus hydrophlox	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+	...	...
Leuciscus balteatus	...	...	...	...	...	...	...	...	...	...	...	...	...	??	??	...	...	+	+	...	?	...	...	...	...
Leuciscus balteatus lateralis	...	...	...	...	...	...	...	...	...	...	...	...	...	+	+	+	+	+	...	+	+	+	...	...	...
Hiodon alosoides	+	...	+	...	...	...	...	...	...	?	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+
Hiodon tergisus	+	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Coregonus williamsoni	...	...	...	...	...	...	...	...	...	...	+	+	...	+	+	...	+	...	...	+	+	+	+	+	...
Coregonus coulteri	...	...	...	...	...	...	...	...	...	...	...	...	+	+	...	...	...	...	...	...	...	...	...	...	...
Coregonus clupeiformis	...	...	...	?	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Coregonus tullibee	?	...	...	?	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Salmo mykiss	...	...	...	...	...	...	...	...	...	...	+	+	...	...	...	+	+	+	...	...	...	...	+	?	...
Thymallus signifer ontariensis	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+	...
Salvelinus namaycush	?	...	...	...	...	...	...	...	...	...	+	+	...	+	+	...	...	...	...	...	...	...	...	...	...
Oncorhynchus tschawytscha	...	...	...	...	...	...	...	...	...	...	...	...	...	+	+	...	...	+	+	...	+	...	...	...	...
Percopsis guttatus	+	...	+	...	+	...	...	+	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Columbia transmontana	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+	...	...	...	...	...
Lucius lucius	+	+	+	...	?	+	...	+	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Pygosteus pungitius	...	...	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Eucalia inconstans	...	...	...	+	+	...	...	+	+	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	+
Etheostoma güntheri	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Etheostoma aspro	+	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Etheostoma nigrum	...	+	+	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Etheostoma iowæ	...	...	...	...	...	...	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Etheostoma quappello	...	...	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Perca flavescens	...	...	+	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Stizostedion canadense griseum	+	?	+	...	...	...	...	...	...	?	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+
Stizostedion vitreum	+	...	...	+	...	+	...	...	...	?	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Aplodinotus grunniens	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cottus asper	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+	+	+	+	+	...	...	...	...	...
Cottus bairdi punctulatus	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+	...
Cottus rhotheus	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+	...	+	...	...
Cottus philonips	...	...	...	...	...	...	...	...	...	...	...	...	+	...	...	...	...	...	...	...	...	...	...	...	...
Cottus onychus	...	...	...	...	...	...	...	...	...	...	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Lota lota maculosa	+	...	...	...	...	...	...	...	...	?	?	...	...	+	?	...	?	...	...	...	...	...	...	+	+
Totals	24	5	17	11	4	3	...	10	3	14	9	5	2	8	6	3	8	8	4	9	7	8	7	8	11

Interrogation marks in the table signify that the species are probably found at the localities indicated, but were not taken by me.

OBSERVATIONS ON THE DISTRIBUTION OF THE SPECIES OBTAINED AND THE RELATION OF THE DIFFERENT RIVER FAUNÆ EXAMINED TO EACH OTHER.

Six of the sixty-five species obtained are found on both the east and west slope of the continent, *Pantosteus jordani*, *Coregonus williamsoni*, *Salmo mykiss*, *Catostomus catostomus*, *Salvelinus namaycush*, *Lota maculosa*. (*Rhinichthys dulcis* is recorded from the Pacific Slope. I obtained none.)

Forty-two species were found in the Winnipeg system. They are:

Acipenser sturio.	Notropis megalops.	Lucius lucius.
Ictalurus punctatus.	Notropis scopiferus.	Pygosteus pungitius.
Ictiobus cyprinella.	Notropis jejunus.	Eucalia inconstans.
Carpiodes velifer.	Notropis atherinoides.	Etheostoma güntheri.
Catostomus catostomus.	Rhinichthys dulcis.	Etheostoma aspro.
Catostomus griseus.	Hybopsis storerianus.	Etheostoma nigrum.
Catostomus commersoni.	Couesius dissimilis.	Etheostoma iowæ.
Moxostoma aureolum.	Platygobio gracilis.	Etheostoma quappelle.
Moxostoma anisurum.	Hiodon alosoides.	Perca flavescens.
Pimephales promelas.	Hiodon tergisus.	Stizostedion canadense griseum.
Notropis jordani.	Coregonus williamsoni.	Stizostedion vitreum.
Notropis heterolepis.	Salmo mykiss.	Aplodinotus grunniens.
Notropis reticulatus.	Salvelinus namaycush.	Cottus onychus.
Notropis deliciosus.	Percopsis guttatus.	Lota lota maculosa.

Eight of these species were found in the Saskatchewan and not in the Red River. They are:

Catostomus griseus.	Couesius dissimilis.	Etheostoma iowæ.
Notropis jordani.	Coregonus williamsoni.	Cottus onychus.
Rhinichthys dulcis.	Salmo mykiss.	

Sixteen species were taken in the Red River of the North and not in the Saskatchewan. Many of these will probably be found in the Saskatchewan when its lower waters are examined:

Acipenser sturio.	Notropis deliciosus.	Etheostoma aspro.
Ictiobus cyprinella.	Notropis megalops.	Etheostoma nigrum.
Moxostoma aureolum.	Hybopsis storerianus.	Etheostoma quappelle.
Moxostoma anisurum.	Pygosteus pungitius.	Perca flavescens.
Notropis heterolepis.	Etheostoma güntheri.	Aplodinotus grunniens.
Notropis reticulatus.		

