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FUNDULUS LARIVERSI, A NEW MIOCENE FOSSIL CYPRINODONT FISH FROM NEVADA

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Abstract.—A new fossil cyprinodont fish, Fundulus lariversi from the Miocene Siebert Tuff of central Nevada is described. Comparisons are made with living and fossil fishes from Nevada and adjacent areas to determine its affinity and evolutional relationships. Fundulus lariversi may represent the ancestral stock of the Pliocene Fundulus fishes and the recent ***Empetrichthys*** fishes of Nevada.

Introduction

The late Tertiary fossil fish fauna of the western Great Basin is poorly known. Salmo cyniclope La Rivers 1962 is the only Miocene fossil fish known from northwestern Nevada. Five fossil fish: ***Gila*** esmeralda La Rivers 1966 originally thought to be Pliocene in age but now placed in the Miocene (Lugaski, 1977); "Leuciscus" ***turneri*** Lucas 1900 (now placed ***in Gila*** by Uyeno and Miller, 1963; La Rivers, 1962; Miller, 1965; La Rivers, 1966); Gasterosteus doryssus (Jordan) 1907; Fundulus nevadensis (Eastman) 1917 and Gasterosteus apodus Mural 1973 (now regarded as a junior synonym of ***G.*** doryssus by Bell (1974), all of Pliocene age have been found in western Nevada. To the south of the Great Basin in the Mohave desert region five cyprinodontid fishes have been found ranging in age from Pliocene to Pleistocene: Fundulus curryi Miller 1945, ***F.*** eulepis Miller 1945, ***F.*** davidae Miller 1945, ***Cyprinodon*** breviradius Miller 1945 and Empetrichthys erdisi (Jordan) 1924. The material described herein represents another cyprinodontid fossil fish that existed in Miocene lakes and streams in the area around Tonopah, Nye County, Nevada which places this fauna between the Pliocene ***F.*** nevadensis fauna found 161 km to the north and the Pliocene ***F.*** curryi faunal association found 242 km to the south.

The comparative analysis of this family was undertaken using data on the following fossil and living species found in or near the study area in order to determine the affinity of this undescribed fossil: Fundulus nevadensis described from the Lahontan basin, Nevada (Eastman, 1917); ***F.*** curryi, ***F.*** eulepis , ***F.*** davidae described from the Death Valley area, California (Miller, 1945); Empetrichthys erdisi (Jordan, 1924; Uyeno and Miller, 1962) from southern California; ***Empetrichthys*** merriami Gilbert 1893 from Ash Meadows area, Nevada; ***Empetrichthys latos*** Miller 1948 described from Pahrump Valley, Nevada; ***Crenichthys*** nevadae Hubbs 1932 from Railroad Valley, Nevada; ***Crenichthys*** baileyi (Gilbert) 1893 from Pahranagat Valley, Nevada

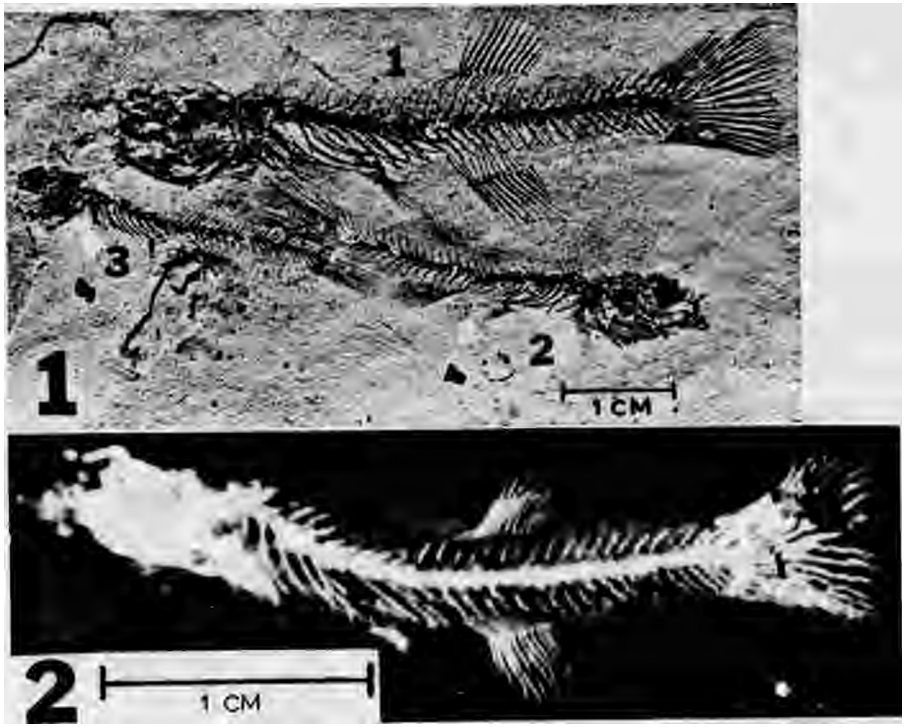

Fig. 1. The holotype, BSN 60-1 and two paratypes, BSN 60-2 and 3 of *Fundulus lariversi* from Tonopah, Nevada.

