

**OCCASIONAL PAPERS OF THE MUSEUM OF  
ZOOLOGY  
UNIVERSITY OF MICHIGAN  
ANN ARBOR, MICHIGAN**

---

**SUMMARY OF LATE CENOZOIC FRESHWATER FISH  
RECORDS FOR NORTH AMERICA**

BY TERUYA UYENO AND ROBERT RUSH MILLER

RECENT renewed interest in late Cenozoic fossil fishes has resulted, in large measure, from a combination of parallel circumstances: stimulation to his students and associates by Claude W. Hibbard, increasing availability of good osteological collections of modern species, and advances in knowledge of the comparative osteology of major groups of North American fishes. Results of paleoichthyological research—both published and in progress—indicate that the nomenclature and classification of numerous groups are badly outmoded. The present contribution is intended to help correct this situation, but the imperfect nature of fossil preservation and large gaps in the record render the task a formidable one.

Inadequate comparative material often led early workers to describe new taxa with little or no comprehension of their relationships to modern forms. Since little consideration was given to intraspecific and ontogenetic variation, several names were often applied to specimens that subsequent consideration strongly suggests pertain to a single species. Age determinations were not infrequently grossly in error. Thus, the Ree Hills beds of South Dakota, assumed for years to be Oligocene, are actually Pleistocene; the Tranquille beds of British Columbia, assigned to the Miocene, are now known to be Middle Eocene; and the abundant vertebrate remains from Fossil Lake and vicinity, Oregon, heretofore regarded to be Pleistocene only, probably include also Pliocene remains (see footnote 5, p. 24).

In this report we summarize what is known about the occurrence of Miocene to Pleistocene freshwater fishes in North America, evaluating the classification and dating wherever possible. This was accomplished by a thorough review of the literature, an examination of

types and other museum material, by field work since 1960, and by maintaining a close liaison with paleontologists and geologists studying continental Cenozoic biotas, stratigraphy, and modern dating methods.

This review is divided into four parts: (1) a systematic list (Table 1) of the fishes regarded as valid species, arranged phylogenetically by family and alphabetically by genera and species, followed by the age and the authority; (2) an annotated list in which we comment on certain valid species and treat those described fossils that we feel are either unidentifiable, or synonyms, or are otherwise unavailable; (3) a description of the localities from which fossils have been described, arranged alphabetically by states of the United States followed by Canada and also according to assigned ages of the deposits, including the families of fishes taken; and (4) a list of the references consulted, which constitutes a review of the North American literature, including papers that contain some of the recent evidence for age determinations.

Certain forms, the status of which is too uncertain for confident allocation at this time, are included in the annotated list but do not appear in Table 1, although when described there usually was no indication of uncertainty. These are: a ray (?), *Oncobatis pentagonus* (Leidy, 1870); *Aphelichthys* (Cope, 1893) and *Oligobelus arciferus* (Cope, 1870), cyprinids of questionable generic status; ?*Sardinius blackburni* (Cope, 1891), assigned to the Myctophidae but determined herein as a cyprinid; *Leuciscus rosei* (Hussakof, 1916a), described as a cyprinid and treated under that family in the list, where it is shown to be a clupeiform; *Catostomites* and *Boreocentrarchus* (Schlaikjer, 1937), referred to the Catostomidae and Centrarchidae, respectively, but of doubtful family allocation; and *Proballostomus* (Cope, 1891), originally placed in the Cyprinodontidae but reidentified by us as a cyprinid. Also, the fossil described as *Plancterus kansae?* (Stovall and McAnulty, 1939), a cyprinodontid, appears as *Menidia* sp. in Table 1, family Atherinidae, as reidentified by Hubbs (1942). The supposed occurrence of a loach (Cobitidae) in North America is also discussed in the annotated list.

The first reports to describe valid species based on North American Cenozoic freshwater fishes were published in 1870 by Cope and Leidy. Working independently, these men described fossils from Plio-Pleistocene beds of southwestern Idaho. Both workers, but especially Cope, dominated the contributions in this field before 1900. In the first half of the following century, Hay, Jordan, Eastman, Hussakof, Hubbs,

Hibbard, Dunkle, Lucas, Miller, and other ichthyologists and vertebrate paleontologists sporadically reported their findings on fossil fishes from Cenozoic beds. There had been, however, no extensive work on any freshwater post-Oligocene fish fauna since Cope's time until 1954, when C. L. Smith published the first of a series of papers on the fishes unearthed with other vertebrates in the High Plains region by C. W. Hibbard and his parties from The University of Michigan. Since 1954, a number of papers have appeared on Miocene to Pleistocene fishes.

In this report, "Late Cenozoic" refers to the period between the beginning of the Miocene and the end of the Pleistocene, an approximate time span of 25,000,000 years (Kulp, 1961). This segment of Cenozoic time was selected largely because available studies demonstrate that pre-Miocene American fish faunas differ notably from later ones. For example, the relatively well-known Eocene ichthyofaunas from the Green River and Bridger formations bear little resemblance to the Recent freshwater fish fauna (Miller, 1959:192). Although only few fossil fishes are known from Oligocene beds, this period is considered to represent a transitional stage between Eocene and Miocene. The Florissant lake beds of Colorado (upper Oligocene) have yielded an archaic sucker of the genus *Amyzon* which also occurs in Eocene beds of British Columbia and in Miocene deposits of Nevada.<sup>1</sup> *Trichophanes*, an extinct genus of pirate perches, is associated with *Amyzon* in Nevada and Colorado. Miocene deposits have produced the earliest records of cyprinid and ictalurid fishes in North America, two families that comprise important elements of the Recent freshwater fauna. Though several genera and species became extinct around the end of the Pliocene, especially in western North America, the Pliocene freshwater fish faunas resemble the Recent ones. With few exceptions, Pleistocene fishes appear to be the same as their living relatives, except for distributional changes that reflect the climatic fluctuations of this period.

Fish fossils occur in different forms of preservation. Some of them appear as isolated bones scattered on the surface of the earth (the "float" of paleontologists); some are embedded in loose sandstone, various types of sedimentary rocks, or in hard concretions; and others are merely impressions of skeletons on sedimentary rocks, diatomaceous earth, or in thin shales.

In general, the age of fossil beds has been determined chiefly by the

<sup>1</sup> Webb, S. David, MS, "Fossil fish in the Great Basin," suggests that the age of the Nevada "*Amyzon* beds" is probably Oligocene.

associated fossil mammals, but more recently in some cases dating has been by Radiocarbon and Potassium-Argon methods. Consequently not all age assignments set forth herein have reached a level of precision that would satisfy the majority of workers. In this report, age determinations were verified in the "Index to the Geologic Names of North America," by Wilson, Keroher, and Hansen (1959), except for certain datings derived from recent research workers.

#### ACKNOWLEDGMENTS

In preparing this paper we have received much assistance from paleontologists, ichthyologists, and geologists. We are greatly indebted to our colleague, Claude W. Hibbard, who provided critical age data, encouraged the work, and read the manuscript. The following persons loaned types and other specimens or allowed us to examine material in their care: Bobb Schaeffer, American Museum of Natural History; C. Lewis Gazin and David H. Dunkle, U. S. National Museum; L. S. Russell and Don E. McAllister, National Museum of Canada; C. C. Lindsey, University of British Columbia; J. Arnold Shotwell, University of Oregon; and William L. Stokes, University of Utah. For assistance in field work we are grateful to William J. Breed, Leland Crummet, Carl L. and Clark Hubbs, John F. Lance, Neal McClymonds, Richard H. Olson, Charles A. Repenning, Dwight W. Taylor, and Ralph T. Winn. Gerald R. Smith, W. Daniel Sable, and Gifford H. Miller served as field assistants. We thank Reeve M. Bailey for aid in identification, and the following individuals for original information on dating of deposits: Jack F. Evernden, E. R. Hampton, Morris F. Skinner, and S. David Webb.

Completion of this contribution was made possible by grants from the National Science Foundation (G-15914, GB-735).

TABLE 1

## RECORDS OF LATE CENOZOIC FRESHWATER FISHES IN NORTH AMERICA

Abbreviations: A—Aftonian interglacial; E—Early; I—Illinoian glacial; Int—Late Pliocene to early Pliostocene; L—Late; M—Middle; S—Sangamon interglacial; W—Wisconsin glacial; X—General occurrence; Y—Yarmouth interglacial. UMMP refers to The University of Michigan Museum of Paleontology. The taxa are arranged alphabetically within each family; those marked by an asterisk are extinct.

Taxon	Age				Locality and Source
	Mio.	Plio.	Int.	Pleis.	
Acipenseridae					
<i>Acipenser</i>					
? <i>medirostris</i>				W	Calif., Sinclair, 1904 (det. by D. S. Jordan)
sp.				L	Penn., Leidy, 1889
Lepisosteidae					
<i>Lepisosteus</i>					
<i>osseus</i>				X	S. Car., Hay, 1923
<i>platostomus</i>				X	Fla., Hay, 1917†
				LI	Kans., Smith, G. R., 1963
<i>spatula</i>				X	Fla., Hay, 1919 (as <i>Atractosteus lapidosus</i> )
	X?				N. Car., Hay, 1929 (as <i>Atractosteus emmonsii</i> )
		E			Okla., Smith, C. L., 1962
				S	Tex., Uyeno and Miller, 1962a
? <i>spatula</i>				X	Tex., Hay, 1926 (as <i>Atractosteus tristoechus</i> ?)
sp.					N. Car., Cope, 1869 (as <i>Pneumatosteus nahunticus</i> )
	X?			A?	Fla., Hay, 1927 (det. by Gidley)
				I	Okla., Smith, C. L., 1954
				LI	Kans., Smith, C. L., 1958
				S	Tex., Dalquest, 1962
		E			Nebr., Smith, C. L., 1962
				S	Tex., Uyeno and Miller, 1962a
				S	Tex., Uyeno, 1963
Amiidae					
<i>Amia</i>					
<i>calva</i>				X	Fla., Hay, 1917 (as <i>Amiatus calvus</i> )
				X	Ill., Hay, 1923 (as <i>Amiatus calvus</i> )
		E			Nebr., Smith, C. L., 1962
Salmonidae					
<i>Oncorhynchus</i>					
sp.				X	Ore., Hubbs and Miller, 1948: 68
<i>Salvelinus</i>					
<i>namaycush</i>				Y?	Wisc., Hussakof, 1916b (as <i>Cristivomer namaycush</i> )

† As identified by Hay. Possibly this is *L. platyrhincus* De Kay, the common gar of the region today.