The seventeen species taken in the Missouri are as follows:

Noturus flavus.*	Notropis atherinoides.	Thymallus signifer ontariensis.*
Carpiodes velifer.	Rhinichthys dulcis.	Eucalia inconstans.
Catostomus griseus.	Couesius dissimilis.	Stizostedion canadense griseum.
Catostomus commersoni.	Platygobio gracilis.	Cottus bairdi punctulatus.*
Moxostoma aureolum.	Hiodon alosoides.	Lota lota maculosa.
Hybognathus placita.*	Coregonus williamsoni.	

Of these, but two species (*Rhinichthys dulcis* and *Platygobio gracilis*) are found both at Poplar and at Craig. Thirteen of the species taken in the Missouri are found in the Saskatchewan basin.

The species of the Saskatchewan, with the exception of the new species, have all been taken in the Mississippi basin. The Saskatchewan basin, therefore, can not be separated from the Mississippi basin by any positive characters.

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* Not found in the Winnipeg system.

The families of the Mississippi basin not yet found in the Saskatchewan basin are:

1. Lepisosteidæ.
2. Amiidae.
3. Clupeidæ.
4. Dorosomidæ.
5. Amblyopsidæ.
6. Cyprinodontidæ.
7. Umbridæ.
8. Anguillidæ.
9. Atherinidæ.
10. Aphredoderidæ.
11. Serranidæ.

Twenty-two specimens were taken in the Columbia. They are:

Ammocœtes tridentatus.
Catostomus catostomus.
Catostomus macrocheilus.
Pantosteus jordani.
Acrocheilus alutaceus.
Agosia nubila.
Agosia falcata.
Mylocheilus caurinus.
Ptychocheilus oregonensis.
Leuciscus atrarius.
Leuciscus hydrophlox.
Leuciscus balteatus lateralis.
Coregonus williamsoni.
Coregonus coulteri.
Salmo mykiss.
Salvelinus namaycush.
Oncorhynchus tschawytscha.
Columbia transmontana.
Cottus asper.
Cottus rhotheus.
Cottus philonips.
Lota lota maculosa.

The ten species taken in the Fraser system are:

Catostomus macrocheilus.
Agosia falcata shuswap.
Mylocheilus caurinus.
Ptychocheilus oregonensis.
Leuciscus balteatus.
Leuciscus balteatus lateralis
Coregonus williamsoni.
Salmo mykiss.
Oncorhynchus tschawytscha.
Cottus asper.

But one variety, *Agosia falcata shuswap*, was found in the Fraser that was not also found in the Columbia. (*Leuciscus balteatus* has been taken by others in the Columbia system.)

Several species of *Oncorhynchus* and *Acipenser* are known from the Columbia and from the Fraser which are not included in these numbers.

STRUCTURAL PECULIARITIES OF THE FRESH-WATER FISHES OF THE PACIFIC SLOPE.

Almost every family of fishes having representatives in the fresh waters of both the Atlantic and the Pacific slopes has one or more of its Pacific slope representatives modified in one or the other of two directions: There is either a larger number of rays or spines in one or more of the fins, or some of the rays have become modified into spines. The largest number of either dorsal or anal rays is almost always found in some Pacific slope species, and the range of variation is always greater in the Pacific slope species than in the Atlantic slope species of the same family, although the number of species is usually less. In most cases the differences are just perceptible, and, were it not for the consensus of differences in all groups they would stand for nothing. The most marked differences are found in those fishes which are generically distinct from their Atlantic slope relatives. In several cases these modifications themselves, aside from all others, are of generic importance, as in the genera *Archoplites*, *Meda*, *Lepidomeda*, *Columbia*, and the subgenus *Richardsonius*.

The modifications of the same set of organs being practically of the same nature, are unquestionably due to one definite cause. What that cause is I am at present unable to say. A comparatively short swift water-course, as most of the Pacific rivers have, suggests itself at once, but, as will be seen under the head of "Local

The *Petromyzontidæ* and *Centrarchidæ* were not secured by me, but Mr. A. J. Woolman found these families in the headwaters of the Red River system.

variations," the number of rays in these streams decreases with the altitude and swiftness of the stream. Moreover, the Pacific streams of South America have still shorter and presumably still swifter streams, and no such modifications are seen in the fishes inhabiting these waters.

The most striking case, that of *Leuciscus* (*Richardsonius*) is explained more fully in the chapter on local variations. In the subgenus *Richardsonius*, confined to the Columbia and to the Fraser systems, the number of anal rays varies from 12 to 25, an increase of from 2 to 15 rays over *Leuciscus*, some of whose species have also reached the headwaters of the Columbia, but whose usual habitat is the Atlantic slope. The genus *Oncorhynchus* has a similar increase of anal rays over *Salmo* and *Salvelinus*, which are genera of wider distribution, some of the species being found on the Atlantic, some on the Pacific, and some on both slopes. On the other hand *Thymallus* has a larger number of dorsal rays than any Pacific slope species.

The change from rays to spines is seen in *Archoplites*, *Meda*, etc. It is most strikingly marked in the change from *Percopsis* to *Columbia*, the only known genera of the *Percopsidæ*. The former is confined to the Atlantic, the latter to the Pacific slope. In the former, feeble unsegmented rays at the beginning of the dorsal and of the anal are developed into strong spines in the latter. Long ago Prof. Cope* noticed a similar modification as to spines in *Meda*. Prof. Cope says:

> As one of the most valuable results derived from a study of the collections, it appears that the basin of the Colorado River is the habitat of a small group of fishes of the family *Cyprinidæ*, which may be called the *Plagopterinæ*, which embraces three genera—*Plagopterus* Cope, *Lepidomeda* Cope, and *Meda* Girard. The group differs from others of the family in the possession of two strong osseous rays of the dorsal fin, the posterior of which is let into a groove in the hinder face of the anterior without being coössified with it, thus constituting a compound defensive spine. The rays of the ventral fin, excepting the first and second, are similarly modified. The greater part of their length consists of an osseous dagger-shaped spine, with grooved posterior edge, which overlaps the border of the succeeding ray, when the fin, like a fan, is closed up. The articulated portion of the ray either emerges from the groove below the free acute apex of the spine, or appears as a continuation of the apex itself. * * * Interest attaches to the *Plagopterinæ* as the only type of fishes not known from other waters than those of the Colorado and San Luis basins.