Fig. 2. An ultraviolet photograph of *Fundulus nevadensis* from western Nevada for comparison with Fundulus lariversi.

and Cyprinodon nevadensis Eigenmann and Eigenmann 1889 from Ash Meadows area, Nevada.

Genus Fundulus Lacepede 1803

Fundulus lariversi, n. sp.

Types. The holotype (Fig. 1) is specimen no. BSN (Biological Society of Nevada) 60-1, Lugaski collection found at the Tonopah sand dunes road-fill pit in the Siebert Tuff on June 10, 1975 by Thomas Lugaski and Ira La Rivers. This specimen is 48 mm standard length (SL), 57 mm total length (TL) of nearly perfect condition (Table 1, Fig. 1). Its body is elongated, compressed behind, robust anteriorly with a moderately large head; snout short and depressed with lower jaw projecting beyond upper jaw and strongly developed. Specimen larger than other fossil fish collected at this locality. Dorsal fin placed halfway between the tip of the snout and upper terminal

Table 1. Morphometric data of the holotype and two paratypes of *Fundulus lariversi.*

Measurements	Holotype BSN 60-1	Paratype BSN 60-2	Paratype BSN 60-3
Head depth[1]	177.1	203.1	188.7
Body depth	218.8	140.6	158.5
Fin length			
dorsal	166.7	125.0	207.5
anal	125.0	156.3	132.1
caudal	208.3	203.1	245.3
pectoral	125.0	109.4	132.1
pelvic	62.5	93.8	75.5
Min. caudal depth	135.4	93.8	113.2
Dorsal-anal depth	177.1	140.6	150.9
Dorsal-occiput length	385.4	343.8	358.5
Snout-occiput length	229.2	343.8	245.3
Pelvic-anal length	166.7	187.5	169.8
Pelvic-snout length	510.4	562.5	471.7
Pectoral-snout length	291.7	343.8	264.2
Snout-anal length	656.3	687.5	641.5
Pectoral-pelvic length	218.8	218.8	169.8
Pelvic-dorsal length	218.8	187.5	226.4
Pectoral-dorsal length	375.0	406.3	396.2
Pelvic-caudal length	552.1	500.0	584.9
Pectoral-caudal length	770.8	687.5	773.6

[1] Measurements from here to the end of the table in thousands of standard length.

tip of caudal fin; length of dorsal fin base lesser in holotype than height of dorsal fin; anal fin base length approximately equal to anal fin height; caudal fin large with greatest depth 18% greater than maximum body depth; total caudal length 15.8% of total length and caudal fin slightly convex in shape. Last rays of dorsal, anal, pectoral and pelvic fins shorter in length than first and intermediate rays with the latter being longest; pectoral fins do not reach origins of pelvics; pelvics are extremely reduced. Origin of dorsal fin is directly over the 16-17 vertebrae and directly over anal fin origin. Vertebrae number 33 in total. Dorsal fin rays 11, anal fin rays 13, caudal fin rays 19, pectoral fin rays 12 and pelvic fin rays 8. Scales present with 11-14 in diagonal series.

Paratypes include specimens BSN 60-2, 3, 4, 7 and 11 from same locality, collected same day as holotype but only specimens BSN 60-2 and 3 are complete; BSN 60-4, 7 and 11 are missing portions of posterior of the specimens. BSN 60-2 (Fig. 1, Table 1) 32 mm SL, 40 mm TL in nearly perfect

condition. Body elongate, compressed behind with head somewhat more robust in comparison to body then found in holotype; snout short and depressed with lower jaw projecting and strongly developed. Dorsal fin placed slightly back behind center of the fossil; length of dorsal fin base greater than dorsal fin height and anal fin base greater than anal fin height. Caudal fin relatively large with greatest depth 10% greater than maximum body depth and total caudal length 20% of total length. Caudal fin slightly convex in shape. Last rays of dorsal, anal, pectoral and pelvic fins the same as in holotype. Origin of dorsal fin slightly ahead of anal fin origin. Vertebrae number 31 in total. Dorsal fin rays 11, anal fin rays 13, caudal fin rays 17, pectoral fin rays 12 and pelvic fin rays 7. Pelvics also extremely reduced; scales present but not countable. Paratype BSN 60-3 (Fig. 1, Table 1) 26.5 mm SL, 33 mm TL in nearly perfect condition. Morphological description of this paratype similar to paratype BSN 60-2. Dorsal fin rays 11, anal fin rays 14, caudal fin rays 18, pectoral fin rays 11 and pelvic fin rays 5. Scales present but not countable. Paratype BSN-4 is similar in description to holotype but also has a series of conical teeth located on its dentary and premaxillary; dorsal fin slightly in advance of anal fin origin. Study of the scales present in the types indicate scales of moderate size, focus of scale behind the scale center with 5-7 radii, 6 radii average. Paratypes BSN 60-7 and 11 similar to holotype but poorly preserved so no counts or measurements were taken. All types are deposited in the Biology Museum of the Biological Society of Nevada.

