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*New Fishes from the Continental Tertiary of Alaska*

BY ERICH M. SCHLAIKJER

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Article I.—NEW FISHES FROM THE CONTINENTAL  
TERTIARY OF ALASKA

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FIGURES 1 TO 7; 1 FOLDING MAP

INTRODUCTION

Geologists and paleontologists have long held that the shallow waters of what is now Bering Strait have periodically receded during at least the past two hundred million years to form a land bridge between Alaska and Siberia. This land bridge has been considered the thoroughfare, across which waves of animals, and forests of plants, probably have migrated back and forth between the Old and New Worlds since the close of the Paleozoic. Ample evidence of this is shown by the many closely related fossil forms that have been recorded from North America and the Old World. From Alaska itself has come a wealth of Pleistocene fossil vertebrates, and from there abundant Mesozoic and Cenozoic floras are known. That Territory, however, had never produced even a fragment of a pre-Pleistocene vertebrate.

Although a considerable amount of geological investigation has been carried out in Alaska, it is not surprising that pre-Pleistocene vertebrates were not found. The United States Geological Survey, since the beginning of its work in 1895, has been occupied mostly with exploration, reconnaissance mapping, and economic geology. Likewise, no party had ever been sent to explore the Alaskan continental Mesozoic and Tertiary deposits for vertebrate remains.

It was decided, therefore, that the writer should conduct, during the field season of 1936, an expedition to Yukon Territory and Alaska for the American Museum to make a reconnaissance survey particularly of the Tertiary deposits. This survey was to involve a search for pre-

Pleistocene vertebrates, a study of the Tertiary sediments especially from the point of view of their origin, and a determination of the most promising localities for future detailed investigation.

Arriving at Skagway, Alaska our party traveled to Dawson, in Yukon Territory by rail and by regular river steamer. At Dawson a thirty-two foot power scow was purchased and was our sole means of transportation throughout our work to Circle, Alaska. From Circle we traveled to Fairbanks, visiting by airplane the area near the mouth of Hess Creek on the Yukon River, and went south by rail to Healy and on to Anchorage. At Anchorage we chartered an airplane and flew northeast into the Chicklooon River country of the upper Matanuska valley. After returning to Anchorage we again went north to Fairbanks, from whence we did a considerable amount of aerial investigating along the north flank of the Alaska Range. We then flew from Fairbanks to Dawson, and returned to Skagway via our previous route. The course of our journey is shown on the accompanying map.

Most of the major areas in which Tertiary formations occur in Yukon Territory west of Dawson, and in Alaska were visited. These are located in the region from Dawson to Circle, in the vicinity of Fairbanks, in the Alaska Range—especially on the north flank—and in the Matanuska valley.

One of the most outstanding results of the expedition was the discovery of a quarry of freshwater fishes approximately six and one-half miles above the mouth of Healy Creek—a tributary of the Nenana River. About two dozen specimens were collected from this quarry. These are the first pre-Pleistocene vertebrates found in Alaska, and the honor of being the discoverer of the first specimen goes to my accomplished assistant Mr. David Bradley Cheek who was first to pick up a fragment on the talus slope at the quarry site. Two new genera and species are represented by most of the specimens in the collection, and the major part of the present paper is devoted to a study of these new forms.

I wish to express my thanks to Dr. Charles Camsell and other members of the Canadian Department of Mines for the coöperation shown in connection with our work in Canada. I am also appreciative of the courtesies extended to myself and party by the Offices of Interior, and Immigration and Colonization of the Dominion. It is a pleasure to acknowledge the friendly assistance received from the Honorable G. A. Jeckell, Comptroller of Yukon Territory, and from Major T. B. Caulkin, officer commanding "B" Division of the Royal Canadian Mounted Police in the Territory. I am especially indebted to President H.



Wheeler of the Whitepass and Yukon Route and to Mr. Charles Viquain, agent at Dawson, for their many kindnesses.

Members of the expedition were, Messrs. David B. Cheek, Louis du Pont Irving, and John Wolbach. The trip was made possible through the generosity of Dr. S. B. Wolbach, Mr. Louis du Pont Irving, Mr. James Dennison, and an anonymous friend of the American Museum.

## DESCRIPTION

### PERCOIDEI

### Centrarchidae

#### **BOREOCENTRARCHUS,<sup>1</sup> NEW GENUS**

TYPE.—*Boreocentrarchus smithi*, new species.

DISTRIBUTION.—?Miocene, north flank of the Alaska Range, Alaska.

DIAGNOSIS.—Medium to large centrarchid. Relatively deep-bodied, the greatest body depth one-third the entire length. Fin formula as follows: D. XI, 12-?13; C., 17; A. VII, 12-13; V. I, 5; P., 13. Spinous portion of the dorsal slightly longer than soft portion. Dorsal fin begins above the posterior of the pectoral fin base. Distance from posterior of dorsal to caudal short. Face steep and mouth small. Minute teeth on dentary, premaxillary, and branchial apparatus. Opercular notched. Scales large.

#### **Boreocentrarchus smithi,<sup>2</sup> new species**

TYPE.—Amer. Mus. No. 8200 (Ichthyology). A nearly complete fish. Collected by E. M. Schlaikjer, Amer. Mus. Yukon Territory-Alaskan Expedition, 1936.

PARATYPES.—Amer. Mus. Nos. 8201, 8202, and 8203 (Ichthyology). Nearly complete fishes.

HORIZON AND LOCALITY.—Tertiary coal-bearing beds, ?Miocene. Approximately six and one-half miles above the mouth of Healy Creek on the east bank of a small tributary entering from the south.

DIAGNOSIS.—Sole known species of genus.

This species is represented by ten fine specimens and at least a dozen more or less fragmentary ones. The preservation of the material is most unusual. In the first place, the siltstone in which the fish were buried has undergone considerable static pressure; and secondly, the deposit has been subjected to some baking due to the burning out of a coal seam a few feet below the level at which the fossils occur. This has resulted in such compression and alteration of the fish that they are preserved almost as impressions only.

*Boreocentrarchus smithi* presents considerable size variation, ranging

<sup>1</sup> Βόρεος, of the north; *Centrarchus*.