An interesting condition is seen in *Hysterocarpus*, the only fresh-water genus of the *Embiotocidæ*. It is confined to the Sacramento Basin and has 16 to 18 dorsal spines, as compared with 8 to 11 in the many marine genera. Unfortunately this is the only available example of the change from salt to fresh water.

I give here a detailed comparison of the rays of the Pacific fishes as compared with their Atlantic relatives, from which it will be seen, as stated above, that in every family the modification is noticeable, although in many cases it is minute. As far as possible the western and eastern representatives of the same forms are placed opposite to each other.

ACIPENSERIDÆ.

Species	Pacific slope.		Species.	Atlantic slope.	
	Dorsal.	Anal.		Dorsal.	Anal.
Acipenser transmontanus...	44-48	28-30	Acipenser sturio	38	27
Acipenser medirostris.....	33-35	22-28	Acipenser rubicundus.....	35	26
			Acipenser brevirostris	41	22

* Cope & Yarrow, Wheeler's Surveys, chapter VI, Report upon the Collections of Fishes made in portions of Nevada, Utah, California, Colorado, New Mexico, and Arizona.

CATOSTOMIDÆ.

Ictiobinæ.

[Lowland species which have not been able to cross the Rocky Mountains.]

Species.	Pacific slope.		Species.	Atlantic slope.	
	Dorsal.	Anal.		Dorsal.	Anal.
Not represented on Pacific slope.	.....	.....	Ictiobus	24-30	7-10
			Cycleptus	30	7-8

Catostominæ.

Pantosteus	10-12	.....	Pantosteus	9-12	.....
Catostomus	10-15	.....	Catostomus	11-12	.....
Xyrauchen	12-15	.....	Hypentelium	10-11	.....
Chasmistes	11-12	.....	Erimyzon	10-13	.....
			Minytrema	12	.....

Moxostominæ.

Not represented on Pacific slope.	.....	.....	Moxostoma	12-15	.....
			Placopharynx	13	.....
			Quassilabia	12	.....

The *Catostominæ* present one of the cases which, if found alone, would not bear evidence either in one or the other direction. The average number of rays is slightly larger on the Pacific side and the highest number of rays is also found on the Pacific slope. The *Ictiobinæ* and *Moxostominæ* are not represented on the Pacific slope.

CYPRINIDÆ.

[The species showing an increased number of rays on either slope are in italic.]

Genera.	Pacific slope.		Genera.	Atlantic slope.	
	Dorsal.	Anal.		Dorsal.	Anal.
Acrocheilus	10	9	Campostoma	8	7-8
Orthodon	9	8			
Lavinia	10	12			
			Chrosomus	7-8	8
			Oxygeneum	8	7
			Hybognathus	8	7-8
			Pimephales	8	8
			Exoglossum	8	7
			Cochlognathus	8	6-7
Tiaroga	8	7	Cliola	8	7
			Notropis	8 or 9	* 7-14
			Erizymba	8	8
Rhinichthys	8	7	Phenacobius	8	7
Agosia	8 or 9	7	Rhinichthys	8	7
Hybopsis	8	7-8			
			Hybopsis	8	8
			Couesius	8	7-8
Pogonichthys	9	8	Platygobio	8	8
Mylocheilus	8	8	Semotilus	7 or 8	7-8
Mylopharodon	8	8			
Ptychocheilus	8 or 9	8-9			
Gila	9-10	9-10			
Leuciscus.					
(*Richardsonius*) †	8	10-22	Leuciscus.		
(Tigoma)	8	8	(*Clinostomus*)	8-9	8-9
(*Squalius*)	8	8-10	(*Tigoma*)	8-9	8
(*Cheonda*)	9	7-10	(*Squalius*)	9	8
Myloleucus	8-9	7-8	(Cheonda)	8	7
			Myloleucus	8	8
			Opsopœodus	9	8
Luxulinus	10-11	11	Hemitremia	8	8
Lepidomeda	II, 7	9	*Notemigonus*	8-10	9-14
Meda	II, 7	8-10			

* 14 in one species, usually 7-9, in a few 10-12. † In this count the two rudimentary spines are omitted.

SALMONIDÆ.

Genera.	Pacific slope.		Genera.	Atlantic slope.	
	Dorsal.	Anal.		Dorsal.	Anal.
Oncorhynchus	9–11	13–17	Salmo	11–12	10
Salmo	11–12	10–12	Salvelinus	10–13	9–11
Salvelinus	11	9–11	Thymallus*	20	11

* *Thymallus* is probably an European element in the Eastern fauna

CYPRINODONTIDÆ.

This family of about fifty species is represented on the Pacific slope by but four species. Many of the forms are marine and only occasionally enter fresh water. To this class belongs the only species of *Fundulus* found on the Pacific slope. Leaving this out of consideration, we have *Cyprinodon baileyi* from the Pacific slope, with two more anal rays than any other *Cyprinodon*, but with two less than the highest number in *Fundulus*, and *Empetrichthys* with anal rays equal to the highest in the family:

Genera.	Pacific slope.		Genera.	Atlantic slope.	
	Dorsal.	Anal.		Dorsal.	Anal.
			Jordanella	I, 16–17	I, 11–13
Cyprinodon	10	10–13	Cyprinodon	10–12	10–11
Fundulus	13	11	Fundulus	10–17	8–15
			Zygonectes	7–11	8–14
			Lucania	9–13	9–11
			Gambusia	6–9	7–11
			Molliencsia	13	7
			Pœcilia	7	4
Girardinus	7	9	Girardinus	7	9
Empetrichthys	11–13	13–15			

GASTEROSTEIDÆ.