Etymology: This new species is named after the late Dr. Ira La Rivers, a student of fossil and living fishes of the Great Basin.

Horizon and Type Locality

The Siebert Tuff consists of fluvio-lacustrine deposits, ash-fall and lapillistone. The facies is thought to be water-reworked volcaniclastic rocks deposited in streams and shallow lakes (Bonham and Garside, 1974). Henshaw (1942) described a Barstovian mammalian fauna collected from the Siebert Tuff at a point 16 km north of Tonopah, Nye County, Nevada. The Siebert Tuff unconformably overlies the Fraction Tuff, 17.8 million years (m.y.) K-Ar date (Silbermann and McKee, 1972) and is in turn overlain by the Oddie Rhyolite and then the Brougher Dacite, 16.2 m.y. K-Ar date (Albers and Stewart, 1972). These K-Ar dates clearly make *F. lariversi* Miocene (late Hemingfordian—early Barstovian) in age.

The type locality is located 17.6 km northwest of Tonopah (sec. 13 T4N R41) east of Nevada State Highway 89 and west of the San Antonio Mountains in a pit used to supply road-fill in the area. The fossil fish were found in a single layer about one-third up a 7.8 m high exposure. Few fish were found but numerous small fish fragments were scattered throughout this layer.

These fluvio-lacustrine deposits are highly stratified and are made up of fine volcanic ash. No other fossils were found in this deposit. Paleoenvironmental indicators such as the fine dust, size of the deposit (7.8 m high and several hundred meters in extent) and the relatively good condition of a number of the fossils point to a shallow to moderately deep lake or marsh rather than a stream environment with a fairly rapid depositional rate.

Discussion of Comparative Material

The family Cyprinodontidae is represented in Nevada and adjacent areas by four living and fossil genera: *Cyprinodon, Crenichthys, Empetrichthys* and *Fundulus. Cyprinodon* is represented in Nevada and closely adjacent regions by numerous species and subspecies (Miller, 1948; La Rivers, 1962). A generalized *C. nevadensis* is used here for comparison. *Cyprinodon nevadensis* differs from *F. lariversi* in having fewer anal fin rays, 9-11 for the former and 13 for the latter; more pectoral fin rays, 14-18 in the former and 12 in the latter; *Cyprinodon* usually has tricuspid jaw teeth (Miller, 1948; La Rivers, 1962) unlike *F. lariversi;* additional comparative data is presented in Tables 2 and 3.

Crenichthys is represented in Nevada by two living endemic species, *C. nevadae* and *C. baileyi.* Comparing the *Crenichthys* as a whole without going into species variation with *F. lariversi* we find that the former lacks a pelvic fin, the latter has a much reduced one; the former has 28 caudal fin rays, the latter has 19 caudal fin rays; the former usually has bicuspid jaw teeth (La Rivers, 1962) unlike *F. lariversi;* additional data is presented in Tables 2 and 3.

Empetrichthys is represented by two endemic species, *E. merriami* and *E. latos* and numerous subspecies (Miller, 1948; La Rivers, 1962) in Nevada and a Pliocene fossil species *E. erdisi* in southern California. All three *Empetrichthys* species and *F. lariversi* agree closely in the number of dorsal fin rays, anal fin rays and caudal fin rays; pectoral fin rays are 16-18 in *E. merriami* and *E. latos* and 12 in *F. lariversi (E. erdisi* numbers lacking); body depth, head depth and minimum caudal depth into standard length in *E. merriami* and *E. laws* is different than *E. erdisi* (Table 3) but *E. erdisi* and *F. lariversi* closely agree. All three *Empetrichthys* species have conical jaw teeth which agrees with *F. lariversi* but they all lack pelvic fins which separates them from *Fundulus* despite the other close morphological and meristic features (Tables 2, 3).

This fossil therefore appears to be a member of the genus *Fundulus* which is characterized by conical teeth on the dentary and premaxillary bones, the presence of pelvic fins and the other cyprinodontid characteristics (Sethi, 1960). *Fundulus* is represented in northwestern Nevada by *F. nevadensis* (Fig. 2, Tables 2, 3) found in the Pliocene Coal Valley Formation (La Rivers,

Table 2. Comparative fin data on eleven cyprinodontid including *Fundulus lariversi,* n. sp. Age of each fish is also given (Rec. = Recent, Plio. = Pliocene and Mio. = Miocene).