<sup>2</sup> Named for Dr. Phillip Sidney Smith, Chief Alaskan Geologist, United States Geological Survey.

from approximately 140 to 290 millimeters in total length. There seems to be, however, no other striking changes from the young, or small, to the large specimens. In general form this species is fairly deep-bodied. The entire length of the fish is always about three times the depth.

The head is large. It constitutes a little over one-third the distance from the tip of the snout to the base of the caudal fin. The mouth is small and is turned obliquely upward. The dentary and premaxillary present quite a formidable array of minute conical teeth. In several specimens clusters of similar teeth can be observed immediately behind the orbit where the preopercular and opercular have been broken away. This means that teeth are present on the branchial apparatus, although most elements of the latter are not distinctly preserved. It is not possible to determine if teeth were present on any of the other mouth parts. Neither is it possible to ascertain the limits of some of the skull elements. The orbit is large, and the distance from its posterior border to the preopercular is short. The preopercular does not seem to be serrated. The opercular is large, and is openly notched postero-dorsally. In nearly all specimens, the branchiostegals are covered over by scale impressions, but in one specimen six are shown. It is possible, however, that there may be seven.

The scales are faintly ctenoid. Beneath and behind the orbit, they are small, but the suborbital number of rows cannot be accurately counted. The scales on the body are large, and there seem to be twenty or twenty-two rows under the third spine of the dorsal. The lateral line is distinct.

The dorsal fin begins at a point above the posterior of the pectoral fin base. It is somewhat larger than the anal, and its spinous and soft portions are confluent. There are eleven spines and they increase in length and robustness from the first to the eleventh. The spinous portion is slightly longer than the soft. The distance from the posterior margin of the dorsal fin to the caudal is short. The caudal is slightly furcate and is composed of seventeen principal rays. The anal fin is somewhat smaller than the dorsal, and it begins slightly posterior to the middle of the spinous portion of the latter. It has seven spines and, as in the dorsal, the last is the largest. The number of soft rays is either twelve or thirteen. The pelvic fin is located directly beneath the pectoral, and extends posteriorly to just beyond the front of the anal. It has a single rather stout spine, and whenever the rays can be counted the number seems to be five. The pectoral is large and the number of rays can be considered tentatively as thirteen.

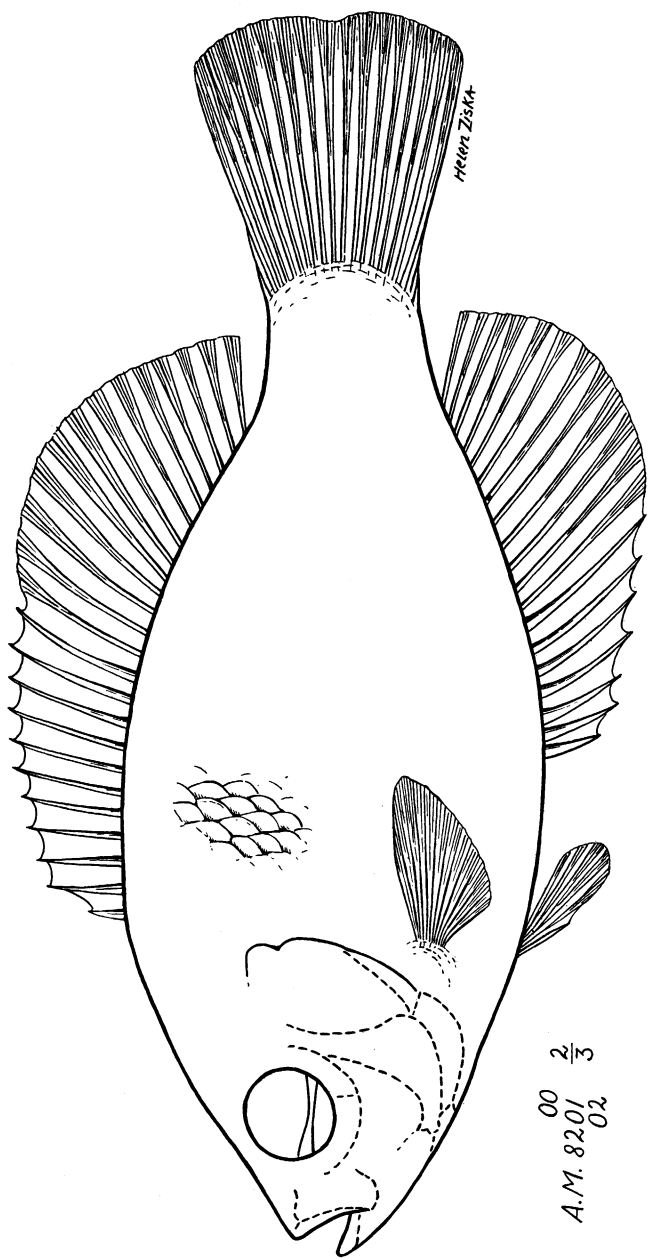


Fig. 1. *Boreocentrarchus smilhi*, new genus and species. Drawing based on Amer. Mus. Nos. 8200, 8201, and 8202 (Ichthyology).



## AFFINITIES

That *Boreocentrarchus smithi* is a centrarchid seems unquestionable. The family Centrarchidae, although closely related to the Serranidae, is a very natural group. Jordan and Gilbert (1883, p. 463) and others regard the reduction or absence of pseudobranchiae in the Centrarchidae as the real distinguishing character of this family. This character, of course, cannot be studied in fossil forms. Tate Regan (1913, p. 115) stresses the absence of a subocular shelf and the attachment of the ribs, and says that in the Centrarchidae the latter are "inserted high up on the centra or on the basis of the neural arches above and behind the parapophyses." While in the Serranidae the subocular shelf is present and, "some or all of the ribs inserted on parapophyses" (p. 113). The peculiar preservation of the Alaskan specimens is such that nearly all of the internal skeleton is obliterated by the scales, so even this character is useless for the present purposes. Nevertheless, in its external characters such as the large number of spines in the anal fin, and in the confluence of the spinous and soft portions of the dorsal, *B. smithi* is decidedly a centrarchid. So close is the similarity with the recent forms that it might be said, *Boreocentrarchus* is a centrarchid if the recent *Centrarchus* itself is one.