The species of those genera of *Gasterosteidæ* having representatives on both slopes are given in detail:

Species.	Pacific slope.		Species.	Atlantic slope.	
	Dorsal.	Anal.		Dorsal.	Anal.
Pygosteus brachypoda	X, I, 10	I, 10	Pygosteus pungitius	VII to IX–I, 9	I, 9
G. cataphractus	III, 11–13	I, 9 or 10	Gasterosteus aculeatus	III, 11 to 13	I, 9 or 10
G. microcephalus	III, 11–13	I, 9	G. atkinsii	III, 11	I, 8
G. williamsoni	IIII, 10	I, 7	G. wheatlandi	III, 10–12	I, 8
			G. dimidiatus	III, 12	I, 8
			Eucalia inconstans	IV, 1–10	I, 10
			Apeltes quadracus	III, I, 11	I, 8

In *Pygosteus brachypoda* we have an increase of one spine over the maximum number in Atlantic specimens (*Pygosteus pungitius*). In the genus *Gasterosteus* no influence is evident except in *G. williamsoni*, in which there is an increase of one dorsal spine.

CENTRARCHIDÆ.

The family *Centrarchidæ* offers an apparent exception, since some of the genera of this family have much longer fins than the only Pacific slope representative, as indicated by the following table:

Atlantic slope genera without representatives on the Pacific slope.

Genera.	Dorsal.	Anal.
Centrarchus	XI or XII, 12	VII or VIII, 15.
Pomoxis	VI–VIII, 15	VI, 18.
Chænobryttus	X, 9 or 10	III, 8 or 9.
Acantharchus	XI, 10	V, 10.
Enneacanthus	IX or X, 9–11	III–IV, 8–10.
Mesogonistius	X, 10	III, 12.
Lepomis	X, 10–12	III, 9–11.
Micropterus	X, 13	III, 12.

But a comparison of *Archoplites* with its nearest Atlantic slope relative gives the following interesting results:

Locality and species.	Dorsal.	Anal.
Pacific slope:		
Archoplites interruptus	XIII, 10	VII, 10
Atlantic slope:		
Ambloplites rupestris	XI, 10	VI, 10

Giving an increase of 2 spines in the dorsal and of 1 spine in the anal for the Pacific slope as compared with the nearest allied species, and an absolute gain of 1 dorsal spine over all the other genera of this family. As the comparison ought obviously to be limited to those genera or closely related genera having representatives on both sides, the contrast (between *Archoplites* and *Ambloplites*) is very striking.

COTTIDÆ.

In this genus the dorsal and anal rays in different species are as follows:

Species.	Pacific slope.		Species.	Atlantic slope.	
	Dorsal.	Anal.		Dorsal.	Anal.
C. asper	VIII, IX, or X, 20.	18	C. bairdi	VII, 16, 17	12½
			C. cognatus	VIII, 18	14
C. semiscaber	VII, 18	14	C. spilotus	VIII, 17	13
C. centropomus	VIII, 17	14	C. pollicaris	VII, 19	13
C. rhotheus	VIII, 15	11	C. viscosus	VI, 18	14
C. bendirei	VIII, 16	12	C. gracilis	VIII, 16	12
C. marginatus	VIII, 18	15	C. goboides	VII, 17	12
C. philonips	VIII, 19	14	C. boleoides	VIII, 17	11
C. beldingi	VI–VIII, 15–18	12	C. franklini	VIII, 17	12
			C. formosus	VIII, 16	11
			C. hoyi	VI, 15	11
Average	VIII–, 17⅛	14+	Average	VII, 17	12+

SUMMARY OF THE FOREGOING COMPARISONS.

1. The Pacific *Acipenser transmontanus* has a maximum of 7 more dorsal rays than any of the Atlantic species.

2. In the *Catostomidæ*, we have the genus *Xyrauchen* with 1 to 2 more rays than any of the Atlantic genera of *Catostominæ* and the genus *Catostomus* with species having 2 more dorsal rays than any of the Atlantic species of the same genus.

3. In the *Cyprinidæ*, *Lepidomeda* and *Meda* differ from all other American species in the development of spines in the dorsal fin. The genera *Acrocheilus*, *Lavinia*, *Pogonichthys*, *Gila*, and the subgenera *Richardsonius*, *Squalius*, and *Cheonda* all have more rays than their Atlantic relatives. The greatest absolute gain in the number of rays over all Atlantic slope species amounts sometimes to 8 rays. To offset this we have only some species of *Notropis* and *Notemigonus* with rays exceeding the usual number on the Pacific slope. In this family both the modifications are found.

4. In the *Salmonidæ*, the species of the genus *Oncorhynchus* have 13 to 17 anal rays, while the highest number in the Atlantic species reaches no more than 11 rays.

Thymallus, on the other hand, has a larger number of dorsal rays than any other American salmonoid.

5. In the *Percopsidæ*, the feeble armature of *Percopsis* is changed into the strong spines of *Columbia*.

6. In the *Gasterosteidæ*, *Pygosteus brachypoda* and *Gasterosteus williamsoni* have each 1 more dorsal spine than any of their Atlantic congeners.

7. In the *Centrarchidæ* we have an absolute gain of 1 dorsal spine over all Atlantic slope genera, while the gain is 2 dorsal spines and 1 anal spine in *Archoplites* as compared with its nearest relative *Ambloplites*.

8. Finally in the *Cottidæ*, *Cottus asper* reaches a higher number of dorsal spines and rays and of anal rays than is ever reached in the numerous Atlantic slope species of this genus. The average number of dorsal spines is 1 more on the Pacific slope than on the Atlantic slope, while the average number of anal rays is higher by 2.