TABLE 1 (Continued)

## RECORDS OF LATE CENOZOIC FRESHWATER FISHES IN NORTH AMERICA

Taxon	Age				Locality and Source
	Mio.	Plio.	Int.	Pleis.	
<i>Salmo</i>					
? <i>salar</i> Linnaeus				X	Quebec, Lambe, 1904
* <i>copei</i> , n. sp.			X		Idaho, Cope, 1870 (as <i>Rhabdofario lacustris</i> ); Uyeno and Miller (this report)
sp.			X		Idaho, Russell, 1902 (as <i>Rhabdofario</i> sp.)
Osmeridae					
? <i>Osmerus</i>					
sp.	M				Mont., Eastman, 1917
Esocidae					
<i>Esox</i>					
<i>masquinongy</i>				I	Okla., Smith, C. L., 1954
				LI	Kans., Smith, G. R., 1963
sp.				W	Tex., Uyeno, 1963
? <i>Esox</i>					
sp.		E			Okla., Smith, C. L., 1962
Cyprinidae					
<i>Campostoma</i>					
<i>anomalum</i>				I	Kans., Smith, G. R., 1963
? <i>Campostoma</i>					
sp.				S	Tex., Uyeno, 1963
* <i>Diastichus</i>					
<i>macrodon</i>			X		Idaho, Cope, 1870, 1883
<i>parvidens</i>			X		Idaho, Cope, 1870; Uyeno, 1961
<i>Dionda</i>					
<i>nubila</i>				LI	Kans., Smith, G. R., 1963
<i>Gila</i>					
* <i>altarcus</i>				X	Ore., Cope, 1878, 1883 (as <i>Anchybopsis altarcus</i> )
<i>mohavensis</i>				W	Calif., Buwalda, 1914, and Blackwelder and Ellsworth, 1936 (as <i>Siphateles mohavensis</i> )
cf. <i>robusta</i>		M			Ariz., Uyeno and Miller, 1964
sp.				W	Calif., Flint and Gale, 1958 (det., as <i>Siphateles</i> , by C. L. Hubbs)
? <i>Gila</i>					
* <i>turneri</i>		E			Nev., Lucas, 1900 (as <i>Leuciscus turneri</i> ); Miller, 1959
*? <i>turneri</i>	M				Mont., Eastman, 1917
*n. sp.		M			Ariz., Uyeno and Miller, 1964
<i>Hybognathus</i>					
<i>hankinsoni</i>				LI	Kans., Smith, G. R., 1963
<i>Hybopsis</i>					
cf. <i>gracilis</i>				I	Okla., Smith, C. L., 1958

TABLE 1 (Continued)

## RECORDS OF LATE CENOZOIC FRESHWATER FISHES IN NORTH AMERICA

Taxon	Age				Locality and Source
	Mio.	Plio.	Int.	Pleis.	
* <i>Mylocyprinus robustus</i>			X		Idaho, Leidy, 1870; Cope, 1883; Uyeno, 1961
		M			Idaho, Uyeno, 1961
<i>Mylopharodon conocephalus</i>				W	Calif., Sinclair, 1904 (det. by Jordan)
* <i>hagermanensis</i>			X		Idaho, Uyeno, 1961
				M	Idaho, Uyeno, 1961
? <i>Mylopharodon condonianus</i>			X		Idaho, Cope, 1883 (as <i>Leucus condonianus</i> )
*cf. <i>condonianus</i>			X		Idaho, Uyeno, 1961
		M			Idaho, Uyeno, 1961
<i>Notemigonus crysoleucas</i>				I	Okla., Smith, C. L., 1954
				W	Tex., Uyeno, 1963
<i>Notropis megalepis</i>		M			Kans., Smith, C. L., 1962
<i>Pimephales promelas</i>				I	Okla., Smith, C. L., 1958
				W	Saskatchewan, Uyeno and Miller, MS
<i>Ptychocheilus grandis</i>			X		Calif., Sinclair, 1904 (det. by Jordan)
			X?		Calif., Jordan, 1927 (as <i>P. tularis</i> )
<i>lucius oregonensis</i>			X		Ariz., Unreported material in UMMP
*n. sp.		M			Idaho, Uyeno, 1961; this report
<i>Semotilus atromaculatus</i>				LI	Kans., Smith, G. R., 1963
				LS	Kans., Hibbard, 1955:205 (det. by R. R. Miller; re-examined by us)
cf. <i>atromaculatus</i> sp.				I	Okla., Smith, C. L., 1954, 1958
				I	Okla., Smith, C. L., 1954
* <i>Sigmopharyngodon idahoensis</i>			X		Idaho, Uyeno, 1961
*New genus n. sp.		M			Ariz., Uyeno and Miller, 1964
Catostomidae					
* <i>Amyzon mentalis</i>	M				Nev., Cope, 1872; Webb, MS (Oligocene)
? <i>brevipinnis</i>	E?				Wash., Eastman, 1917
<i>Carpionodes carpio</i>			S		Tex., Dalquest, 1962
<i>Catostomus commersoni</i>			I		Okla., Smith, C. L., 1954

TABLE 1 (Continued)

## RECORDS OF LATE CENOZOIC FRESHWATER FISHES IN NORTH AMERICA

Taxon	Age			Locality and Source
	Mio.	Plio.	Int. Pleis.	
			I	Kans. and Okla., Smith, C. L., 1958
			LI	Kans., Smith, G. R., 1963
<i>*cristatus</i>			X	Idaho, Cope, 1883
<i>latipinnis</i>			X	Ariz., Unreported material in UMMP
<i>**"reddingi"</i>			X	Idaho, Cope, 1883; Hussakof, 1908
<i>*shoshonensis</i>			X	Idaho, Cope, 1883
<i>Chasmistes</i>				
<i>*batrachops</i>			X	Ore., Cope, 1883 (as <i>Catostomus batrachops</i> )
sp.			X	Ore., Hubbs and Miller, 1948: 68
<i>Ictiobus</i>				
cf. <i>bubalus</i>		E		Okla., Smith, C. L., 1962
sp.			S	Tex., Uyeno and Miller, 1962; Dalquest, 1962
			LI	Kans., Smith, G. R., 1963
<i>Moxostoma</i>				
<i>duquesnei</i>			LI	Kans., Smith, G. R., 1963
Ictaluridae				
<i>Ictalurus</i>				
<i>*benderensis</i>		L		Kans., Smith, C. L., 1962
<i>*decorus</i>	X?	X?		Tex., Hay, 1924 (as <i>Ameiurus? decorus</i> )
	X			S. Dak., Smith, C. L., 1961
<i>*lambda</i>		E		Kans., Hubbs and Hibbard, 1951; Smith, C. L., 1962
<i>melas</i>			I	Okla., Smith, C. L., 1954
			I	Kans. and Okla., Smith, C. L., 1958
			LI	Kans., Smith, G. R., 1963
<i>nebulosus</i>			L	Penn., Leidy, 1889 (as <i>Ameiurus atrarius</i> )
		M		Kans., Smith, C. L., 1962
<i>punctatus</i>			I	Okla., Smith, C. L., 1954
			LI	Kans., Smith, C. L., 1958
			S	Tex., Uyeno and Miller, 1962a
			LI	Kans., Smith, G. R., 1963
cf. <i>punctatus</i>		E		Nebr., Smith, C. L., 1962
<i>*sawrockensis</i>		L		Kans., Smith, C. L., 1962
sp.			LS	Kans., Hibbard, 1955:205 (as <i>Ameiurus</i> sp.)
	X	X		Nebr., Matthew, 1918; Cook and Cook, 1933 (as <i>Ameiurus</i> sp.)
	X	X		Nebr., Matthew, 1924 (as <i>Ameiurus</i> sp.)
		E		Okla., Smith, C. L., 1962
			S	Tex., Uyeno and Miller, 1962a
			S & W	Tex., Uyeno, 1963
<i>Pylodictis</i>				
<i>olivaris</i>			S	Tex., Uyeno and Miller, 1962a



TABLE 1 (Continued)

## RECORDS OF LATE CENOZOIC FRESHWATER FISHES IN NORTH AMERICA

Taxon	Age				Locality and Source
	Mio.	Plio.	Int.	Pleis.	
Cyprinodontidae					
<i>Cyprinodon</i>					
* <i>breviradius</i>					Miller, 1945 ("Late Tertiary," Calif.)
<i>Empetrichthys</i>					
* <i>erdisi</i>		M			Calif., Jordan, 1924a (as <i>Parafundulus erdisi</i> ); Uyeno and Miller, 1962b
<i>Fundulus</i>					
* <i>curryi</i>		X?			Calif., Miller, 1945
* <i>davidae</i>			X?		Calif., Miller, 1945
* <i>detillai</i>		M			Kans., Hibbard and Dunkle, 1942; Smith, C. L., 1962
<i>diaphanus</i>				X	S. Dak., Cope, 1891 (as <i>Gephyrura concentrica</i> )
* <i>eulepis</i>		X?			Calif., Miller, 1945
* <i>nevadensis</i>		E			Nev., Eastman, 1917 (as <i>Parafundulus nevadensis</i> )
* <i>sternbergi</i>		M			Kans., Robertson, 1943
sp		X			Okla., Hubbs, 1942
				I	Okla., Smith, C. L., 1954 (as <i>Aplodinotus grunniens</i> )
				LI	Kans., Hibbard and Taylor, 1960 (as <i>Aplodinotus grunniens</i> )
		M			Calif., Uyeno and Miller, 1962b
		E			Okla., Smith, C. L., 1962 (as ? <i>Aplodinotus</i> sp.)
		L			Kans., Smith, C. L., 1962 (as ? <i>Aplodinotus</i> sp.)
? <i>Fundulus</i>	X				Calif., Pierce, 1959 (as unidentified cyprinodont); Uyeno and Miller, 1962b
Gasterosteidae					
<i>Gasterosteus</i>					
<i>aculeatus</i>				X	Ontario, Dawson, 1872
* <i>doryssus</i>		E			Nev., Jordan, 1907 (as <i>Merriamella doryssus</i> ); Webb, 1963
<i>Pungitius</i>					
* <i>haynesi</i>		X?			Calif., David, 1945
Aphredoderidae					
* <i>Trichophanes</i>					
<i>hians</i>	M				Nev., Cope, 1872; Webb, MS (Oligocene)
Centrarchidae					
<i>Ambloplites</i>					
cf. <i>rupestris</i>		L			Kans., Smith, C. L., 1962
<i>Chaenobryttus</i>					
* <i>kansasensis</i>		M			Kans., Hibbard, 1936; Smith, C. L., 1962; see annotated list.