Of the known fossil forms, *Boreocentrarchus* is most closely related to *Plioplarchus*. This genus with two species, *P. whitei* and *P. sexspinosus*, was described by Cope in 1883. For the genus he gave the following diagnosis, "Teeth few, simple and conic. No indication of large pharyngeal bones. Preoperculum entire-posteriorly and at the angle; inferior edge unknown. Operculum rounded, entire. One dorsal fin. Anal fin commencing below the middle of the spinous radii. Caudal fin openly emarginate. Lateral line continuous, uninterrupted" (p. 414). The genoholotype, *P. whitei*, is an excellently preserved specimen, but *P. sexspinosus* was based on two mutilated specimens, each lacking the head region. The main distinction Cope made between the two species was in fin formulae which he gave as follows:

*P. whitei*, D.IX, 12; C. + 17 +; A.V, 14; V.?.; P.13.

*P. sexspinosus*, D.X, 13; C. + 17 +; A.VI, 9.

He did state, however, that in the latter species the anal rays were injured and that there may have been more than nine. Only *P. whitei* was figured by Cope (1884, Pl. 24G, fig. 1). These specimens are in the National Museum. In 1917, Eastman published a paper on fossil fishes in that institution, and figured a specimen (No. 8118) which he rightfully referred to *P. sexspinosus*. He pointed out that the anal fin of this specimen has six spinous and twelve soft rays. I have studied the Na-

tional Museum material and have found that this character is shown in still another fine specimen (No. 11319) in that collection. In addition, I have had the privilege of studying a collection of *Plioplarchus* specimens in the American Museum, in which *P. sexspinosus* is represented by five, and *P. whitei* by ten specimens. These were collected by Mr. John S. Larimer of Glendive, Montana, from Oligocene beds on Sentinel Butte,<sup>1</sup> Golden Valley County, North Dakota. This is the type locality of both *P. whitei* and *P. sexspinosus*, and the locality from which all of the above mentioned materials were collected.

In the light of this new material it has been possible to substantiate and elucidate the characters of both species. The only outstanding difference between them is to be found in the fin formulae, which may now be given as follows:

*P. whitei*, D.IX, 12; C. 17; A.V, 14; V.I, 5; P. 13.

*P. sexspinosus*, D.X, 13; C. 17; A. VI, 12-13; V. I, 5; P. 13.

These fin characters, and the additional feature of the confluence of the spinous and soft portions of the dorsal fin, together with the other characters of the skeleton as set forth by Cope, show that this Oligocene genus is a primitive Centrarchid. It should, therefore, be placed in the family Centrarchidae, and not in the Percidae as was done by Eastman (1917, p. 294), Hay (1929, p. 780), and others.

Both species of *Plioplarchus* are small. The largest specimen I have seen is one in the American Museum collection, assignable to *P. sexspinosus*, that is nearly six inches in total length. Compared with *Boreocentrarchus* perhaps the most striking differences between it and the two *Plioplarchus* species is one of size. The average Alaskan specimen is about twice as large as the average *Plioplarchus*. In addition, the more important characters in which *Plioplarchus*, as represented by *P. whitei* and *P. sexspinosus*, differs from *B. smithi* are as follows:

1. Proportionately not as deep-bodied.
2. Mouth relatively larger.
3. Posterior margin of the opercular complete.
4. Dorsal fin originates quite far back.
5. Dorsal and anal fins with fewer spines.
6. Distance from posterior of dorsal to base of caudal is proportionately longer.

These characters show that *Plioplarchus* and *Boreocentrarchus* are

<sup>1</sup> Sentinel Butte is a prominent topographic feature just south of the town by the same name in Golden Valley County, western North Dakota. The topmost forty feet of this butte are composed of clay and limestone beds which have supplied the *Plioplarchus* specimens. These beds rest on the Fort Union of the Paleocene and were first described by Dr. C. A. White (1883, pp. 411-419) who correlated them with the Green River Eocene of Southwestern Wyoming. Leonard studied this deposit (1922, pp. 224-226) and concluded quite logically, I think, that it is lower White River in age.

generically distinct. Nevertheless, the two forms are quite closely related, for in all of their other important characters they are very similar.

There is one more fossil species with which *Boreocentrarchus* should be compared. In 1889, Professor Cope (pp. 625–626) recorded four mutilated specimens from the John Day Basin of Oregon and referred them to a new species which he named *Plioplarchus septemspinosus*. Cope regarded the age of the bed in which these specimens were collected as older than what is known as the John Day Oligocene. The beds are now known to be unquestionably Mascall (upper Miocene) in age (Merriam, 1901, pp. 305–310; Merriam and Sinclair, 1907, pp. 195–197).

Many characters of *Plioplarchus septemspinosus* are indeterminable because the specimens are so badly injured. A considerable number of the more salient features, however, are preserved, and aid greatly in determining its taxonomic position. *P. septemspinosus* belongs to the Centrarchidae. But its place in the genus *Plioplarchus* may be questioned since in some, at least, of the more important characters, it is quite different from either *P. whitei* or *P. sexspinosus*. In the first place, it is a large species. The largest specimen of Cope's measures 260 millimeters from the tip of the jaw to the base of the caudal fin, and has a maximum body depth of 90 millimeters. Then, too, the position of the dorsal fin is more anterior, and there is a greater number of spines in the dorsal and anal fins, the known fin formula being D.XI, ?; A.VII, ?12. In all of these characters, *P. septemspinosus* is decidedly much closer to *Boreocentrarchus*, and on the basis of this perhaps ought to be placed in that genus. In general form, however, it is less deep-bodied. Likewise, there are several features such as the number of rays in the fins, form, and characteristics of the opercular, etc., which the present specimens do not show. In light of the present material it would seem logical to conclude that *P. septemspinosus* is very closely related to *Boreocentrarchus*, and if the two are regarded as generically distinct the Oregon species ought not to be placed in *Plioplarchus*, but ought to be made the type of a new genus. This, however, should await the discovery of more complete material.