	Measurements				
	Dorsal Fin Rays	Anal Fin Rays	Caudal Fin Rays	Pectoral Fin Rays	Pelvic Fin Rays
Crenichthys nevadae" (Rec.)	12	13	28	16	
baileyi[4] (Rec.)	11	14	28	16	
Empetrichthys merriami" (Rec.)	9–12	12–15	18–20	16–18	
latos[3,4] (Rec.)	10-12	11-13	16-23	16-18	
erdisi[5] (Plio.)	11-13	11-13	17-19		
Cyprinodon nevadensis[3,4] (Rec.)	8-12	9-11	14-22	14-18	0-9
Fundulus nevadensis" (Plio.)	11-12	10-13	23	11-12	9
eulepis[2] (Plio.)	13-14	13-14			6
curryi[2] (Plio.)	14-15	16	19-20	14–16	6
davidae[2] (Plio.)	11-12	11-12	20	15-16	6
lariversi[7] (Mio.)	11-12	13	19	12	8

[1] Hubbs, 1932 [2] Miller, 1945 Miller, 1948 La Rivers, 1962 Uyeno and Miller, 1963 [6] Lugaski, unpublished data n = 20 Lugaski, type data.

Table 3. Body depth, head depth and minimum caudal depth into standard length (SL); dorsal fin position in eleven species of cyprinodontid fish.

	Measurements			
	Body Depth in SL	Head Depth in SL	Min. Caudal Depth in SL	Dorsal Fin Position
Crenichthys nevadae"	3.3	3.2	7	Only slightly in advance of anal fin
baileyi[4]	3.2	3.2	5-7	Equal with anal fin
Empetrichthys merriami[3,4]	2.8-3.7	2.8-3.4	7	Equal with anal fin
latos	3.0-3.6	2.8-3.4	7	Equal with anal fin
erdisi	4	4-5	7-8	Slightly in advance of anal fin
Cyprinodon nevadensis	2-3	2.7-3.5	5	Well in advance of anal, midway between pelvic and anal fin
Fundulus nevadensis"	5-8	3.5-6.0	7-11	Well in advance of anal, midway between pelvic and anal origin
eulepis[2]	4.5-5.0	3.5		In advance of anal
curryi	3.0-3.5	3.5		Only slightly in advance of anal fin
davidae[2]	4.0	3.5		Slightly behind anal fin
lariversi	4.5-7.0	4.5-5.5	7–11	Equal with anal fin

[1] Hubbs. 1932 Miller, 1945 Miller. 1948 La Rivers, 1962 Uyeno and Miller, 1962 [6] Lugaski, unpublished data n = 20 Lugaski, type data.

1962) and in southern Nevada and adjacent areas by *F. curryi*, *F. davidae* and *F. eulepis* all of Pliocene age. *Fundulus lariversi* differs from *F. nevadensis* in placement of the dorsal fin in relation to the anal fin; *F. nevadensis* dorsal fin is well in advance of the anal fin where as the dorsal fin in *F. lariversi* is equal with the anal fin (Table 3); *F. nevadensis* has a higher number of caudal rays (23) than *F. lariversi* (19) but *F. lariversi* is larger and more robust than *F. nevadensis* (Figs. 1, 2, Table 2).

Fundulus lariversi differs from *F. curryi, F. davidae* and *F. eulepis* in having more pelvic fin rays, 8 in the former and 6 in the latter three; having fewer pectoral fin rays, 12 in the former and 14-16 in the latter three; head depth into standard length, 4.5-5.5 in the former and 3.5 in the latter three; placement of the dorsal fin directly over the anal fin in the former with dorsal fin in advance of anal in *F. curryi* and *F. eulepis* and slightly behind in *F. davidae* (Tables 2, 3).

Conclusions

The comparative material has shown that this new fossil cyprinodontid fish is not a member of the genera *Cyprinodon* and *Crenichthys* but shows a close affinity to *Empetrichthys* and due to the presence of the pelvic fin and other data is placed in the genus *Fundulus. Fundulus lariversi* has been shown to be different from the other known *Fundulus* in Nevada and southern California; the K-Ar age date also establishes *F. lariversi* as the oldest described cyprinodontid fish. The close morphological and meristic data agreement between the genus *Empetrichthys* and *F. lariversi* is understandable since Uyeno and Miller (1962) have shown that *Empetrichthys* is thought to be derived from *Fundulus* stock sometime before Middle Pliocene time. *F. lariversi* being Miocene in age may represent the *Empetrichthys* ancestral stock as well as the ancestral stock for other *Fundulus* of Nevada.

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