TABLE I (Concluded)

## RECORDS OF LATE CENOZOIC FRESHWATER FISHES IN NORTH AMERICA

Taxon	Age				Locality and Source
	Mio.	Plio.	Int.	Pleis.	
<i>Lepomis cyanellus</i>				I	Okla., Smith, C. L., 1954
		L			Kans., Smith, C. L., 1962
				LI	Kans., Smith, G. R., 1963
<i>?humilis</i>				LI	Kans., Smith, G. R., 1963
				X	S. Dak., Cope, 1891 (as <i>Oligoplarchus squamipinnis</i> ); this report
cf. <i>microlophus</i> sp.		E			Nebr., Smith, C. L., 1962
				X	Fla., Hay, 1923
				X	Ill., Hay, 1923
				S	Tex., Dalquest, 1962
				S & W	Tex., Uyeno, 1963
<i>Micropterus salmoides</i>				LI	Kans., Smith, G. R., 1963
cf. <i>Micropterus</i> sp.	X	X			Nebr., Matthew, 1924
		E			Kans., Smith, C. L., 1962
* <i>Plioplarchus septemspinus</i>	M				Ore., Cope, 1889a; Eastman, 1917: Pl. 22; Webb, 1963; see annotated list
<i>Pomoxis ?lanei</i>		M			Kans., Hibbard, 1936; see annotated list
Percidae					
<i>Perca flavescens</i>				X	S. Dak., Cope, 1891 (as <i>Mioplosus multi-dentatus</i> ); see annotated list
				I	Kans. and Okla., Smith, C. L., 1954, 1958
cf. <i>flavescens</i>				LI	Kans., Smith, G. R., 1963
Sciaenidae					
<i>Aplodinotus grunniens</i>				W	Mich., Hubbs, 1940
				S	Tex., Dalquest, 1962; Uyeno and Miller, 1962a
Cottidae					
<i>Cottus beldingi</i>		E			Nev., Jordan, 1924b; Hubbs and Miller, 1948:26
? <i>Cottus ?divaricatus</i>			X		Ida. and Ore., Cope, 1883; see annotated list
Atherinidae					
<i>Menidia</i> sp.		X			Okla., Stovall and McAnulty, 1939 (as <i>Plancterus kansae?</i> ); Hubbs, 1942

## ANNOTATED LIST

## RAJIDAE

*Oncobatis pentagonus* Leidy.—Age and locality in doubt (Leidy, 1870). This species, the type of which has not been found, is said to have come from the “Rocky Mountains.” It was described at the same time as the extinct cyprinid, *Myloocyprinus robustus*, which is known thus far only from Plio-Pleistocene deposits in southern Idaho. Cope (1883:153) stated that Leidy did not characterize his genus *Oncobatis* and placed this species in the genus *Raja* (spelled *Raia*). He referred it to the “Idaho Lake” (Pliocene) formation in this statement: “A species said to have been found in the beds of this deposit.” We do not believe that this fish, if a ray, was associated with *Myloocyprinus*, which commonly occurs with other minnows and with suckers and sunfishes—all true freshwater fishes. Furthermore, extensive collecting in the beds of the “Idaho Lake” in recent years has failed to yield a ray. The status of this fossil must therefore remain in doubt until the type specimen is found and the locality data are verified.

## LEPISOSTEIDAE

*Atractosteus*.—This genus is considered to be a synonym of *Lepisosteus*.

*Atractosteus emmonsii* Hay.—Miocene?, North Carolina (Hay, 1929). The type specimen is a scale, described and figured by Emmons (1858) but without a specific name, which was supplied by Hay. We feel that the drawing of the type lacks characters to distinguish it from the alligator gar, *L. spatula* Lacépède.

*Atractosteus lapidosus* Hay.—Pleistocene, Florida (Hay, 1919). The types constitute an opercle and scales. Judging from the figures, this species is also a synonym of *L. spatula*.

*Atractosteus tristoechus* (Bloch and Schneider)?.—Pleistocene, Texas (Hay, 1926). Hay's queried identification was based on several scales which seem to represent *L. spatula*. Though the name *L. tristoechus* is now used for a species confined to Cuba, it was formerly used for the gar that is now called *L. spatula*—a species that occurs along the Gulf Coast and in the lower Mississippi River.

*Pneumatosteus nahunticus* Cope.—Miocene, North Carolina (Cope, 1869). This is probably a gar of the genus *Lepisosteus*, but the holotype, a caudal vertebra, is insufficient to assign it specifically.

## SALMONIDAE

*Oncorhynchus tshawytscha?*—Pleistocene?, Oregon (Jordan, 1907). There appear to be no objective data to support this identification which was based on numerous fragments of jaws, teeth, and vertebrae. The photographs of the specimens show that they bear close resemblance to "*Rhabdofario lacustris*" Cope from Idaho (= *Salmo copei*, see below).

*Rhabdofario lacustris* Cope.—Late Pliocene or early Pleistocene, Idaho (Cope, 1870). Examination of the type specimen and other material collected from the same formation (Cope's "Idaho Lake") in Idaho and Oregon shows that *Rhabdofario* should be synonymized with the genus *Salmo*. Since the combination *Salmo lacustris* dates from Linnaeus (1758:309), the fossil species described by Cope is here-with renamed *Salmo copei*. The diagnosis given by Cope will serve to distinguish it from its living relatives; the holotype is USNM 16352, the type of *R. lacustris*.

## CYPRINIDAE

*Alburnops angustarcus* Cope.—Plio-Pleistocene?, Oregon (Cope, 1878). This was recognized as a valid species of the genus *Gila* by Uyeno (1961:340); however, we now consider it to be a synonym of *Gila altarcus* (Cope)—see the discussion under *Anchybopsis altarcus* Cope.

*Alburnops gibbarcus* Cope.—Plio-Pleistocene?, Oregon (Cope, 1878). This species, placed in the genus *Gila* by Uyeno (1961:341), is herein synonymized with *Anchybopsis altarcus* (= *Gila altarcus*; see below).

*Alisodon mirus* Hay.—Pleistocene, Texas (Hay, 1920). The type specimen is not a fish bone (Uyeno, 1961), and probably does not even represent the remains of an animal.

*Anchybopsis altarcus* Cope.—Plio-Pleistocene?, Oregon (Cope, 1878). This species was assigned to the genus *Gila* by Uyeno (1961:341). After careful study of numerous pharyngeals of *Gila* (*Siphateles*) *bicolor* (Girard), which most closely resembles this fossil, we conclude that the four species described by Cope (two in *Alburnops* and two in *Anchybopsis*) belong to a single taxon. As first revisers we select *Gila* (*Siphateles*) *altarcus* for this species because this name emphasizes a distinctive specific feature—namely, the elevated dentigerous surface of the pharyngeal arch. Thus, *G. angustarcus*, *G. gibbarcus*, and *G. breviaricus* are synonymized with *Gila altarcus*.

*Anchybopsis breviaricus* Cope.—Plio-Pleistocene?, Oregon (Cope, 1878). This nominal species, placed in *Gila* by Uyeno (1961:341), is discussed above.

*Anchybopsis fasciolatus* Cope.—Russell (1902), *nomen nudum* (see Hay, 1929).

*Anchybopsis latus* Cope.—Late Pliocene or Early Pleistocene, Idaho (Cope, 1870). The type (?) specimens, constituting very incomplete pharyngeal arches, bear some resemblance to those of *Diastichus parvidens* Cope. However, they lack the posterior edentulous process that characterizes the pharyngeal arch of that species. Consequently, we are uncertain as to the status of *A. latus*, although it may be the same as *D. parvidens*.

*Aphelichthys lindahlii* Cope.—Pleistocene?, Illinois (Cope, 1893). The type specimen has not been found and we are unable to identify the species from the original description.

*Diastichus strangulatus* Cope.—Late Pliocene or Early Pleistocene, Idaho (Cope, 1883). The type specimen, comprising only incomplete pharyngeals, is too fragmentary to enable us to determine its status (Uyeno, 1961:341).

*Leucus condonianus* Cope.—See ?*Mylopharodon condonianus* (Cope) in Table 1.

*Leuciscus rosei* Hussakof.—Middle Eocene, British Columbia (Hussakof, 1916a). The Tranquille beds that yielded this species were originally thought to be Miocene, which led to the belief that this record represents the earliest appearance of the Cyprinidae in North America (Miller, 1959:203). Recent dating of these beds by the Potassium-Argon method (Rouse and Mathews, 1961) gave an age of 49 million years, or Middle Eocene. An examination of the type specimens of *Leuciscus rosei* in the National Museum of Canada (Holotype, No. 2156, 2156a) and in the American Museum of Natural History (Paratype, No. 8059) shows conclusively that this species is not a cyprinid for the following reasons: there are two postterminal centra, as in the fossil clupeoid *Pterothrissus gissu* (Gosline, 1961: fig. 1A), and the three posterior vertebrae are upturned; there is no upright neural arch on the terminal vertebra; the hypurals are attached to the last three vertebrae (terminal and postterminal 1 and 2) rather than to the terminal vertebra; there are more than three branchiostegals (probably 7); there are many uniform-shaped, interneural spines; intermuscular bones are present; there is no trace of a Weberian apparatus; and there are teeth on the lower jaw and on the palatines (?) and pterygoids (?). Hay (1929:724) referred this species to the living American cyprinid genus *Richardsonius*, to which it bears a superficial appearance. *Leuciscus rosei* looks like a clupeiform fish, but we are not prepared to identify it further.

*Leuciscus turneri* Lucas.—See ?*Gila turneri* (Lucas) in Table 1.

*Myloocyprinus inflexus* Cope.—Late Pliocene or Early Pleistocene, Idaho (Cope, 1883). It seems that this species is not congeneric with *M. robustus* Leidy, but further study is necessary to determine its status (Uyeno, 1961:341).

*Myloocyprinus kingii* Cope.—Late Pliocene or Early Pleistocene, Idaho (Cope, 1870). This species is a synonym of *M. robustus* Leidy (Merrill, 1907:13; Uyeno, 1961:341).