Another percoid deserving of mention here is *Oligoplarchus squamipinnis* Cope from the Oligocene of South Dakota.<sup>1</sup> This is the only known species. It is smaller than *Plioplarchus whitei* and has the following fin formula: D.X, 9–10; C.5, 17, 5; A.III, 7–8; V.I, 5; P.I, 12. Cope

<sup>1</sup> The only other recorded pre-Pleistocene centrarchid material known to me is a fish scale from the Eocene (Coalmont) of Colorado described by Cockerell (1919, p. 188) as a new genus and species (*Centrarchites coloradensis*), and a few fragments from the lower Snake Creek beds (upper Miocene) which Matthew (1924, p. 68) hesitatingly referred to the recent genus *Micropterus*. This material is highly unsatisfactory and is of little or no use in the present consideration.



believed that it was most closely related to *Plioplarchus* and has stated further that, "This genus appears to be allied to the percoid genera related to *Centrarchus*, which now inhabit North American waters. It differs from all of them in one way or another, as for instance in the form of the opercular border, or in the number of the spinous rays and their proportions . . . These differences are the same as those that separate some of the recent genera, showing that the same diversities existed in Cenozoic times as now" (1891, p. 656). A comparison of *Plioplarchus* and *Oligoplarchus* does show that "the same diversities," or at least similar diversities, did exist among the Centrarchidae in the Oligocene as do exist today. There are two ways this fact may be interpreted. First, that the diversification of the Centrarchidae in the Oligocene is of phylogenetic significance, and that the recent forms with the spinous portion of the anal fin reduced to three spines are direct descendants of *Oligoplarchus*. Accordingly, at least some of the recent genera represent lines that have been distinct since Oligocene times. The alternative view is that *Oligoplarchus*, with its reduced fins, is of no phylogenetic significance as far as the recent forms are concerned; that it represents simply a specialized off-shoot in the Oligocene from a generalized form such as *Plioplarchus*, just as such recent forms as *Lepomis* and *Micropterus* represent digressions from *Centrarchus*, the most primitive of all living centrarchids. While the first of these views is possible, it seems to me that the latter is the most probable, principally for the following reasons:

1.—The living Centrarchidae form a very natural group, the members of which are all closely related. The only possible exception being *Micropterus* which, especially in its elongate body form and its deeply notched dorsal fin, has advanced quite far towards the Percidae. It seems rather improbable, therefore, that these recent and closely related genera represent even some lines that have been distinct for twenty millions of years.

2.—In none of the recent genera are the dorsal and anal fins as reduced as in *Oligoplarchus*, and in most of them with three anal spines the rays are considerably more numerous. Of course, there is always the possibility that there has been a reversal of evolution; that after the reduction in number of spines and rays in *Oligoplarchus*, the number again increased in the later forms. This, however, seems improbable and unnecessary. For the fossil record, as seen in *Plioplarchus*, in the Oregon species, and in *Boreocentrarchus*, shows that the primitive centrarchid fin condition was many spines and many rays.

It seems logical, therefore, to regard *Oligoplarchus* as a specialized centrarchid in Oligocene times that had nothing to do with the diversities in the recent centrarchidae.

After taking into account the whole of the meagre fossil record, it is

clear that the nearest approach to *Boreocentrarchus* is seen in the Oregon species, "*Plioplarchus*" *septemspinus*.

In considering the affinities of *Boreocentrarchus*, it is also necessary to make a comparison with the recent forms. Such a comparison is essential in evaluating the evolutionary stage represented in the Alaskan species—an evaluation that is particularly important stratigraphically as will be shown later. This, however, has involved a study of all the recent centrarchids to ascertain what are primitive and what are advanced characters among the Centrarchidae. In this study I have been concerned with working out a phylogeny on the basis of groups of characters, and have given attention particularly to such features as body proportions, size and position of fins, fin formulae, and all of the more salient characters of the skull and internal skeleton.

The family name Centrarchidae was first proposed by Gill (1872) who suggested a further division of the group into three subfamilies—Centrarchinae, Lepominae, and Micropterinae. This subfamily division has been more or less followed by later workers and seems satisfactory, at least for the present purpose. Thirty or more genera have been described, but since the present discussion has in no sense whatever anything to do with revising the Centrarchidae, and since details of taxonomy have no place in this consideration, I have found acceptable the recognition by Jordan, Evermann, and Clark (1930, pp. 297–305) of eighteen genera.

Carefully weighing all evidence, with the paleontological record always in mind, I feel that the following deductions regarding the phylogeny of the recent centrarchids are warranted.

1.—*Centrarchinae*. The two genera, *Centrarchus* and *Pomoxis*, comprising this subfamily are the most primitive of all the living centrarchids. Of these, *Centrarchus* is the most generalized in nearly every respect, particularly in its fairly deep body, its dorsal and anal fins with many spines and many rays, its medium-sized mouth, etc. *Pomoxis*, however, with its many rayed anal, is more primitive, but it is decidedly more specialized in the tendency to become long-bodied, and in the reduced and posteriorly placed dorsal. All this shows that *Pomoxis* probably represents a pre-*Centrarchus* branching from the main centrarchid line that has become somewhat specialized. *Centrarchus* seems to be the most archaic. It is a living fossil closely representing what probably was the main and perhaps dominant centrarchid type at the close of the Tertiary.

2.—*Micropterinae*. This subfamily includes two genera, *Micropterus* and *Huro*, and is the most progressive of all the Centrarchidae, that is, at least the most progressive towards the Percidae. This is strikingly shown in the perciform body, the large mouth, the much reduced three anal spines, and the almost separated spinous and soft portions of the dorsal.

3.—*Lepominae*. This is the dominant group of centrarchids today, including all but four of the eighteen genera. They range in size from less than three to over twenty inches, and a tendency towards a deep body is a feature of all. Some, however, tend to bridge the gap between the extremes of this and the Micropterinae. *Ambloplites* seems to fill this position quite well. Its rather elongated yet fairly deep body form, its medium sized mouth, its primitive anal fin, and a number of other generalized characters display a structural stage intermediate between the perciform Micropterinae and the more progressive deep bodied members of the Lepominae. Nevertheless, in some features, as the quite reduced dorsal, it is too specialized for an intermediate form and perhaps should be regarded as only near to what was the transition stage. *Acantharchus* displays a primitiveness similar to that of *Ambloplites*, and although it is somewhat more specialized, it is certainly close to that genus. *Archoplites* has very primitive fins and in this respect could be ancestral to all of the other genera. It is, however, already a large-mouthed, fairly long-bodied member. It seems closest to *Chaenobryttus*, a genus somewhat higher up the scale of leptomine evolution. The remaining genera are all deep-bodied and closely related. *Mesogonistius* seems nearest to *Enneacanthus* and they both, especially because of the large soft portion of the anal, seem closer to *Apomotis* than to *Lepomis*, *Eupomotis*, *Sclerotis*, *Xenotis*, *Xystroplites*, *Helioperca*, or *Allotis*. These genera are very close, and there is some question as to whether or not they are all distinctive.