These data fully warrant the statement made at the beginning of this chapter that "almost every family of fishes having representatives in the fresh waters of both the Atlantic and the Pacific slopes has one or more of its representatives modified in one or the other of two directions: There is either a larger number of rays or spines in the fins, or some of the rays have become modified into spines."

EXTENT OF VARIATION BETWEEN THE PACIFIC SLOPE SPECIES OF THE DIFFERENT FAMILIES AS COMPARED WITH THE ATLANTIC SLOPE SPECIES OF THE SAME FAMILIES.

Utilizing the data contained in the detailed lists in the preceding chapter, we obtain the following:

Families having both Atlantic and Pacific Slope species.	Pacific slope.		Atlantic slope.	
	Dorsal.	Anal.	Dorsal.	Anal.
Acipenseridæ:				
Highest number of rays	48	30	41	27
Lowest number of rays	33	22	35	22
Extent of variation	15	8	6	5
Catostominæ:*				
Highest number of rays	15	.....	13	.....
Lowest number of rays	10	.....	10	.....
Extent of variation	5	.....	3	.....
Cyprinidæ:				
Highest number of rays	11	22	10	14
Lowest number of rays	8	7	7	6
Extent of variation	3	15	3	8
Salmonidæ:				
Highest number of rays	12	17	20	†15
Lowest number of rays	9	9	11	9
Extent of variation	3	8	9	6
Cyprinodontidæ:				
Highest number of rays	13	15	17	15
Lowest number of rays	7	7	7	7
Extent of variation	6	8	10	8

*For obvious reasons subfamilies of *Catostomidæ* not found in Pacific waters are not taken into consideration.
† Or if we leave out of consideration *Thymallus*, we obtain dorsal 13; anal 11.

In the following spiny-rayed fishes the combination of highest number of spines and rays need not occur in the same species:

Families having both Atlantic and Pacific Slope species.	Pacific slope.		Atlantic slope.	
	Dorsal.	Anal.	Dorsal.	Anal.
Gasterosteidæ:				
Pygosteus—				
Highest number of spines and rays	X, I, 10	I, 10	IX, I, 9	I, 8
Gasterosteus—				
Highest number of spines and rays	IV, 13	I, 10	III, 13	I, 10
Lowest number of spines and rays	III, 10	I, 7	III, 11	I, 8
Extent of variation	I, 3	3	2	2
Eucalia	.....	.....	IV, I, 10	I, 10
Apeltes (brackish water of Atlantic coast)	.....	.....	IV, 11	I, 8
Total extent of variation in Gasterosteidæ	VIII, 3	3	VII, 4	2
Centrarchidæ (only a single specimen found on Pacific slope).				
Cottidæ:				
Highest number of spines and rays	X, 20	18	VIII, 18	14
Lowest number of spines and rays	VII, 15	12	VI, 15	11
Extent of variation	III, 5	6	II, 3	3

We learn from these tables that in all families but the *Cyprinodontidæ* with more than one species on the Pacific slope the extent of variation is greater than in the same families on the Atlantic slope.* This might have been expected if the number of species were greater on the Pacific than on the Atlantic slope, but in most cases the reverse is true, as may be seen from the following table:

Family or subfamily.	Pacific slope.		Atlantic slope.	
	Genera.	Species.	Genera.	Species.
Acipenseridæ	1	2	2	4
Catostominæ	4	21	4	11
Cyprinidæ	17	75	21	175
Salmonidæ	3	12	4	12
Cyprinodontidæ	4	5	9	About 45
Gasterosteidæ	2	4	4	7
Centrarchidæ	1	1	9	26
Cottidæ	1	8	1	12

I can conceive of but three possible explanations for this variation:

(1) The Pacific slope fauna may be new as compared with the Atlantic. The comparatively new conditions may have thrown the characters into a condition of unstable equilibrium with the selection of the adapted forms. The fluctuations in the fin rays of some of the species would lend weight to such a supposition.

(2) The Pacific slope fauna may be of diverse origin.

(3) Both of these factors may have contributed to bring about the present condition.

This last seems to me to be the true solution. Most of the forms have undoubtedly been derived within comparatively recent time from the Atlantic slope of North America, while others have a decidedly Asiatic cast.

Acipenser and *Oncorhynchus* are certainly of Asiatic origin. While I am not sufficiently acquainted with Asiatic minnows to speak with certainty, some of the genera of minnows seem to have a decided Asiatic affinity.

Many of the *Catostominæ*, the *Cyprinidæ*, and *Salvelinus*, *Archoplites*, and probably *Cottus* have all been derived from forms from the eastern slope of North America.

* The only other exception is introduced by *Thymallus*.

LOCAL VARIATIONS.*

Since all structures differing from the average are usually confined to a definite horizon or more or less restricted region, all such differences may be considered local variations. The larger zoogeographical regions or provinces are in this extended sense localities, and the orders, families, or species are the local variations peculiar to the region or province. A somewhat more restricted definition would include such phenomena as are noticed in the peculiar modifications of the fins of Pacific slope fresh-water fish described in the previous chapter. Some *Cyprinidæ* of the Colorado basin, for instance, have the anterior dorsal rays strong and spinous, while all the Atlantic slope species have them weak and rudimentary. Another instance is the increased number of rays in the fins of Pacific slope fishes. Still another instance is offered by the *Percopsidæ*. *Columbia* has strong spines in both the dorsal and anal fins, while *Percopsis*, the Atlantic slope genus, has none.

For the present purpose I want to restrict the meaning still further. In studying the South American catfishes, I found that all the Amazonian species of the genus *Rhamdia* have 6 dorsal rays, while several of the southern forms have more. One peculiar to the La Plata has 6–9; another from the San Francisco has 10 rays. More remarkable still is the case of *Pseudopimelodus zungaro*. All the specimens taken in the Amazon have 6 dorsal rays, while of a smaller number taken further south several have 7 dorsal rays.