*Myloocyprinus longidens* Cope.—Late Pliocene or Early Pleistocene, Idaho (Cope, 1870). This species is also a synonym of *M. robustus* Leidy (Uyeno, 1961:342).

*Oligobelus arciferus* Cope.—Late Pliocene or Early Pleistocene, Idaho (Cope, 1870). The holotype has evidently been misplaced and the status of this species is uncertain (Uyeno, 1961:342).

*Oligobelus laminatus* Cope.—Late Pliocene or Early Pleistocene, Idaho (Cope, 1870). This species, referred by Cope (1883:157) to the European genus *Squalius*, is a synonym of *Ptychocheilus oregonensis* (Richardson), as confirmed by new material collected by us in Idaho and compared with the holotype.

*Proballostomus longulus* Cope.—Pleistocene, South Dakota (Cope, 1891). This fish, assigned to the Cyprinodontidae by Cope, was treated in the same family by Rosen and Gordon (1953:38–9), who described and figured the anal-fin skeleton and associated vertebrae. However, we identify it as a cyprinid for the following reasons: the type specimen possesses a good tripus and a robust, modified rib of the 4th vertebra, both of which are parts of the Weberian apparatus; the hypural plate is made up of several (rather than two or less) hypural bones; and there are numerous intermuscular bones in the trunk and caudal regions. Dr. Rosen has re-examined the type and agrees with our conclusion. Since the associated fossil fishes from these beds are now all reidentified as living species (or very close relatives), we doubt that *Proballostomus* is a valid genus, but we are uncertain as to its status. Reasons for regarding the age as Pleistocene are given in the list of localities.

*Ptychocheilus tularis* Jordan.—?Pleistocene, California (Jordan, 1927). Judging from the description, locality, and probable age, this species seems to be a synonym of *P. grandis* (Ayles). The representatives of the genus *Ptychocheilus* in the Columbia River system (*P. oregonensis*) and in the Colorado River system (*P. lucius*) have undergone but little evolutionary change since Middle Pliocene time (Uyeno, 1961:334–35; Uyeno and Miller, 1964).

?*Sardinius blackburni* Cope.—Pleistocene, South Dakota (Cope, 1891). Although the holotype (AMNH 8091) lacks the head region, and we are not confident as to what genus it may pertain, we have no doubt that it represents a cyprinid fish. Consequently it cannot be referred to *Sardinius*, which is a member of the marine family Myctophidae.

*Semotilus bairdii* Cope.—Late Pliocene or Early Pleistocene, Idaho (Cope, 1870). The type specimen of this species has been misplaced or lost. Judging from the original description and our knowledge of the living and fossil material of *Ptychocheilus* from southern Idaho, we feel that *S. bairdii* is probably a synonym of *P. oregonensis* (Richardson).

*Semotilus posticus* Cope.—Late Pliocene or Early Pleistocene, Idaho (Cope, 1870). Study of variation in *Ptychocheilus oregonensis* (Richardson) and of new fossil material of this genus from Idaho convinces us that *S. posticus* is a synonym of *P. oregonensis*.

*Siphateles*.—This genus is regarded as a subgenus of *Gila*.<sup>2</sup>

*Siphateles mohavensis* Snyder.—See *Gila mohavensis* (Snyder) in Table 1.

*Squalius reddingi* Cope.—Late Pliocene or Early Pleistocene, Idaho (Cope, 1883). This species is a synonym of *Ptychocheilus oregonensis* (Richardson).

#### CATOSTOMIDAE

Gerald R. Smith, currently studying the osteology of this family, provided the information given below under *Catostomus* and *Chasmistes*.

?*Catostomites alaskensis* Schlaikjer.—Early Oligocene to Early Miocene, Alaska (Schlaikjer, 1937). The types are so incomplete that even the family allocation is uncertain (R. R. Miller, in MacNeil *et al.*, 1961:1806).

*Catostomus batrachops* Cope.—See *Chasmistes batrachops* (Cope) in Table 1.

*Catostomus labiatus* Ayres.—Pleistocene, Oregon (Cope, 1883; Starks, in Jordan, 1907). Misidentification. The specimens are not the Recent species *Catostomus occidentalis* (of which *C. labiatus* is a synonym—see Jordan, Evermann and Clark, 1930:738), but represent *Chasmistes batrachops* (Cope).

<sup>2</sup> Uyeno, Teruya, 1960. Osteology and phylogeny of the American cyprinid fishes allied to *Gila*. Ph.D. thesis, Univ. Mich., 174 pp. 35 pls.

*Chasmistes* spp.—Pleistocene, Oregon. Hubbs and Miller (1948:68, 74) and D. W. Taylor (1960:329) referred to sucker remains from Lower Klamath Lake and Fossil Lake as presumably *Chasmistes*; these references are too indefinite for allocation here.

*Chasmistes oregonus* Starks.—Pleistocene, Oregon (Starks, in Jordan, 1907). This species is provisionally synonymized with *Chasmistes batrachops* (Cope) on the grounds that the specimen referred by Starks to *Chasmistes* sp. appears to be intermediate between *C. oregonus* and *C. batrachops*. However, fossils collected at Fossil Lake represent more than one age (see list of localities) and there is a possibility that *oregonus* and *batrachops* are successional species. More extensive study of interspecific variation is required to clarify their status.

#### COBITIDAE

In an attempt to evaluate the record by Cope (1873, 1883:161) of a loach of the genus *Cobitis* in western North America, in Plio-Pleistocene lake beds of southern Idaho, we sought in vain to locate the type material. Furthermore, extensive collecting in the same area, by us as well as by others, has failed to uncover remains that could possibly be referred to this wholly Old World family. We feel that Cope erred in his interpretation of the remains he briefly described (but did not figure), and hence we do not accept this record.

#### ICTALURIDAE

*Ameiurus*.—This genus is currently synonymized with *Ictalurus* (Taylor, W. R., 1954:43; Smith, C. L., 1961).

*Ameiurus atrarius* (De Kay).—Pleistocene, Pennsylvania (Leidy, 1889). This species is a synonym of *Ictalurus nebulosus* (LeSueur).

*Ameiurus decorus* Hay.—See *Ictalurus decorus* (Hay) in Table 1.

*Ictalurus*.—As indicated by Uyeno and Miller (1962a:340), the reference of pectoral spines from Plio-Pleistocene beds of southern Idaho and eastern Oregon to this genus (Cope, 1883:161, as ?*Amiurus* sp.; Miller, 1959:194, as *Ictalurus*) may have been premature. Hence these records are not included in Table 1.

#### CYPRINODONTIDAE

*Fundulus sternbergi* Robertson—Middle Pliocene, Kansas. Although Miller (1955:12) wrote that this species is evidently the same as *F. detillai* Hibbard and Dunkle, from the same locality, and C. L. Smith (1962:512) synonymized the two species, we recognize both forms. The original descriptions contain a number of statements that clearly



distinguish the two and we feel that study of the type specimens should be made before concluding that they are identical.

*Gephyrura concentrica* Cope.—Pleistocene, South Dakota (Cope, 1891). The holotype (AMNH 8089), a well-preserved specimen in fine condition, has been examined by R. M. Bailey as well as by us. There is no doubt that it is a species of *Fundulus*. Cope overlooked the well-developed conical teeth on the premaxillary; the bone is shaped much like that of *F. notti* (see Uyeno and Miller, 1962*b*: fig. 5D). Although incomplete posteriorly (only 9 rays remaining), the dorsal fin originated posterior to the insertion of the 7-rayed pelvics but anterior to the origin of the anal, which has 12 rays. The branchiostegals number 6, possibly 7. The total vertebral count (including the hypural plate) appears to be at least 32 to 34 (not 28, as recorded by Cope), but it is likely that more were present. There are about 18 principal caudal rays (33 total elements). The scales are of moderate size, perhaps 36 to 39 in the lateral series. The general shape of the body, position of fins, size of scales, and meristic data given above are in close agreement with those of *Fundulus diaphanus* (LeSueur), a species living today as far north as the Hudson Bay drainage of North Dakota (Miller, 1955:8). We, therefore, synonymize *Gephyrura concentrica* with *Fundulus diaphanus*.

*Parafundulus*.—This genus was synonymized with *Fundulus* by Miller (1945).

*Parafundulus erdisi* Jordan.—See *Empetrichthys erdisi* (Jordan) in Table 1.

*Parafundulus nevadensis* Eastman.—See *Fundulus nevadensis* (Eastman) in Table 1.

*Plancterus kansae?*.—This fossil is a species of *Menidia*, family Atherinidae; see Table 1.

*Proballostomus longulus* Cope.—See the family Cyprinidae in this list.

#### GASTEROSTEIDAE

*Merriamella*.—This genus is a synonym of *Gasterosteus* (Eastman, 1917:291).

*Merriamella doryssa* Jordan.—See *Gasterosteus doryssus* (Jordan) in Table 1.

*Gasterosteus williamsoni leptosomus* Hay.—Early Pliocene, Nevada (Hay, 1907). A synonym of *G. doryssus* (Jordan); see Jordan (1908).

#### CENTRARCHIDAE

*Boreocentrarchus smithi* Schlaikjer.—Early Oligocene to Early Miocene, Alaska (Schlaikjer, 1937). The type material of this species

was examined many years ago by Reeve M. Bailey<sup>3</sup> who referred the species to the subfamily Centrarchinae, chiefly on the basis of the number of anal spines. Recent study of these specimens by Clarence L. Smith led him to feel (pers. comm.) that they are too incomplete (represented largely by impression) to identify confidently even to family level.

*Chaenobryttus kansasensis* Hibbard.—Middle Pliocene, Kansas (Hibbard, 1936). See below, under *Pomoxis lanei*.

?*Lepomis*.—The sunfish remains from Plio-Pleistocene deposits in southern Idaho and eastern Oregon, that were tentatively referred to the living genus *Lepomis* by Miller (1959:194), are receiving further study to clarify their status. Possibly a different Recent genus is involved. Hence this record is not given in Table 1.

*Miocentrarchus* Bailey, MS.—This name, used by Branson and Moore (1962:89), has not been formally proposed and hence is a *nomen nudum*.

*Oligoplarchus squamipinnis* Cope.—Pleistocene, South Dakota (Cope, 1891). Recent examination of the holotype (AMNH 8078) by R. M. Bailey and by us shows that this nominal species is a member of the genus *Lepomis*, to which Cope thought it was allied. The Pleistocene (rather than Oligocene) age of the beds containing the fossil, the known distribution of centrarchids in the region today (Bailey and Allum, 1962:95), and certain characters of the type (see Bailey, footnote 3) suggest that *O. squamipinnis* is close to, if not identical with, *Lepomis humilis* (Girard), present today in South Dakota.