These suggestions on the phylogeny of the recent centrarchidae are pictorially shown in figure 2.<sup>1</sup> In this figure I have attempted to illustrate only the broader relationships. Typical species were selected and five advanced genera—*Sclerotus*, *Xenotis*, *Xystroplites*, *Helioperca*, and *Allotis* of the Lepominae have been omitted. They are all very closely related forms and are at least as near to *Lepomis* as to any of the other genera. To include them in the present phylogeny seems unnecessary.

After a survey of the recent and fossil centrarchids, conclusions regarding their phylogeny may be briefly summarized as follows:

1.—Diversities similar to those seen in the present centrarchids are shown among the fossil forms of the Oligocene. These early diversities probably are of no phylogenetic significance as far as the recent forms are concerned.

2.—The primitive centrarchid type was one in which the following outstanding characters were present: a fairly deep body form; dorsal fin large, extending quite far anteriorly and with many spines and soft rays; anal fin large and with many spines and many soft rays; and, mouth medium in size.

3.—From this generalized condition there is, in one direction, a tendency towards a large-mouthed perciform type in which the spinous portion of the anal becomes greatly reduced and the spinous and soft portions of the dorsal are nearly separated.

<sup>1</sup> In this study of the recent centrarchids, I have followed more or less the same procedure as that employed by Professor William K. Gregory and Mr. G. Miles Conrad which is expressed in their recent paper on, "Pictorial phylogenies of deep sea Isospondyli and Iniomi."



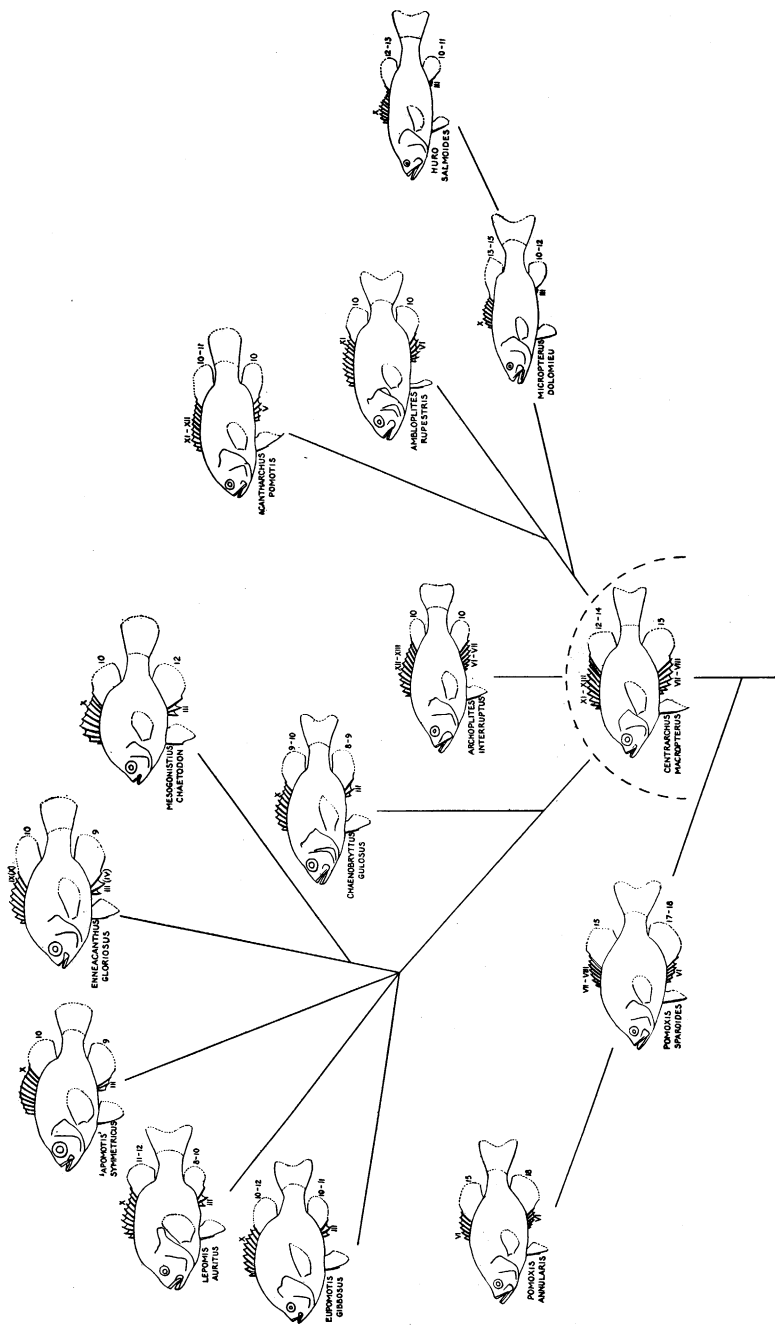


Fig. 2. Phylogeny of the recent Centrarchidae.

4.—In the other direction the body form tends to become proportionately deeper and the anal fin, particularly the spinous portion, is reduced. These characters prevail among the Lepominae—the dominant group of centrarchids today.

Turning now to a comparison of *Boreocentrarchus* with the recent forms, it becomes unmistakably evident that the Alaskan species has its closest affinity with *Centrarchus*. This relationship is particularly well expressed in body proportions, fin formulae, and position of the dorsal and anal fins, although the recent genus shows slight advancement in all these features. As was pointed out above, *Boreocentrarchus* is surprisingly similar to the Oregon species, "*Plioplarchus*" *septemspinus*—at least, as far as the latter is known. And it may be further stated that when compared with the *Plioplarchus* species of the Oligocene and with *Centrarchus*, *Boreocentrarchus* is seen to be considerably more like the recent genus. All in all, the evidence at hand strongly favors the assignment of *Boreocentrarchus* to a Miocene stage of centrarchid evolution and to a phyletic position rather off the main line. Yet the possibility of it being a slightly specialized member of Oligocene or even Eocene age can be wisely entertained. Furthermore, it should be noted that of the recent forms, *Centrarchus*, the most archaic of all, presents the nearest approach to *Boreocentrarchus*. The most convincing bit of evidence we have for assigning *Boreocentrarchus*, tentatively at least, to the Miocene is its close approximation to the species from the Miocene of Oregon.