It is to variations like the last, *i. e.*, variations within the species or closely related species found in different localities within a restricted region, that I want to confine my present remarks. Variations within species are a matter of lines and curves, minute measurements, and shades of color: all matters difficult to keep in mind, still more so to represent to others. All naturalists are aware of the existence of slight differences peculiar to different localities, but such variations are usually but vaguely conceived by the observer, and still more vaguely by any one to whom the observer may attempt to explain them.

The past summer I collected a large series of specimens of *Leuciscus* and *Richardsonius*. These were taken in a number of different localities and in two separate river systems, the Columbia and the Fraser. The localities extend from tide water to an elevation of 1,900 feet on the Fraser, and from 300 to 4,700 feet on the Columbia system. I have also examined a number of specimens collected by Dr. Jordan in Utah. There were in all 296 specimens which I was personally able to examine. In these specimens the local variations are so well marked that a graphic method of demonstrating the variations is possible.

Before attempting to explain the charts which illustrate this matter, it is necessary to state that there have been known from the two river systems two groups or genera of *Cyprinidæ* having elongate anal fins. These were *Richardsonius* (*balteatus* and *lateralis*) and a section of *Leuciscus* (*montanus*, *hydrophlox*, and *gilli*). There are, first, variations which do away with the genus *Richardsonius*, as distinct from *Leuciscus*; second, a number of variations which, while very striking, need not be taken into consideration, because the variations in a single character are sufficient for our purposes. We shall limit the observation to the variation in the number of anal rays.

* Read at the December meeting of the Indiana Academy of Sciences, 1892.

In the American genera of *Cyprinidæ* the number of anal rays is usually fixed within two or three for any genus. In the group of fishes under consideration the number varies within 12.

Now a word as to the charts. The vertical lines on plates 7 and 8 represent the number of anal rays, beginning on the left with the lowest number observed and ending on the right with the highest. A certain height (100 mm.) is taken to represent 100 per cent. The height of the curve on each vertical line is made to represent the per cent of specimens having that particular number of rays expressed in millimeters of height.

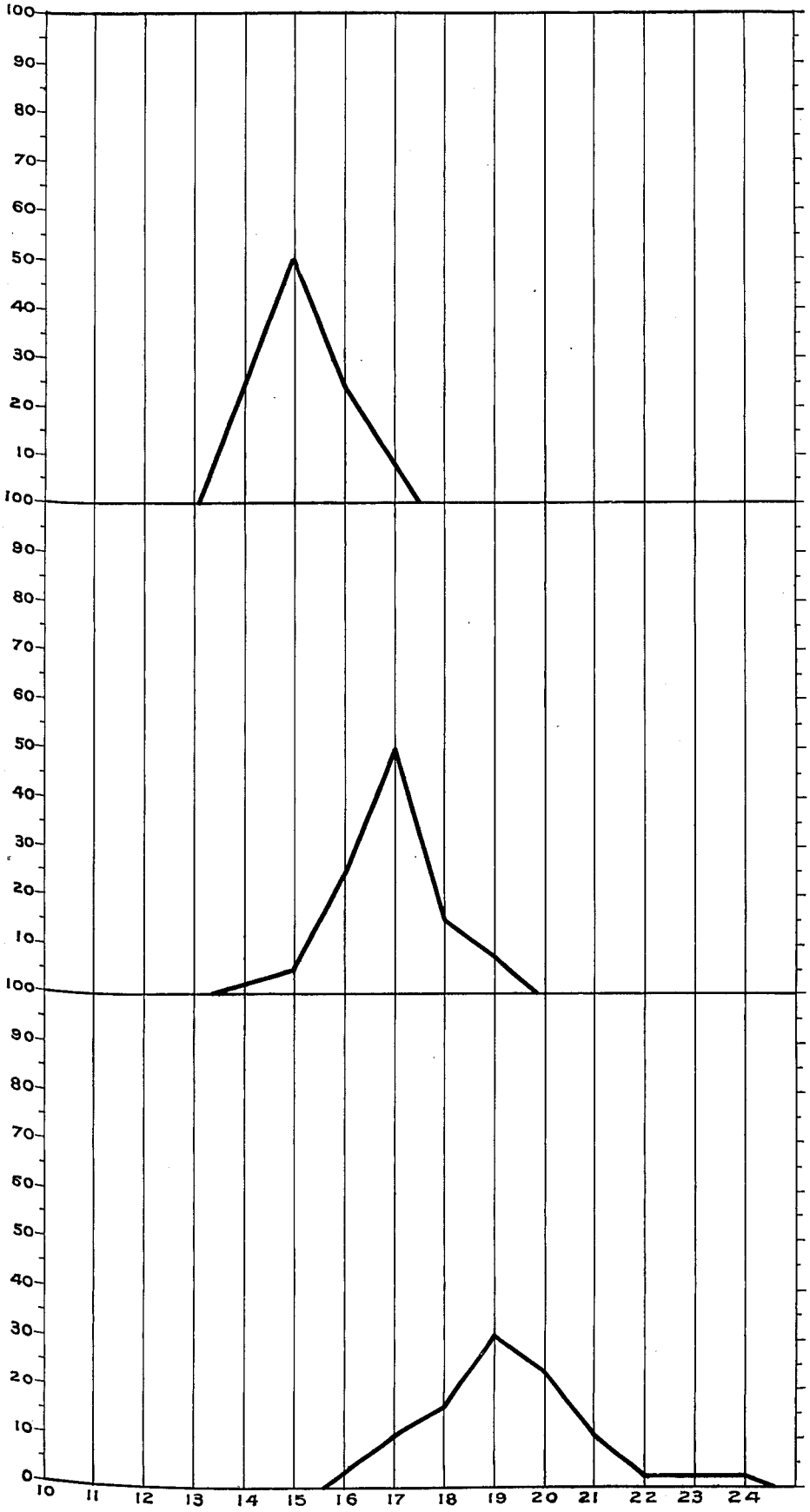
In the table below the numbers in the headings represent the numbers of anal rays found in specimens of *Richardsonius*, and opposite each locality is given the number of specimens from that locality possessing the given number of rays. Thus from Idaho Falls, 2 specimens had 12½ rays in the anal, 14 specimens had 13½ rays, and 4 specimens had 14½ rays. At the bottom is given the nearest per cent that the sum of any given column bears to all the (300) specimens examined.