*Plioplarchus septemspinus* Cope.—Middle Miocene, Oregon (Cope, 1889a). Bailey (footnote 3) confirmed the tentative conclusion of Schlaikjer (1937) that this species is not referable to *Plioplarchus*, and erected a new genus (*Miocentrarchus*) for its sole reception. Although still unpublished, Branson and Moore (1962:89) used the name.

*Pomoxis lanei* Hibbard.—Middle Pliocene, Kansas (Hibbard, 1936). Branson and Moore (1962:96) synonymized *Chaenobryttus kansasensis* with *C. gulosus* and *Pomoxis lanei* with *P. nigromaculatus*, stating that the fossil remains fall well within the limits of variation for these Recent species. We have not examined the holotypes of these two fossils. Bailey (footnote 3), however, stated that *Pomoxis lanei* is fully differentiated from the Recent species “. . . in the lower number of

<sup>3</sup> Bailey, Reeve M., 1938. A systematic revision of the centrarchid fishes, with a discussion of their distribution, variations, and probable interrelationships, Ph.D. thesis, Univ. Mich., 256 pp., 10 pls.

anal soft rays (12 instead of 17 to 20)." In discussing the phylogeny of sunfishes, Branson and Moore (1962:90) hypothesized that the lines containing *Pomoxis* and *Chaenobryttus*—the Centrarchinae and Lepominae, respectively—seemingly diverged during Plio-Pleistocene times. This conclusion contradicts their view (1962:96) that *Chaenobryttus gulosus* and *Pomoxis nigromaculatus* have not changed since Middle Pliocene (the age of the beds that yielded *C. kansasensis* and *P. lanei*). Under these circumstances, we tentatively recognize the two species described by Hibbard (see Table 1).

#### PERCIDAE

*Mioplosus multidentatus* Cope.—Pleistocene, South Dakota (Cope, 1891). The holotype (AMNH 8075) of this nominal species has been examined by R. M. Bailey and by us, with the conclusion that it is identical with the living yellow perch, *Perca flavescens* (Mitchill). In agreement with the distinctive morphological characters of that species it has the following bones serrated (evidently the basis for the specific name): preopercular (the anterior serrations on the lower limb are strong and directed forward), cleithrum, and posttemporal, and probably the supracleithrum and subopercular. The two dorsal fins are separated; the spinous part has about 13 spines and the soft dorsal has the same number of rays. There is one interneural, 6 (probably 7) branchiostegals, and the frontal bone is roughened by ridges. Cope's low count of 31 vertebrae reflects the incompleteness of the type specimen, which lacks the caudal fin and much of the caudal peduncle. Jordan (1919) erected the genus *Eoperca* for the sole reception of this fossil, believing Cope's species to be intermediate between *Mioplosus* and *Perca*.

#### SCIAENIDAE

It now appears that the only valid fossil records of the freshwater drum (*Aplodinotus grunniens*) are for Michigan (Hubbs, 1940) and Texas (Dalquest, 1962; Uyeno and Miller, 1962a). The literature records cited below represent misidentifications for the cyprinodontid genus *Fundulus* (see Table 1); the materials were reidentified by Gerald R. Smith (see Hibbard, 1964).

*Aplodinotus grunniens* Rafinesque.—Pleistocene (Illinoian), Oklahoma (C. L. Smith, 1954). Equals *Fundulus* sp.

*Aplodinotus grunniens* Rafinesque.—Pleistocene (Illinoian), Kansas (Hibbard and Taylor, 1960:57). Equals *Fundulus* sp.

?*Aplodinotus* sp.—Pliocene (Early), Oklahoma; Late Pliocene, Kansas (C. L. Smith, 1962). Equals *Fundulus* sp.

## COTTIDAE

We have examined the holotypes of the following species and believe three of these to be synonyms of "*Cottus*" *divaricatus*. The status of that species is briefly mentioned below.

*Cottus cryptotremus* Cope.—Late Pliocene or Early Pleistocene, Idaho (Cope, 1883). Synonym of *C. divaricatus* Cope.

*Cottus divaricatus* Cope.—See ?*Cottus divaricatus* Cope in Table 1. Although the type specimen and other referred materials are quite incomplete, it is almost certain that this species does not belong in the genus *Cottus*. The peculiar form of the preopercular spine and the apparently associated remarkable scale-like structures are unlike any known species of *Cottus*. However, since more material and further study are required to clarify the systematic status of this fish, we tentatively retain it in the genus *Cottus*.

*Cottus hypoceras* Cope.—Late Pliocene or Early Pleistocene, Idaho (Cope, 1883). Synonym of *C. divaricatus* Cope.

*Cottus pontifex* Cope.—Late Pliocene or Early Pleistocene, Idaho (Cope, 1883). Synonym of *C. divaricatus* Cope.

LOCALITIES YIELDING LATE CENOZOIC FRESHWATER  
FISHES IN NORTH AMERICA

## ALASKA

OLIGOCENE (EARLY) TO MIOCENE (EARLY)?.—About 80 mi. S of Fairbanks on N flank of Alaska Range (see Wahrhaftig, 1958), in Tertiary coal-bearing beds, about 6 1/2 mi. above mouth of Healy Cr. on E bank of small tributary entering from south; Schlaikjer, 1937: Catostomidae?, Centrarchidae?. Miller (*in* MacNeil *et al.*, 1961:1806) commented that the status of *Catostomites* is too indefinite for speculation. It and *Boreocentrarchus* (which may not be a sunfish) are discussed in the annotated list and are not listed in Table 1.

## ARIZONA

PLEISTOCENE.—Navajo Co., 2.7 mi. S of Taylor P. O., Snowflake fauna; material in UMMP (unreported): Cyprinidae, Catostomidae. For comments on age, based on mammals, see Lance (1960:157).

PLIOCENE (MIDDLE).—Navajo Co., Bidahochi formation—(1) Roberts Mesa, 4.4 mi. by road NW of White Cone Trading Post; Uyeno and Miller, 1964: Cyprinidae. (2) Coliseum diatrema, near Indian Wells, about 35 mi. N of Holbrook (see Hack, 1942:354, pl. 1, no. 3); Uyeno

and Miller, 1964: Cyprinidae. (3) White Cone, about 50 mi. N of Holbrook, White Cone fauna (Taylor, 1957), dated at 4.1 million years (Evernden *et al.*, 1963); Uyeno and Miller, 1964: Cyprinidae.

#### CALIFORNIA

PLEISTOCENE?—Kings Co., in bed of Tulare Lake, near head of San Joaquin Valley, in white marl 12 ft. below lake bottom; Jordan, 1927: Cyprinidae.

PLEISTOCENE (WISCONSIN).—(1) San Bernardino Co., beds of Lake Manix, about 40 mi. E of Barstow; Blackwelder and Ellsworth, 1936; Hubbs *et al.*, 1962:227 (radiocarbon age  $19,500 \pm 500$ ): Cyprinidae. (2) San Bernardino Co., Searles Lake (dry); Flint and Gale, 1958: Cyprinidae. (3) Shasta Co., Potter Cr. Cave, Sec. 25, T. 34 N, R. 4 W, Mt. Diablo Meridian; Sinclair, 1904: Acipenseridae, Cyprinidae.

LATE TERTIARY (PLIOCENE?).—Inyo Co., (1) 3 mi. SW of Chloride Cliffs in Funeral Mts., on E side of Death Valley National Monument; Miller, 1945: Cyprinodontidae. (2) About 6 mi. S of Furnace Cr. Ranch in Black Mts., on E side of Death Valley National Monument; Miller, 1945: Cyprinodontidae.

AGE UNKNOWN (PLIO-PLEISTOCENE?).—San Bernardino Co., near Black Mt. in Mohave Desert, about 40 mi. NW of Barstow and 25 mi. SE of Johannesburg; Miller, 1945: Cyprinodontidae.

PLIOCENE (MIDDLE).—Los Angeles Co., (1) NW corner, Sec. 13, T. 6 N, R. 18 W, U.S.G.S. Tejon Quadrangle, part of Ridge Route formation; David, 1945: Gasterosteidae. (2) 1700 ft. W and 680 ft. S of NE corner, Sec. 25, T. 7 N, R. 19 W, Black Mt. Quadrangle, Piru Mts., Posey Canyon shale; Uyeno and Miller, 1962*b*: Cyprinodontidae. (3) 1000 ft. S and 1100 ft. E of NW corner, Sec. 2, T. 6 N, R. 18 W, Beartrap Canyon Quadrangle, Piru Mts., Posey Canyon shale; Uyeno and Miller, 1962*b*: Cyprinodontidae.

MIOCENE.—San Bernardino Co., Mule Cañon Drive, Calico Mts., Barstow formation (Palmer, 1957); Pierce, 1959: pl. 25 only (see Hubbs and Miller, 1962); Uyeno and Miller, 1962*b*: Cyprinodontidae.

#### FLORIDA

PLEISTOCENE.—(1) Levy Co., "Mixon bone bed," near Williston; Hay, 1919: Lepisosteidae. (2) St. Lucie Co., No. 3 or "Muck bed," Vero; Hay, 1917, 1919, 1923: Lepisosteidae, Amiidae.

PLEISTOCENE (AFTONIAN?).—Brevard Co., Melbourne; Gidley *in* Hay (1927:274): Lepisosteidae.

## IDAHO

PLEISTOCENE (MIDDLE).—Owyhee Co., Jackass Butte, NE 1/4, Sec. 15, T. 4 S, R. 2 E; Uyeno, 1961, and unreported material at UMMP: Cyprinidae, Catostomidae (family only), Centrarchidae (family only).

PLIOCENE (LATE) TO PLEISTOCENE (EARLY).—(1) Twin Falls Co., many localities in Glens Ferry formation (Malde and Powers, 1962: 1206–09); Cope, 1870, 1883; Uyeno, 1961: Salmonidae, Cyprinidae, Catostomidae, Centrarchidae (genus undet., perhaps *Lepomis*), Cottidae. (2) Elmore Co., same as above. (3) Owyhee Co., same as above.

PLIOCENE (MIDDLE).—Owyhee Co., NE 1/4, Sec. 12, T. 5 S, R. 1 W, Oreana Quadrangle, Chalk Hills formation (Malde and Powers, 1962); Uyeno, 1961: Cyprinidae.