#### DISTRIBUTION OF THE CENTRARCHIDAE

The living Centrarchidae are restricted to North America<sup>1</sup> and have a distribution from Manitoba to Mexico, eastward to the Atlantic coast from Maine to Florida, and westward to the Rocky Mountains with only a single genus and species—*Archoplites interruptus*—beyond in California. Fossil centrarchids have been reported only from North America. Previously they have been reported from North Dakota, South Dakota, Nebraska, Colorado, and Oregon—representing a geological range from early Eocene to late Miocene. The discovery of *Boreocentrarchus* in Alaska extends the distribution of this family considerably beyond its former limits, and the presence of a fossil centrarchid in Alaska makes it probable that in the geologic past, members of this family migrated back and forth between the Old and New Worlds via an Alaskan-Siberian land bridge. This would explain the presence of

<sup>1</sup> Not including *Siniperca*, *Coreoperca*, and *Bryttossus* from the fresh waters of China, Amurland, Korea, and Japan. There is some doubt as to the taxonomic position of these genera, although they are usually placed in the Serranidae. Regardless of how they are classified, their centrarchid likenesses should be recognized.

the recent fresh water percoids in the Far East, particularly if they are considered as belonging to the Centrarchidae. It also shows that climatic and physiographic conditions were such that other fresh water fishes could have used, and probably did use, the same route. *Boreo-centrarchus* likewise corroborates the evidence, shown by the presence of such Tertiary plants as the palm, the magnolia, the redwood, the cycad, and the baldcypress, that until late in the Tertiary, Alaska was subtropical or at least far milder than it is today.

Distribution of the recent centrarchids and the recorded fossil forms would seem to indicate that the family goes back to perhaps the earliest Tertiary, and that it may be indigenous to North America.

## OSTARIOPHYSI

### Catostomidae

#### CATOSTOMITES, NEW GENUS

TYPE.—*Catostomites alaskensis*, new species.

DISTRIBUTION.—?Miocene, north flank of the Alaska Range, Alaska.

DIAGNOSIS.—Fairly large cyprinoid. Depth of body about one-fourth the total length. Scales small. Peduncle deep. Caudal large, and pelvic quite posterior.

#### *Catostomites alaskensis*, new species

TYPE.—Amer. Mus. No. 8210 (Ichthyology). Major portion of the trunk with posterior of the head, and with dorsal and pectoral fins. Collected by E. M. Schlaikjer, Amer. Mus. Yukon Territory-Alaskan Expedition, 1936.

PARATYPES.—Amer. Mus. No. 8211 (Ichthyology). The caudal region with most of the anal fin, and No. 8212, the head of a smaller individual.

HORIZON AND LOCALITY.—Tertiary coal-bearing beds, ?Miocene. Approximately six and one half miles above the mouth of Healy Creek on the east bank of a small tributary entering from the south.

DIAGNOSIS.—Sole known species of genus.

This genus and species is represented in the collection from the Healy Creek quarry by four fragmentary specimens. The type is the most complete and consists of a fragmentary individual lacking the tail, anal and pelvic fins, and most of the skull. The tail and anal fin are excellently preserved in one paratype, the head region in the other, and a fourth specimen substantiates most of the characters shown in the type. A conservative estimation of the total length of the species is from twelve to fourteen inches.

*Catostomites alaskensis* is assigned to the Catostomidae with some hesitancy since the real criteria for distinguishing this family from the Cyprinidae are to be found in the pharyngeal region, and that region is

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<sup>1</sup> *Catostomus*; *irns*, like.



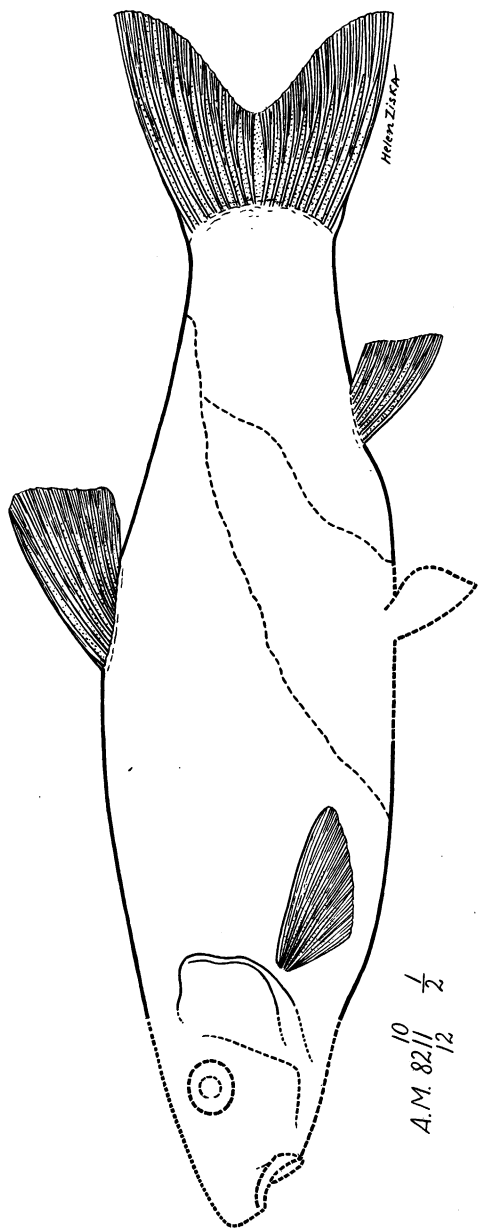


Fig. 3. *Catostomites alaskensis*, new genus and species. Restoration based on Amer. Mus. Nos. 8210, 8211, and 8212 (Ichthyology).

not preserved in the Alaska specimens. It is a rather large, small-scaled form with the dorsal fin quite far anteriorly. Of the known cyprinoids, it seems nearest to the recent sucker, *Catostomus catostomus*, living in Alaska today, and as far as the preserved characters indicate, differs from that species mainly in the proportionately deeper body.

A fuller consideration of this new cyprinoid will, unfortunately, have to await the discovery of more complete material.

