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G. Gary Scoppettone
U.S. Geological Survey, Reno, Nevada

James E. Harvey
U.S. Fish and Wildlife Service, Reno, Nevada

James Heinrich
Nevada Division of Wildlife, Boulder City, Nevada

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CONSERVATION, STATUS, AND LIFE HISTORY OF THE ENDANGERED WHITE RIVER SPINEDACE, *LEPIDOMEDA ALBIVALLIS* (CYPRINIDAE)

G. Gary Scoppettone[1], James E. Harvey[2], and James Heinrich[3]

ABSTRACT.—*Lepidomeda albivallis* (White River spinedace), a fish species endemic to the White River, Nevada, appeared headed toward extinction. In 1991 only 1 population remained, and it comprised fewer than 50 individuals in a 70-m stream reach. We monitored population recruitment and distribution and studied life history and habitat use from 1993 through 1998. We determined that *L. albivallis* was not reproducing and was continuing to decline, and as an emergency measure we relocated the population (14 in spring 1995 and 6 in spring 1996) downstream 200 m to a secure habitat that we judged more favorable for reproduction. The relocated population reproduced, and by September 1998 it had increased to 396 individuals that inhabited more than 1 km of stream including both pond and stream habitats. In streams they oriented near the bottom but frequently moved up in the water column to strike at drift items. Gut analysis of museum specimens indicated *L. albivallis* is omnivorous but feeds primarily upon aquatic invertebrates. Conservation of *L. albivallis* will require reestablishing additional populations within its former range.

Key words: Lepidomeda, *spinedace, Plagopterini, endangered fish, life history, White River, Colorado River, largemouth bass.*

Lepidomeda albivallis (White River spinedace) is an endangered fish species endemic to the White River system, Nye and White Pine Counties, Nevada. It is a member of the cyprinid tribe Plagopterini known only from the lower Colorado River basin (Miller and Hubbs 1960). Plagopterini has undergone population declines throughout its range as a result of habitat alteration and introduced species (Miller 1961, 1963, Douglas et al. 1994). One species, *Lepidomeda altivelis* (Pahranagat spinedace), is extinct, and 5 others are listed or have been considered for federal listing (U.S. Fish and Wildlife Service 1994a, 1997). When the type specimen of *L. albivallis* was collected in 1938, the species was abundant and had been sampled from 7 spring systems (Miller and Hubbs 1960, La Rivers 1962). By the time of its listing (U.S. Fish and Wildlife Service 1985), distribution was limited to 2 spring systems, and in 1991 there were fewer than 50 individuals inhabiting a single 70-m stream reach (U.S. Fish and Wildlife Service 1994b). Remaining *L. albivallis* were large, suggesting the population was not recruiting and on the verge of extinction.

The purpose of this study was to monitor the *L. albivallis* population to gauge recruitment (or verify nonrecruitment) and to generate basic life history information useful for species management and recovery. During the study we relocated the population and monitored reproduction response and habitat use.

STUDY AREA

The Flag Springs/Sunnyside Creek system, which harbors *L. albivallis*, is in the southern portion of the White River system and one of the few spring systems directly discharging into the historical White River channel (Fig. 1). Most spring discharge is diverted for irrigation and is disjunct from the White River channel. Flag Springs consists of 3 springs originating within 300 m of each other. In 1991 the northernmost spring (herein North Fork) harbored the last known *L. albivallis* in its upper 70 m (Fig. 1); habitat consisted of shallow riffle (≈10 cm deep) and 2 ponds (the upper 300 m^2 with a maximum depth of 1 m, the lower about 75 m^2 with a maximum depth of 0.7 m). Restricted distribution of *Lepidomeda albivallis* in the Flag Springs system was

[1]Biological Resources Division, U.S. Geological Survey, 1340 Financial Blvd., Suite 161, Reno, NV 89502.
[2]U.S. Fish and Wildlife Service, 1340 Financial Blvd., Reno, NV 89502.
[3]Nevada Division of Wildlife, 1204 Avenue I, Boulder City, NV 89005.