MIOCENE (LATE AND MIDDLE).—Nez Perce Co., 11 mi. E of Lewiston, T. 36 N, R. 4 W, Latah formation; Scheid, 1937: Cyprinidae (recorded as "*Leuciscus* skeletons"; not in Table 1).

## ILLINOIS

PLEISTOCENE?: Pulaski Co.; Cope, 1893: Cyprinidae (see *Aphelichthys* in annotated list).

PLEISTOCENE.—Around S end of Lake Michigan; Hay, 1923: Amiidae, Centrarchidae.

## KANSAS

PLEISTOCENE (LATE SANGAMON).—Meade Co., XI Ranch in SW 1/4 Sec. 32, T. 33 S, R. 29 W, Jinglebob local fauna; Hibbard (1955:205): Cyprinidae, Ictaluridae.

PLEISTOCENE (LATE ILLINOIAN).—Meade Co., (1) XI Ranch in SE 1/4 Sec. 32, T. 34 S, R. 29 W, Butler Spr. local fauna locality; Smith, C. L., 1958: Lepisosteidae, Catostomidae, Ictaluridae, Percidae. (2) Two localities, SW 1/4 Sec. 13 and SE 1/4 Sec. 14, T. 32 S, R. 29 W, and one locality in SE 1/4 Sec. 18, T. 32 S, R. 28 W; Smith, G. R., 1963: Lepisosteidae, Esocidae, Cyprinidae, Catostomidae, Ictaluridae, Percidae, Centrarchidae.

PLIOCENE (LATE).—(1) Seward Co., Sawrock Canyon, Sec. 36, T. 34 S, R. 31 W, Rexroad formation; Smith, C. L., 1962: Ictaluridae, Cyprinodontidae. (2) Meade Co., four localities in Rexroad formation; Smith, *op. cit.*: Cyprinidae (family only), Ictaluridae, Centrarchidae, Cyprinodontidae.

PLIOCENE (MIDDLE).—Logan Co., Sec. 7, T. 11 S, R. 37 W, Ogallala formation; Hibbard and Dunkle, 1942; Robertson, 1943; Smith, C. L., 1962: Cyprinidae, Ictaluridae, Cyprinodontidae, Centrarchidae.

PLIOCENE (EARLY).—Trego Co., Sec. 15, T. 11 S, R. 22 W, Ogallala formation; Hubbs and Hibbard, 1951: Ictaluridae.

#### MONTANA

MIOCENE (MIDDLE).—Gallatin Co., Madison Valley, 4 mi. S of Three Forks; Eastman, 1917; Webb, MS: Osmeridae, Cyprinidae.

#### NEBRASKA

PLIOCENE (EARLY).—Brown Co., Sec. 33, T. 33 N, R. 23 W, Lower Valentine formation; Smith, C. L., 1962: Lepisosteidae, Amiidae, Ictaluridae, Centrarchidae.

MIOCENE (LATE) TO PLIOCENE (EARLY).—Sioux Co., Snake Cr. and Sheep Cr., about 20 mi. S of Agate; Cook and Cook, 1933:44; Matthew, 1918, 1924: Ictaluridae, Centrarchidae.

#### NEVADA

PLIOCENE (EARLY).—Churchill Co., (1) cave on E side of Carson Sink, about 5 mi. S of Stillwater, Truckee formation?; Jordan, 1924*b*; Webb, MS: Cottidae. (2) 3 mi. SW of Hazen, SW 1/4, Sec. 8, T. 19 N, R. 26 E, Truckee formation (Early Pliocene, rather than Pleistocene, dating for formation was recorded by Miller, 1955:12); Hay, 1907; Jordan, 1907; Eastman, 1917: Cyprinodontidae, Gasterosteidae.

MIOCENE TO PLIOCENE.—(1) Esmeralda Co., NE end of Silver Peak Range in extreme SW end of Big Smokey Valley; Lucas, 1900; Hubbs and Miller (1948:46): Cyprinidae, Catostomidae (family only). (2) Mineral Co., Stewart Valley, 25 mi. E of Mina; Webb, MS: Salmonidae, Cyprinidae (family only, as det. by us).

MIOCENE?.—Elko Co., 15.5 mi. by dirt road SE and W of Winecup Ranch (old Wilkins Ranch), about 25 mi. NE of Wells, Humboldt formation; material examined at Univ. of Utah: Centrarchidae (family only).

MIOCENE (LATE TO MIDDLE).—Washoe Co., Virgin Valley, N part of T. 45 N, R. 31 E, in extreme NW Nevada (Webb, MS); Hubbs and Miller (1948:26): Cyprinidae (family only).

MIOCENE (MIDDLE).<sup>4</sup>—Elko Co., 25 mi. NE of Elko, near Osino, lower part of Humboldt formation; Cope, 1872: Catostomidae, Aphredoderidae.

#### NORTH CAROLINA

MIOCENE?—(1) Wayne Co., Nathan Edgerton Plantation; Cope, 1869: Lepisosteidae. (2) Brunswick Co., Cape Fear; Emmons, 1858; Hay, 1929: Lepisosteidae.

#### OKLAHOMA

PLEISTOCENE (ILLINOIAN?).—(1) Beaver Co., SE corner of Sec. 6, T. 5 N, R. 28 ECM, near Gate Ash Pit, 4 1/2 mi. N and nearly 1 mi. W of Gate; Smith, C. L., 1954: Lepisosteidae, Esocidae, Cyprinidae, Catostomidae, Ictaluridae, Cyprinodontidae, Centrarchidae, Percidae. (2) Harper Co., N 1/2 of SW 1/4, Sec. 10, T. 27 N, R. 24 W, Doby Spring locality; Smith, C. L., 1958; Stephens, 1960: Cyprinidae, Catostomidae, Ictaluridae, Centrarchidae, Percidae.

PLIOCENE.—Roger Mills Co., NE 1/4 of NE 1/4, Sec. 8, T. 2 N, R. 23 W, 5 mi. S and 1 1/2 mi. E of Cheyenne; Stovall and McAnulty, 1939; Hubbs, 1942: Cyprinodontidae.

PLIOCENE (EARLY).—Beaver Co., NE 1/4, Sec. 4, T. 3 N, R. 28 ECM and two other localities of Laverne formation; Smith, C. L., 1962: Lepisosteidae, Catostomidae, Ictaluridae, Cyprinodontidae, Centrarchidae (family only).

#### OREGON

PLEISTOCENE<sup>5</sup>.—(1) Klamath Co., Lower Klamath Lake; Cressman, 1942: Salmonidae, Catostomidae (see Hubbs and Miller, 1948:68). (2) Klamath Co., Lost R., diatomaceous deposit; Jordan, 1907: Salmonidae (family only). (3) Lake Co. (a) Silver Lake, Cope, 1883; Catostomidae; (b) near Fossil Lake, Starks *in* Jordan, 1907: Catostomidae; and (c) Fossil Lake, Cope, 1883, 1889b; Jordan, 1907; Allison, 1940; Hubbs and Miller, 1948: Salmonidae, Cyprinidae, Catostomidae.

PLIOCENE (LATE) TO PLEISTOCENE (EARLY).—Baker Co., Willow Creek; Cope, 1883: Cottidae (see annotated list); unreported material examined at Yale University: Cyprinidae, Catostomidae.

<sup>4</sup> See footnote 1.

<sup>5</sup> The three localities in Lake Co. very probably include fossils of Pliocene as well as of Pleistocene age (E. R. Hampton, pers. comm.).



PLIOCENE (MIDDLE).—Jefferson Co., Gravel pit. about 1 mi. by road WSW of Gateway; examined by us (age det. by A. J. Shotwell, pers. comm.): Salmonidae (family only).

MIOCENE (MIDDLE).—Grant Co., Sec. 14, T. 13 S, R. 28 E, NE rectangle of Alrich Mt. quadrangle, 13 mi. E of Dayville and 0.1 mi. W of milepost 144 on John Day Highway (see Webb, MS); Cope, 1889a: Centrarchidae.

#### PENNSYLVANIA

PLEISTOCENE (LATE).—Bucks Co., Durham Cave, near Riegelsville; Leidy, 1889: Acipenseridae, Ictaluridae.

#### SOUTH CAROLINA

PLEISTOCENE.—Charleston Co., (1) Ashley R., bed elevated only a few ft. above tide-level of South Carolina coast; Hay, 1923: Lepisosteidae. (2) Young Id., Wadmalaw Sound, nearly 20 mi. SW of Charleston; Hay, 1923: Lepisosteidae.

#### SOUTH DAKOTA

PLEISTOCENE.—Hand Co., Ree Heights or Ree Hills, on Leonard Fawcett Farm, NE 1/4, Sec. 21, T. 111 N, R. 70 W; Cope, 1891: Cyprinidae (see *Proballostomus* and *Sardinius* in annotated list), Cyprinodontidae, Centrarchidae, Percidae. In describing fossils from this locality, Cope thought they might be of Oligocene age; Wilson *et al.* (1959:541) listed the deposit (under Ree beds) as Eocene or Oligocene. At Bobb Schaeffer's request, Morris F. Skinner studied the geology and stratigraphy of the beds, concluding (pers. comm.) that they are Pleistocene. This is in accord with our findings that the identifiable fossil fishes from these beds are all Recent species.

MIOCENE (EARLY).—Bennett Co., Jim Ross Ranch, W of Martin, Flint Hill fauna; Smith, C. L., 1961: Ictaluridae.

#### TEXAS

PLEISTOCENE.—San Patricio Co., about 20 mi. SW of Refugio and 1 mi. N of railroad bridge crossing Aransas R.; Hay, 1926: Lepisosteidae.

PLEISTOCENE (WISCONSIN).—Delta Co., five quarry sites near state highway 38 bridge across Sulphur R., just N of Ben Franklin, Sulphur R. formation; Uyeno, 1963: Esocidae, Cyprinidae, Catostomidae (family only), Ictaluridae, Centrarchidae.

PLEISTOCENE (SANGAMON).—(1) Denton Co., Trietsch Pit in second terrace above Clear Cr., on NE side of cr. and 7 mi. upstream from its junction with Elm Fork of Trinity R.; Uyeno, 1963: Lepisosteidae, Cyprinidae, Catostomidae (family only), Ictaluridae, Centrarchidae. (2) Dallas Co., T-2 terrace of Trinity R. on S side of Dallas; Uyeno and Miller, 1962a: Lepisosteidae, Catostomidae, Ictaluridae, Sciaenidae. (3) Foard Co., almost at E base of Texas Panhandle, Good Cr. formation; Dalquest, 1962: Lepisosteidae, Cyprinidae (family only), Catostomidae, Ictaluridae, Centrarchidae, Sciaenidae.