#### AGE OF THE SEDIMENTS IN THE HEALY CREEK LOCALITY

Healy Creek is one of the more important tributaries of the Nenana River on the northern watershed of the Alaska Range. Along the lower half of its course, a series of little indurated sediments over four thousand feet in thickness are excellently exposed. These sediments rest unconformably upon the Birch Creek schist, which is probably pre-Cambrian in age, and are readily divisible into at least two distinct formations. The lower-most of these is known in the literature as the "coal-bearing formation" and consists of approximately nineteen hundred feet of conglomerate, sandstone, shale, clay, and lignite. Resting conformably, or disconformably, on these coal-bearing sediments is the Nenana gravel, with a maximum thickness of over two thousand feet. This formation was previously known to be made up of, "unconsolidated or only loosely cemented materials consisting mainly of rather coarse, well-rounded gravel, with only subordinate amounts of interbedded layers of sand" (Capps, 1932, p. 279). It also includes, in its upper limits, rather thick layers of sandy carbonaceous shales that contain plant remains and that are even lignitic in places. A good example of this lithologic variation in the Nenana gravel formation was observed near the head of the first main canyon below the mouth of Gagnon Creek on the right limit of Healy Creek. These shaly phases are but little indurated, hence plant remains can be collected from them only with considerable difficulty. Since no fossils whatever have been described from this formation its geologic age can only be inferred. Certainly it is pre-Pleistocene, and it was, naturally, laid down after the coal-bearing formation.

Local occurrences of the coal-bearing and the Nenana gravel formations are to be found rather extensively distributed along much of the north flank of the Alaska Range. Outcrops are particularly abundant in the vicinities of Healy and Hoseanna (Lignite) Creeks. Throughout the area, however, almost no detailed stratigraphy work was carried out. Before any accurate correlation can be made from locality to locality, or before any age assignments are possible for this series, a detailed in-





Fig. 5. Lower phase of the "coal-bearing formation," three and one-half miles up Healy Creek, in which a total of 174 feet of coal is exposed in seven seams. Photograph by E. M. Schlaikjer.

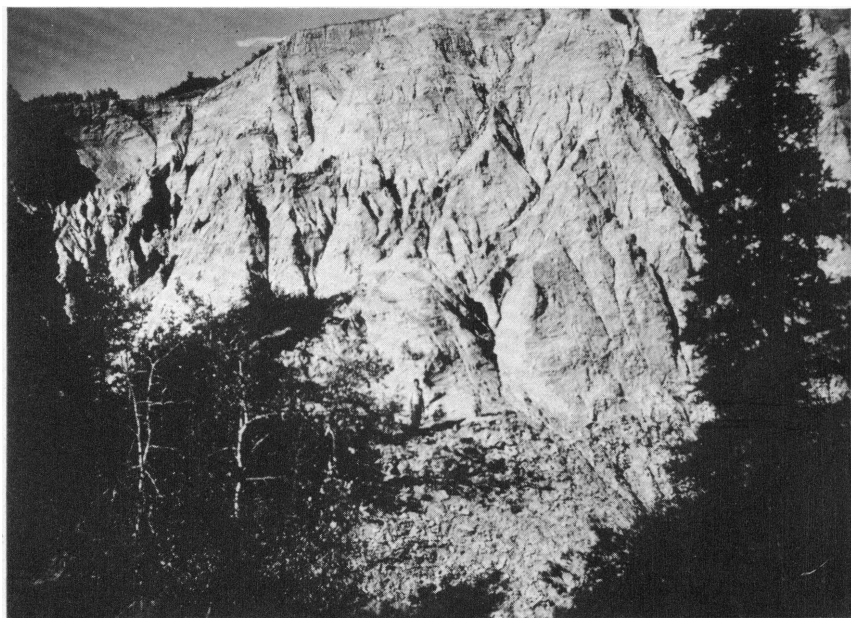


Fig. 6. The fish quarry on Healy Creek. Type locality of the first pre-Pleistocene vertebrates discovered in Alaska. Photograph by E. M. Schlaikjer.

vestigation and thorough search for fossils will be necessary. The time our party spent in the area was very limited, and our work there was, of course, purely reconnaissance. Attention was given especially to the coal-bearing beds on Healy Creek, for it was in them that we discovered the fish quarry. A good summary account of the stratigraphy of these

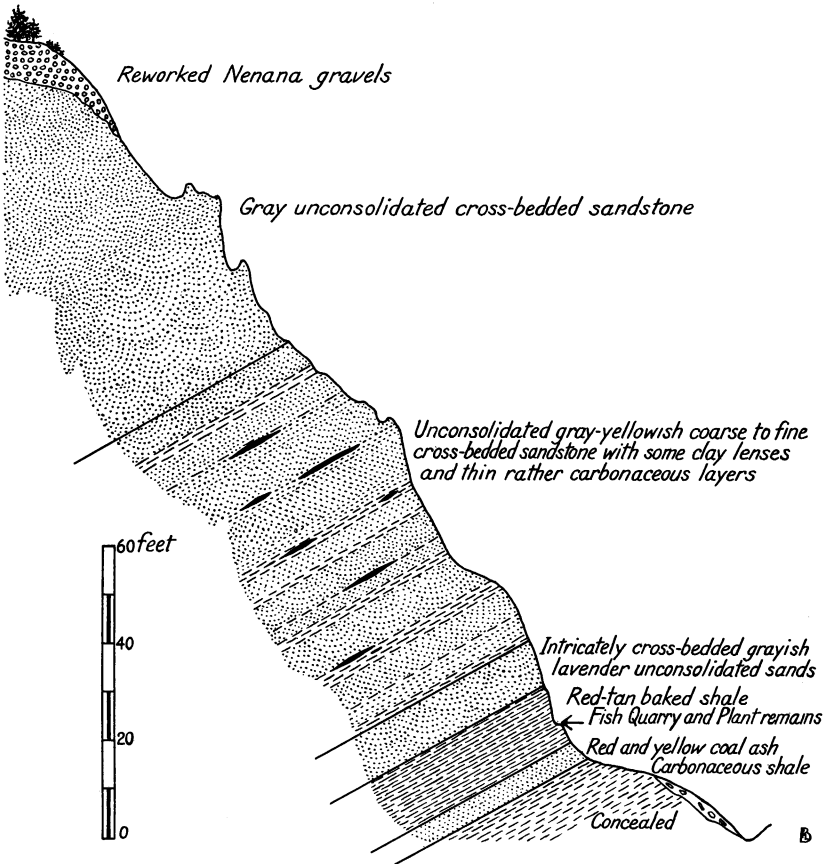


Fig. 7. Geologic section at the fish quarry on Healy Creek, Alaska.