Locality.	Elevation.	Number of rays in the anal.												
		11½.	12½.	13½.	14½.	15½.	16½.	17½.	18½.	19½.	20½.	21½.	22½.	23½.	24½.
	Feet.														
Provo River (*montanus*)		....	26	12	....	....	....	....	....	....	....	....	....	....	....
Columbia Basin.															
Idaho Falls (*hydrophlox*)	4,712	....	2	14	4	....	....	....	....	....	....	....	....	....	....
La Grande	2,786	....	....	....	2	6	11	4	....	....	....	....	....	....	....
Golden	2,550	....	....	....	1	7	5	4	1	....	....	....	....	....	....
Caldwell	2,372	....	....	....	1	2	6	7	8	7	2	1	....	....	....
Revelstoke	1,475	....	....	....	....	1	....	....	....	....	....	....	....	....	....
Umatilla	300	....	....	....	....	....	....	1	5	1	2	1	....	....	....
Fraser Basin.															
Griffin Lake	1,900	....	....	3	3	7	3	1	....	....	....	....	....	....	....
Sicamous	1,300	....	....	..	1	3	13	28	8	5	....	....	....	....	....
Kamloops	1,158	....	....	....	....	....	....	....	....	....	1	1	....	....	....
Mission	1	....	....	....	....	....	2	7	13	25	18	8	2	2	2
Per cents.		....	9	9	4	8	13	17	11	12	8	4	1	1	1

Taking all the specimens recorded (300), adding the columns, and representing the variations in the anal rays in a curve,* we find that there is a certain number of shoulders or peaks. Each of these represents a distinct species or variety. The extent of intergradation can be measured by the depth of the valley between any two peaks. In well-separated species the slopes of the two peaks would not meet. Now it will be noticed that the depth of the valley between the two right peaks is quite shallow; and, in fact, I find the variation almost perfect between *L. balteatus* and *lateralis*, the two varieties represented by these two peaks. The valley between the middle one and the two on the left is deep. In other words, *L. lateralis* is well separated in the character under consideration from *L. hydrophlox* and *montanus*, the species represented by the peak to the left. On the other hand, the latter species merge into each other perfectly in the number of rays.

I have represented in a double curve or composite photograph, as it were (plates

* By an oversight this curve has been omitted. The height of the curve in millimeters at various points is indicated by the numbers at the bottom of the table. With these the curve can easily be constructed by using the lines of plate 7 or plate 8.



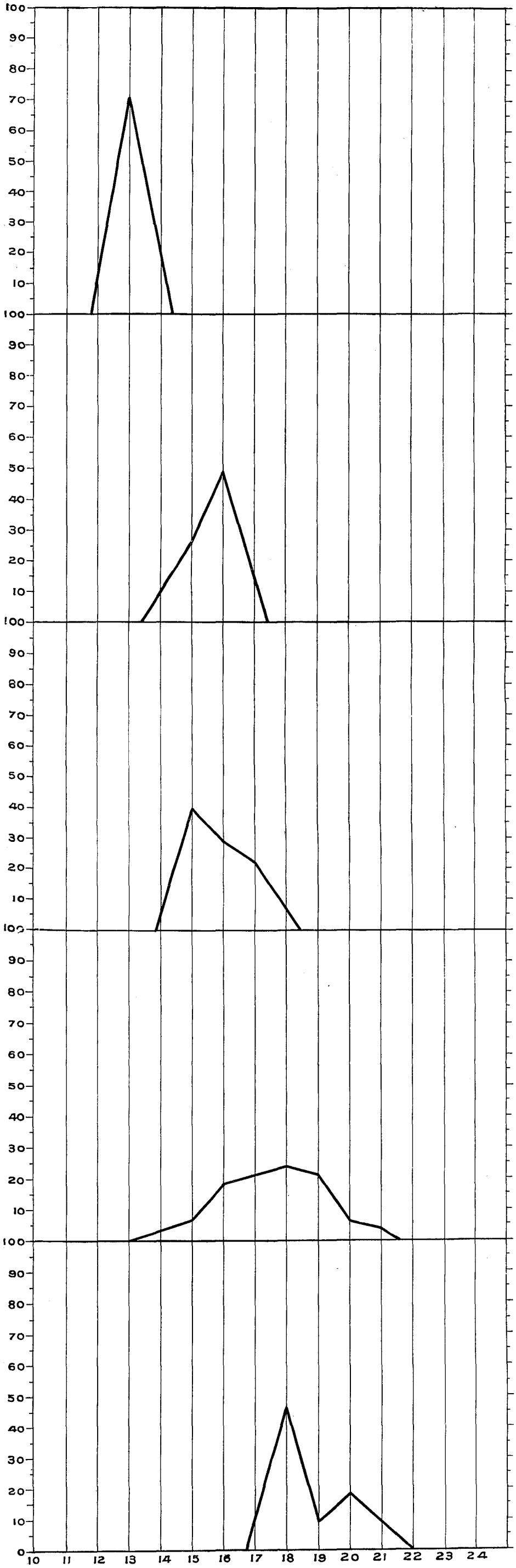
Griffin Lake; altitude, 1,900 feet.

Sicamous; altitude, 1,800 feet.

Mission; altitude, 1 foot.

LOCALITY CURVES OF THE ANAL FIN OF LEUCISCUS LATERALIS AND BALTEATUS IN THE FRASER BASIN.