MIOCENE (LATE) OR PLOCENE (EARLY).—Grimes Co., Jesse Garvin Farm, about 2 1/4 mi. due N of Navasota; Hay, 1924: Ictaluridae.

#### UTAH

PLOCENE (MIDDLE).—Cache Co., Cache Valley, Salt Lake formation (Brown, 1949); material examined by us in USNM and UMMP: Cyprinidae (family only).

#### WASHINGTON

MIOCENE (EARLY?).—Ferry Co., near Republic; Eastman, 1917: Catostomidae.

#### WISCONSIN

PLEISTOCENE (YARMOUTH?).—Dunn Co., clay beds at Menomonie in valley of Red Cedar R.; Hussakof, 1916b: Salmonidae.

#### CANADA

PLEISTOCENE.—(1) Ontario, Ottawa Valley, near Ottawa; Dawson, 1872: Gasterosteidae. (2) Quebec, Goose R., N shore of St. Lawrence R.; Lambe, 1904: Salmonidae.

PLEISTOCENE (WISCONSIN).—Saskatchewan, Lillestrom, 16 mi. SW of Moose Jaw (W of Regina) and just N of Johnstone Lake (age about 10,000 years); Uyeno and Miller, MS: Cyprinidae.

## LITERATURE CITED

ALLISON, IRA S.

- 1940 Study of Pleistocene lakes of south central Oregon. Carnegie Inst. Wash. Year Book, 39:299-300.

BAILEY, REEVE M., AND MARVIN O. ALLUM

- 1962 Fishes of South Dakota. Misc. Publ. Mus. Zool. Univ. Mich., 119:1-131, Figs. 1-7, Pl. 1.

BLACKWELDER, ELIOT, AND ELMER W. ELLSWORTH

- 1936 Pleistocene lakes of the Afton basin, California. Amer. Jour. Sci., 31:453-63, Figs. 1-4.

BRANSON, BRANLEY A., AND GEORGE A. MOORE

- 1962 The lateralis components of the acoustico-lateralis system in the sun-fish family Centrarchidae. Copeia, 1962:1-108, Figs. 1-149.

BROWN, ROLAND W.

- 1949 Pliocene plants from Cachee [sic] Valley, Utah. Jour. Wash. Acad. Sci., 39 (7):224-29, Figs. 1-27.

BUWALDA, JOHN P.

- 1914 Pleistocene beds at Manix, in the eastern Mohave Desert region. Bull. Univ. Calif. Dept. Geol., 7:443-64, Pls. 22-25.

COOK, HAROLD J., AND MARGARET C. COOK

- 1933 Faunal lists of the Tertiary vertebrata of Nebraska and adjacent areas. Nebraska Geol. Surv. Paper, 5:1-58.

COPE, E. D.

- 1869 Second addition to the history of the fishes of the Cretaceous of the United States. Proc. Amer. Philos. Soc., 11:240-44.
- 1870 On the fishes of a fresh-water Tertiary in Idaho, discovered by Capt. Clarence King. *Ibid.*, 11:538-47.
- 1872 The fish-beds of Osino, Nevada. Amer. Nat., 6:775-76.
- 1873 On the occurrence of fossil Cobitidae in Idaho. Proc. Amer. Philos. Soc., 12:55.
- 1878 Descriptions of new vertebrata from the Upper Tertiary formations of the West. *Ibid.*, 18:219-31.
- 1883 On the fishes of the Recent and Pliocene lakes of the western part of the Great Basin, and of the Idaho Pliocene lake. Proc. Acad. Nat. Sci. Philadelphia, 1883:134-66, 1 map.
- 1889a On a species of *Plioplarchus* from Oregon. Amer. Nat., 23:625-26.

- 1889*b* The Silver Lake of Oregon and its region. *Ibid.*, 23:970-82, Fig. 1, Pls. 40-41.
- 1891 On some new fishes from South Dakota. *Ibid.*, 25:654-58.
- 1893 A new extinct species of Cyprinidae. Proc. Acad. Nat. Sci. Philadelphia, 1893:19-20.
- CRESSMAN, L. S.
- 1942 Archaeological researches in the northern Great Basin. Carnegie Inst. Wash. Publ. 538:i-xvii, 1-158, frontisp., Figs. 1-102.
- DALQUEST, WALTER W.
- 1962 The Good Creek formation, Pleistocene of Texas, and its fauna. Jour. Paleontol., 36 (3):568-82, Figs. 1-9.
- DAVID, LORE ROSE
- 1945 A Neogene stickleback from the Ridge formation of California. Jour. Paleontol. 19 (3):315-18, Figs. 1-2.
- DAWSON, J. WILLIAM
- 1872 Notes on the post-Pliocene geology of Canada; with especial reference to the condition of accumulation of the deposit and the marine life of the period. Montreal, 1872:iv-vi, 1-112, Pls. 2-7. (Ref. copied.)
- EASTMAN, CHARLES R.
- 1917 Fossil fishes in the collection of the United States National Museum. Proc. U. S. Natl. Mus., 52:235-304, Figs. 1-9, Pls. 1-23.
- EMMONS, EBENEZER
- 1858 Agriculture of the eastern countries, together with descriptions of the fossils of the marl beds. Rept. N. Car. Geol. Surv., 1858:i-xv, 1-314, Figs. 1-256.
- EVERNDEN, J. F., G. H. CURTIS, D. E. SAVAGE, AND G. T. JAMES
- 1963 Potassium-Argon dates and the Cenozoic mammalian chronology of North America. Amer. Jour. Sci.
- FLINT, RICHARD FOSTER, AND W. A. GALE
- 1958 Stratigraphy and radiocarbon dates at Searles Lake, California. Amer. Jour. Sci., 256:689-714, Figs. 1-5, Pls. 1-2.
- GOSLINE, WILLIAM A.
- 1961 Some osteological features of modern lower teleostean fishes. Smithsonian Misc. Coll., 142 (3):1-42, Figs. 1-8, Diags. 1-4.
- HACK, JOHN T.
- 1942 Sedimentation and volcanism in the Hopi Buttes, Arizona. Bull. Geol. Soc. Amer., 53:335-72, Figs. 1-14, Pls. 1-5.

## HAY, OLIVER PERRY

- 1902 Bibliography and catalogue of the fossil vertebrata of North America. Bull. U. S. Geol. Surv., 179:1-868.
- 1907 A new fossil stickleback fish from Nevada. Proc. U.S. Natl. Mus., 32:271-73, Figs. 1-3.
- 1917 Vertebrata mostly from stratum No. 3, at Vero, Florida, together with descriptions of new species. Rept. Fla. Geol. Surv., 9:43-68, Pl. 3.
- 1919 Description of some mammalian and fish remains from Florida of probably Pleistocene age. Proc. U. S. Natl. Mus., 56:103-12, Pls. 26-28.
- 1920 Descriptions of some Pleistocene vertebrates found in the United States. *Ibid.*, 58:83-146, Pls. 3-11, 4 figs.
- 1923 The Pleistocene of North America and its vertebrated animals from the states east of the Mississippi River and from the Canadian provinces east of longitude 95°. Carnegie Inst. Wash. Publ. 322:1-499, Figs. 1-25, Maps 1-41.
- 1924 Description of some fossil vertebrates from the Upper Miocene of Texas. Proc. Biol. Soc. Wash., 37:1-20, 1 fig., Pls. 1-6.
- 1926 A collection of Pleistocene vertebrates from southwestern Texas. Proc. U. S. Natl. Mus., 68:1-18, Figs. 1-2, Pls. 1-8.
- 1927 The Pleistocene of the western region of North America and its vertebrated animals. Carnegie Inst. Wash. Publ. 322B:1-346, Pls. 1-12.
- 1929 Second bibliography and catalogue of the fossil vertebrata of North America, Volume 1. *Ibid.*, Publ. 390:i-viii, 1-916.

## HIBBARD, CLAUDE W.

- 1936 Two new sunfish of the family Centrarchidae from the Middle Pliocene of Kansas. Univ. Kans. Sci. Bull., 24 (11):177-85, Pls. 6-7.
- 1955 The Jinglebob interglacial (Sangamon?) fauna from Kansas and its climatic significance. Contrib. Mus. Paleontol. Univ. Mich., 12 (10):179-228, Figs. 1-8, Pls. 1-2.
- 1964 A contribution to the Saw Rock Canyon local fauna of Kansas. Papers Mich. Acad. Sci., Arts, and Letters, 49 (1963). In press.

## HIBBARD, CLAUDE W., AND DAVID H. DUNKLE

- 1942 A new species of cyprinodontid fish from the Middle Pliocene of Kansas. State Geol. Surv. Kans. Bull., 41:270-76, Pl. 1.

## HIBBARD, CLAUDE W., AND DWIGHT W. TAYLOR

- 1960 Two Late Pleistocene faunas from southwestern Kansas. Contrib. Mus. Paleontol. Univ. Mich., 16 (1):1-223, Figs. 1-18, Pls. 1-16.

## HUBBS, CARL L.

- 1940 The cranium of a fresh-water sheepshead from postglacial marl in Cheboygan County, Michigan. Papers Mich. Acad. Sci., Arts, and Letters, 25 (1939):293-96, Pl. 1.