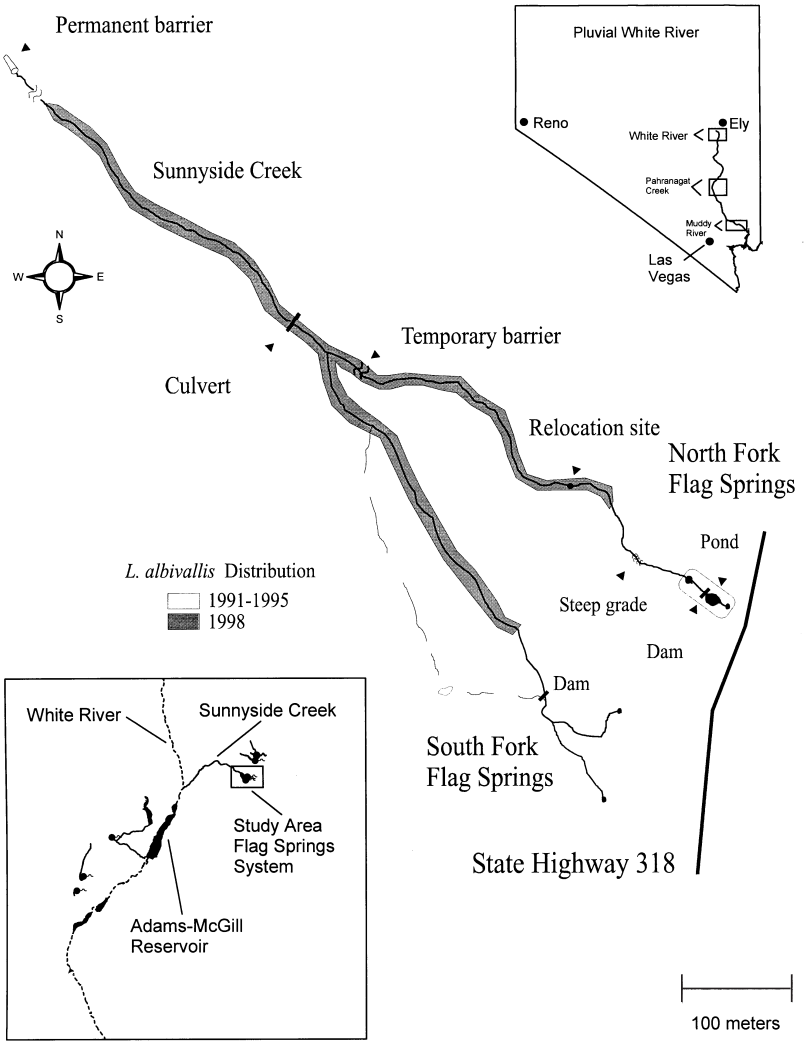

Fig. 1. Map of the Flag Springs/Sunnyside Creek system, Nevada, showing *Lepidomeda albivallis* distribution before relocation (1991–1995) and 3 years after relocation (1998). Insets show the relationship of the Flag Springs/Sunnyside Creek system to the White River and the White River to the course of the pluvial White River.

a result of *Micropterus salmoides* (largemouth bass) predation (U.S. Fish and Wildlife Service 1994b). The upper North Fork was isolated and protected from *M. salmoides* by a steep stream grade and 2-m-high dam (Fig. 1).

The North Fork discharged 0.03 $m^3 \cdot s^{-1}$ and flowed 550 m to join the combined outflow (0.04 $m^3 \cdot s^{-1}$) of the 2 southern Flag Springs (herein South Fork) and form Sunnyside Creek (Fig. 1). Water temperature was approximately 16.0°C at the origin of the North Fork and 20°–23°C at the origin of the 2 southern Flag springs. The upper 70 m of North Fork had a riparian corridor of willow (*Salix*), currant (*Ribes*), and wild rose (*Rosa*), and the upper 100 m of the 2 southern spring outflow channels was lined with cottonwood (*Populus*) and willow. Sunnyside Creek flowed through open grassland for about 4 km before discharging into the White River channel and then Adams-McGill Reservoir (Fig. 1). *Lepidomeda albivallis* co-occurred with *Catostomus clarki* (desert sucker) and *Rhinichthys osculus* (speckled dace) in the Flag Springs/Sunnyside Creek system.