beds is given by Capps who writes that, "On Healy Creek a completely exposed section shows a thickness of 1,900 feet of coal-bearing beds, consisting of gravel, shale, sand, and lignite, of which 220 feet is lignite in 23 separate beds. The stratigraphic relations at this locality are typical of the formation in many other places. The basal beds consist

of about 100 feet of smoothy rounded pebbles of chert and white quartz in a matrix of white sand and kaolinic material, lying unconformably upon the Birch Creek schist. The conspicuous white color is characteristic over wide areas and is of great value in identifying the base of the formation. Above the white basal gravel are alternating beds of shale, clay, sand, and lignite, and some fine gravel. The lignite beds are thickest and most numerous in the lower half of the section, where there are seven beds that aggregate 174 feet of coal. In the upper half of the section the coal occurs in thinner beds, and fine gravel is more abundant" (1932, p. 273). Perhaps the best exposure, in the locality, of the lower lignite-bearing phase of the series occurs at the site of a coal mine which is located on the north bank of Healy Creek, three and one-half miles above its mouth. Here all of the thicker lignite seams are shown in a continuous vertical sequence (see figure 5).

The fish quarry is located at the base of the second of three principal exposures on the northeast side of a small tributary that enters Healy Creek from the southeast, about a mile below the mouth of Cripple Creek (see figures 4 and 6). The beds here dip north-northwest about  $30^{\circ}$  and strike N.  $77^{\circ}$  E. At the quarry site the strata are exposed on the face of a hundred and fifty-foot cliff, of which a section is given in figure 7. The fish remains occur in a quite indurated siltstone that has undergone a considerable amount of static pressure, and some baking that has resulted from the burning out of a thin coal seam several feet beneath. Plant impressions are also excellently and abundantly preserved at this horizon. This section is part of the coal-bearing beds, and quite obviously belongs somewhere in the more lignitic lower half of the formation. Just where is uncertain, but it probably represents a continuation farther up Healy Creek of some part of the section shown at the coal mine, and its fossils probably are typical of that lower lignitic phase.

The coal-bearing formation in the Healy Creek locality has been regarded by Capps (1932, pp. 276–278) as probably Eocene, and he has suggested that it may be of the same age as the Kenai formation on Cook Inlet. He has, however, very wisely refrained from applying the name "Kenai" to the beds along the north flank of the Alaska Range since very little has been done with correlating the Tertiary in different parts of Alaska. Although plant remains not far from Healy Creek, from what seems to be the same formation, are considered by paleobotanists as belonging to the Kenai.

A small collection of plants was made at the fish quarry and these were turned over to Dr. Roland W. Brown of the United States Geologi-



cal Survey for identification. Dr. Brown lists and comments on the species as follows<sup>1</sup>:

*Sequoia langsdorffii* (Brongniart) Heer

*Populus gaudini* Fischer-Ooster

*Populus genetrix* Newberry

Pistillate ament of *Salix*

*Juglans nigella* Heer

*Pterocarya septentrionale* Hollick

*Coccolobis chapini* Hollick

*Faxinus yukonensis* Hollick

"*Sequoia langsdorffii*, which is reported from the Eocene to the Pliocene and is said to be the fossil equivalent of the living coast redwood, is probably a mixture of several species that have not yet been separated. Its value as a stratigraphic indicator is therefore not great." The last three species are found only in Alaska and the other three, according to Dr. Brown, have not been found outside of the Eocene. Dr. Brown further states that of these species "Only *Sequoia langsdorffii* is found in the Mascall flora," and concludes by saying, "I have no hesitation in saying that this group of species has a Tertiary aspect and is of Eocene age, but I do not think a more definite subdivision is possible now—that is, to say whether the age is lower, middle, or upper Eocene."

The fish remains do not substantiate, directly at least, this age determination of the beds at the quarry on Healy Creek. As was pointed out above, the Alaskan centrarchid—*Boreocentrarchus smithi*—has its closest affinity with "*Plioplarchus*" *septemspinus* from the upper Miocene Mascall formation of Oregon, and with the recent sunfish *Centrarchus*; rather than with *Plioplarchus whitei*, *P. sexspinus*, and *Oligoplarchus squamipinnis* of the Oligocene. It was shown, however, that *Boreocentrarchus* and its close relatives of the Miocene and recent are all very primitive. Likewise, it was emphasized that the fossil record of this group of freshwater fishes is a very meagre one. Nevertheless, the evidence at hand does favor an assignment of the deposit to the Miocene, and I have very tentatively regarded it as such.

In a recent paper on, "Plant distribution as a guide to age determination," Dr. Ralph W. Chaney has emphasized a point which has considerable bearing on the present problem. The main thesis of his paper is that the early Cenozoic floras of the higher latitudes migrated southward during the Cenozoic and successively occupied the lower latitudes. He specifically points out (p. 323) that the Siberian-Alaskan temperate

<sup>1</sup> From letters to the writer dated January the twenty-third, and February the twenty-eighth, 1937.

forest of the Eocene shifted south and was present in Oregon during the Miocene. Perhaps the same would apply to the fishes—that is, a Miocene centrarchid in Oregon simply represents an Eocene form in Alaska. Accordingly, the coal-bearing formation on Healy Creek, with *Boreocentrarchus*, would be Eocene in age. In such a consideration, however, two things should be kept in mind. First, we should be certain that we are dealing with an Eocene flora in Alaska, for if that territory were subjected to no appreciable physiographic and climatic changes from Eocene to Miocene—and we have no evidence that it was—it is to be expected that Alaska and Oregon could have had the same or similar forests during the Miocene. Second, no fossil or recent centrarchids are known outside of North America, and on the basis of available evidence they would seem to be indigenous to this continent. If such be the case, we are therefore confronted with the possibility that a Miocene centrarchid in Oregon could represent a Pliocene centrarchid in Alaska.

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