- 1942 An atherinid fish from the Pliocene of Oklahoma. *Jour. Paleontol.*, 16 (3):399-400.
- HUBBS, CARL L., GEORGE S. BIEN, AND HANS E. SUSS
- 1962 La Jolla natural radiocarbon measurements II. *Radiocarbon*, 4:204-38.
- HUBBS, CARL L., AND CLAUDE W. HIBBARD
- 1951 *Ictalurus lambda*, a new catfish, based on a pectoral spine from the Lower Pliocene of Kansas. *Copeia*, 1951:8-14, Pls. 1-3.
- HUBBS, CARL L., AND ROBERT R. MILLER
- 1948 Correlation between fish distribution and hydrographic history in the desert basins of western United States. *In* *The Great Basin*, with emphasis on glacial and postglacial times. *Bull. Univ. Utah*, 38 (20):17-166, Figs. 1-29.
- 1962 Supposed Miocene fish eggs from Calico Mountains nodules identified as ostracodes. *Bull. So. Calif. Acad. Sci.*, 60 (3):119-21, Pl. 33.
- HUSSAKOF, L.
- 1908 Catalogue of type and figured specimens of fossil vertebrates in the American Museum of Natural History. Part I. Fishes. *Bull. Amer. Mus. Nat. Hist.*, 25:1-103, Figs. 1-49, Pls. 1-6.
- 1916a A new cyprinid fish, *Leuciscus rosei*, from the Miocene of British Columbia. *Amer. Jour. Sci.*, 42:18-20, Fig. 1.
- 1916b Discovery of the Great Lake trout, *Cristivomer namaycush*, in the Pleistocene of Wisconsin. *Jour. Geol.*, 24 (7):685-89, Figs. 1-2.
- JORDAN, DAVID STARR
- 1907 The fossil fishes of California; with supplementary notes on other species of extinct fishes. *Bull. Univ. Calif. Dept. Geol.*, 5 (7):95-144, Figs. 1-33, Pls. 11-12.
- 1908 Note on a fossil stickleback fish from Nevada. *Smithsonian Misc. Coll.*, 52:117.
- 1919 Fossil fishes of southern California. I. Fossil fishes of the Soledad deposits. *Leland Stanford Jr. Univ. Publ., Univ. Ser.*, No. 38:3-12, Pls. 1-6.
- 1924a Description of Miocene fishes from southern California. *Bull. So. Calif. Acad. Sci.*, 23:42-50, Pls. F-L.
- 1924b Description of a recently discovered sculpin from Nevada regarded as *Cottus beldingi*. *Proc. U. S. Natl. Mus.*, 65:1-2, Pl. 1.
- 1927 The fossil fishes of the Miocene of southern California. *Stanford Univ. Publ., Univ. Ser., Biol. Sci.*, 5 (2):85-99, Pls. 1-4.
- JORDAN, DAVID STARR, BARTON WARREN EVERMANN, AND HOWARD WALTON CLARK
- 1930 Check list of the fishes and fishlike vertebrates of North and Middle America north of the northern boundary of Venezuela and Colombia. *Rept. U. S. Comm. Fish.*, 1928 (2):I-IV, 1-670.

## KULP, J. LAURENCE

- 1961 Geologic time scale. *Science*, 133 (3459):1105-14.

## LAMBE, L. M.

- 1904 Progress of vertebrate paleontology in Canada. *Trans. Roy. Soc. Canada, Ser. 2*, 10 (4):13-56.

## LANCE, JOHN F.

- 1960 Stratigraphic and structural position of Cenozoic fossil localities in Arizona. *Ariz. Geol. Soc. Digest*, 3:155-59, Fig. 1.

## LEIDY, JOSEPH

- 1870 [Prof. Leidy on fossil fishes.] *Proc. Acad. Nat. Sci. Philadelphia*, 1870: 69-71.
- 1889 Notice and description of fossils in caves and crevices of the limestone rocks of Pennsylvania. *Ann. Rept. Geol. Surv. Pennsylvania for 1887:1-20*, 2 pls. [Copied from Hay, 1902.]

## LINNAEUS, CAROLUS

- 1758 *Systema Naturae*. Vol. 1, Ed. 10:824 pp.

## LUCAS, FREDERIC A.

- 1900 A new fossil cyprinoid, *Leuciscus turneri*, from the Miocene of Nevada. *Proc. U.S. Natl. Mus.*, 23:333-34, Pl. 8.

## MACNEIL, F. S., J. A. WOLFE, D. J. MILLER, AND D. M. HOPKINS

- 1961 Correlation of Tertiary formations of Alaska. *Bull. Amer. Assoc. Petrol. Geol.*, 45 (11):1801-09.

## MALDE, HAROLD E., AND HOWARD A. POWERS

- 1962 Upper Cenozoic stratigraphy of western Snake River Plain, Idaho. *Bull. Geol. Soc. Amer.*, 73:1197-1219, Figs. 1-2, Pl. 1.

## MATTHEW, W. D.

- 1918 Contributions to the Snake Creek fauna; with notes upon the Pleistocene of western Nebraska: American Museum Expedition of 1916. *Bull. Amer. Mus. Nat. Hist.*, 38:183-229, Figs. 1-20, Pls. 4-10.
- 1924 Third contribution to the Snake Creek fauna. *Ibid.*, 50:59-210, Figs. 1-63.

## MERRILL, GEORGE P.

- 1907 Catalogue of the types, cotypes, and figured specimens of fossil vertebrates in the department of geology, U.S. National Museum. *Bull. U.S. Natl. Mus.*, 53 (2):i-v, 1-81.

## MILLER, ROBERT RUSH

- 1945 Four new species of fossil cyprinodont fishes from eastern California. *Jour. Wash. Acad. Sci.*, 35 (10):315-21, Fig. 1.

- 1955 An annotated list of the American cyprinodontid fishes of the genus *Fundulus*, with the description of *Fundulus persimilis* from Yucatan. Occ. Papers Mus. Zool. Univ. Mich., 568:1-25, Pl. 1.
- 1959 Origin and affinities of the freshwater fish fauna of Western North America. In Zoogeography. Amer. Assoc. Adv. Sci. Publ. 51 (1958):187-222, Figs. 1-19.
- PALMER, ALLISON R.
- 1957 Miocene arthropods from the Mojave Desert, California. U.S. Geol. Surv. Prof. Paper, 294-C:i-iii, 237-80, Figs. 83-101, Pls. 30-34.
- PIERCE, W. DWIGHT
- 1959 Silicified eggs of vertebrates from Calico Mountains nodules. Bull. So. Calif. Acad. Sci., 58 (2):79-83, Pls. 24-26.
- ROBERTSON, GEORGE M.
- 1943 *Fundulus sternbergi*, a Pliocene fish from Kansas. Jour. Paleontol., 17 (3):305-07, Pl. 52.
- ROSEN, DONN ERIC, AND MYRON GORDON
- 1953 Functional anatomy and evolution of male genitalia in poeciliid fishes. Zoologica, 38 (1):1-47, Figs. 1-47, Pls. 1-4.
- ROUSE, GLENN E., AND W. H. MATHEWS
- 1961 Radioactive dating of Tertiary plant-bearing deposits. Science, 133 (3458):1079-80.
- RUSSELL, ISRAEL C.
- 1902 Geology and water resources of the Snake River plains of Idaho. Bull. U.S. Geol. Surv., 199:1-192, Figs. 1-6, Pls. 1-25.
- SCHEID, VERNON E.
- 1937 Fish in the Latah formation of Idaho. Science, 85 (2196):120.
- SCHLAIKJER, ERICH M.
- 1937 New fishes from the continental Tertiary of Alaska. Bull. Amer. Mus. Nat. Hist., 74 (1):1-23, Figs. 1-7.
- SINCLAIR, WILLIAM J.
- 1904 The exploration of the Potter Creek Cave. Univ. Calif. Publ. Amer. Arch. and Ethn., 2 (1):1-27, Pls. 1-14.
- SMITH, C. LAVETT
- 1954 Pleistocene fishes of the Berends fauna of Beaver County, Oklahoma. Copeia, 1954:282-89, Figs. 1-7.



- 1958 Additional Pleistocene fishes from Kansas and Oklahoma. *Ibid.*, 1958: 176-80, Figs. 1-3.
- 1961 An ictalurid catfish, *Ictalurus decorus* (Hay), from the Miocene of South Dakota. *Jour. Paleontol.*, 35 (5):923-26, Pl. 103.
- 1962 Some Pliocene fishes from Kansas, Oklahoma and Nebraska. *Copeia*, 1962:505-20, Figs. 1-9.

## SMITH, GERALD R.

- 1963 A Late Illinoian fish fauna from southwestern Kansas and its climatic significance. *Copeia*, 1963: 278-85, Figs. 1-4.

## STEPHENS, JOHN J.

- 1960 Stratigraphy and paleontology of a Late Pleistocene basin, Harper County, Oklahoma. *Bull. Geol. Soc. Amer.*, 71:1675-1702, Figs. 1-9, Pl. 1.

## STOVALL, J. WILLIS, AND WILLIAM N. McANULTY

- 1939 Cyprinodontidae from the Pliocene in Roger Mills County, Oklahoma. *Amer. Midland Nat.*, 22:749-52, Figs. 1-3.

## TAYLOR, DWIGHT W.

- 1957 Pliocene fresh-water mollusks from Navajo County, Arizona. *Jour. Paleontol.*, 31 (3):654-61, Figs. 1-6.
- 1960 Distribution of the freshwater clam *Pisidium ultramontanum*; a zoogeographic inquiry. *Amer. Jour. Sci.*, 258-A:325-34, Figs. 1-3.

## TAYLOR, WILLIAM RALPH

- 1954 Records of fishes in the John N. Lowe collection from the Upper Peninsula of Michigan. *Misc. Publ. Mus. Zool. Univ. Mich.*, 87:1-50, Map 1.

## UYENO, TERUYA

- 1961 Late Cenozoic cyprinid fishes from Idaho with notes on other fossil minnows in North America. *Papers Mich. Acad. Sci., Arts, and Letters*, 46 (1960):329-44, Figs. 1-3.
- 1963 Late Peistocene fishes of the Clear Creek and Ben Franklin local faunas of Texas. *Jour. Grad. Res. Center So. Methodist Univ.*, 31 (3):168-71, Figs. 1-2.

## UYENO, TERUYA, AND ROBERT RUSH MILLER

- 1962a Late Pleistocene fishes from a Trinity River terrace, Texas. *Copeia*, 1962: 338-45, Figs. 1-5.
- 1962b *Empetrichthys erdisi*, a Pliocene cyprinodontid fish from California, with remarks on the Fundulinae and Cyprinodontinae. *Ibid.*,:520-32, Figs. 1-7.
- 1964 Middle Pliocene fishes from the Bidahochi formation, Arizona. *Copeia*, 1964.

## WAHRHAFTIG, CLYDE

- 1958 Quaternary geology of the Nenana River valley and adjacent parts of the Alaska Range. U. S. Geol. Surv. Prof. Pap. 293-A:1-68, Figs. 1-29, Pls. 1-8.

## WILSON, DRUID, GRACE C. KEROHER, AND BLANCHE E. HANSEN

- 1959 Index to the geologic names of North America. U. S. Geol. Surv. Bull., 1056-B:i-iv, 407-622.

*Accepted for publication May 28, 1963*