Below are given the anal rays, on the left the percents to 100. The curves represent the percents of specimens having the given number of anal rays. At Mission the greatest percent have 19 anal rays, at Sicamous 17, and at Griffin Lake 15.



Idaho Falls; altitude, 4,712 feet.

La Grande; altitude, 2,786 feet.

Golden; altitude, 2,550 feet.

Caldwell; altitude, 2,372 feet.

Umatilla; altitude, 300 feet.

LOCALITY CURVES OF THE ANAL FIN OF LEUCISCUS LATERALIS AND HYDROPHLOX IN THE COLUMBIA BASIN.

Figures as in plate 7. The uppermost curve represents *Leuciscus hydrophlox*, the others *Leuciscus lateralis*.

7 and 8), the variations in the one point, the number of anal rays for each locality where a sufficient number of specimens were obtained. It will be seen that while the curves for different localities in some cases resemble each other closely, there are no two which are exactly alike. In other words, each locality has its own variety, which in the aggregate is different from the variety in every other locality.

In order to have these curves give exact results an equal number of specimens ought to have been taken from each locality, but this was impossible, and the curves are therefore based on different numbers of specimens. The highest point would probably in no case be moved either to the right or to the left by an examination of a larger number of specimens, but the width of the curve would probably be greater and the height along the different perpendicular lines might be greater or less. In other words, the smaller the number of specimens the higher and narrower will be the curve.

There are presented three curves for three localities with different altitudes on the Fraser system (plate 7). The number of specimens was, respectively, 79, 58, and 14; the elevation 1, 1,300, and 1,900 feet. The variation is seen to be much greater in the lowest locality, a fact which can not be entirely attributed to the greater number of specimens examined, for the variation from the normal, which is 19 rays, to a higher number of rays, is as great as the entire variation for the next locality.

In the second locality a much larger per cent have the normal number of rays, but the normal number has been decreased to 17. The specimens from this locality, with two exceptions, I have identified as *L. lateralis*. Those from the first locality, Mission, represent *L. balteatus*.

The third list is interesting from the fact that the normal number of rays is again moved two rays to the left. In other words, the higher the altitude the fewer the number of rays and the narrower the limits of variation. Moreover, the curves are not symmetrical for any of the three localities, but in the aggregate the more gradual slope is on the side of an increased number of rays, a condition which, considering the general variation of rays on the Pacific Slope, seems to indicate that the number of rays of the species of this genus in the Fraser system is increasing and that the increase is progressing from lower to higher altitudes.

The curves for the Columbia system (plate 8) are not so unanimous in their indications. It will, however, be noticed that, with one exception, they show that the number of rays decreases with the increase of the altitude, the highest point examined, Idaho Falls, having the fewest rays. These specimens represent *L. hydrophlox*, which, with *montanus*, does not descend from the mountains or high plateaus.

The greatest variation in this system was not at the lowest altitude, but at an elevation of 2,372 feet. None of the curves are symmetrical, but the asymmetry is again, as in the Fraser system, greater on the right than on the left. The variation is again greater toward the higher number of rays than toward the lower.

I am not aware that a similar attempt has been made before to represent variations between localities. While the curves here given will no doubt vary slightly with every additional specimen examined, the nature of the curve will probably not be greatly changed. Certainly the important point, that each locality has a variety which in the aggregate is different from the variety of every other locality, can not be gainsaid; nor are additional specimens likely to overthrow the generalization that the number of rays in the species considered decreases with the altitude.

GENERAL SUMMARY OF THE RESULTS.

The fish fauna of the whole region traversed is poor in comparison with that of the streams of the Ohio Valley. I obtained in all but 65 species, about 20 per cent of which were new to science. They belong to 14 families and 37 genera. In the Winnipeg system, *i. e.*, in the whole region drained by the tributaries of Lake Winnipeg, only 3 of the 10 families characterizing the Nearctic region were obtained, and the Pacific Slope contains only two.

The following notable additions to the knowledge of the North American fauna were made by these explorations:

1. A species of *Pantosteus* (*P. columbianus*= *P. jordani* of the Missouri) discovered on the Pacific Slope.
2. *Noturus flavus* found at the base of the Rockies at Craig, Mont.
3. Four new species of *Notropis* added to the east-Canadian fauna.
4. Two new species of *Agosia* added to the Pacific fauna.
5. A new species of whitefish (*Coregonus coulteri*) discovered in the Rocky Mountain streams of a restricted region in British Columbia.
6. The family of *Percopsidæ* found to have a representative on the Pacific Slope in the new genus *Columbia*.
7. Several species of *Etheostoma* found in Canada, among them two new species.
8. One new *Cottus* (*C. onychus*) added to the fauna of the Saskatchewan.
9. A new *Cottus* (*C. philonips*) discovered in the Kicking Horse at Field.
10. A species of *Lota* reported both in the Columbia and the Fraser. A specimen since secured from the Columbia.
11. It was discovered that the fins of the fishes of the Pacific Slope vary from the fins of fishes of the Atlantic Slope in definite directions.
12. The extent of variation between the species of any given family of fishes on the Pacific coast was found to be greater than that between the species of the same family on the Atlantic Slope.
13. *Richardsonius* was proved to be a subgenus of *Leuciscus*. Its species were found to vary directly with the locality. Each locality examined has a variety which in the aggregate differs from the variety of every other locality.

NOTE.—Since this paper has been put in type Drs. Jordan and Evermann have placed the proofs of the Fishes of North America in my hands, and I have adopted all the changes in nomenclature suggested by them up to *Cyprinidæ*. Dr. Jordan has also made many suggestions regarding the chapter on "Structural Peculiarities," etc., p. 122. I have not been able to give these suggestions the attention they merit, but they will receive due consideration in a more detailed study of this subject.