MATERIALS AND METHODS

Species Status and Adaptive Management Actions

Adaptive management actions were taken to expand the *L. albivallis* population. First, *M. salmoides* was eradicated from the upper 500 m of the North Fork by electrofishing in spring 1993, and a temporary fish barrier was installed to prevent reinvasion (Fig. 1). To determine if *L. albivallis* was reproducing and its distribution expanding downstream following this initial eradication, the North Fork was snorkeled from the temporary fish barrier upstream to the springhead seasonally from November 1993 to March 1995. Meanwhile, in summer 1994, personnel of the Nevada Division of Wildlife eradicated remaining *M. salmoides* in North and South Forks/Sunnyside Creek to a permanent barrier about 2.5 km downstream from the springheads (Fig. 1).

The 2nd action was relocation in April and May 1995, 1996, and 1997 of all *L. albivallis* from the upper 70 m of North Fork to a site 200 m downstream. Thirty standard "Gee" minnow traps, half lined with 1-mm-mesh plastic screen, were baited with dry dog food and fished within the 70-m reach. A hoop net (6.4-mm stretch mesh, 1.6 m long, with a 0.7-m opening) was also fished in each of the 2 large pools. Traps were fished 7–10 days within the 2-month fishing period. In May 1997 the entire area within the 70-m reach was electrofished with a Smith-Root Type VII electroshocker to ensure all *L. albivallis* had been removed. Relocated fish had access to 3 km of *M. salmoides*–free water and habitat similar to that used for spawning by other Plagopterini (Barber et al. 1970, Rinne 1971, Blinn et al. 1998).

We monitored recruitment success and population expansion after *L. albivallis* relocation. In September 1995 we began snorkeling the North Fork, and in September 1996 and 1997 and October 1998 we added the upper 1.5 km of Sunnyside Creek and the South Fork. For each monitoring period the snorkeler moved upstream to count *L. albivallis* and estimated fork length (FL) of 33%–100% of the fish sighted. Samples selected were representative of the population. These data were compared with lengths of a sample taken from the upstream 70 m of North Fork on 8 May 1992, prior to management actions.

Age and Growth

Age and growth data were generated from museum specimens ($n = 30$) collected from the Flag Springs system in 1938 (UMMZ 124990). *Lepidomeda albivallis* scales were small and annuli could not be determined. We therefore used opercle bones to estimate age (Scoppettone 1988). By scraping the opercle with a scalpel, we removed the flesh and then used a dissection microscope to identify annuli, which were assumed to be zones where opaque bone met more transparent zones (Casselman 1974). We generated a logarithmic equation to illustrate the relationship of *L. albivallis* age to growth (Sokal and Rohlf 1995).

Food Habits

Food habit analysis was done on the 30 Flag Springs fish used for age growth analysis plus 14 specimens collected from Preston Big Spring in 1961, 1964, and 1965 (5F-141, 4F-1145, and 4F-1148, Zoology Museum, University of Nevada, Las Vegas). Specimens ranged from 61 mm to 96 mm FL. The anterior third of the gut was examined with a dissecting scope, and food items were identified and quantified by percent frequency of occurrence and percent volume (Windell 1971). We also compared gut length to fish total length (Nikolsky 1963).

Habitat Use

In July, September, and November 1993, and March, May, and July 1994, we quantified *L. albivallis* microhabitat use in the 2 headwater ponds of North Fork and in July and October 1998, and January and April 1999 in the Flag Springs/Sunnyside Creek outflow (Fig. 1). Measured variables were total depth (water column depth at the subject fish), focal depth (depth from water surface to fish), focal velocity (water velocity at fish), and mean velocity (mean water column velocity at fish). Relative depth was determined by dividing focal depth by total depth. Fish were located using mask and snorkel. A Marsh and McBirney model 210 flow meter on a graduated rod was used to measure stream velocity and depth. We classified life stages as larva (<20 mm FL), juvenile (20–60 mm FL), and adult (>60 mm FL).

Sexual Dimorphism and Reproduction

Color differences and presence of tubercles have been used to determine sex of *L. albivallis*

(Miller and Hubbs 1960), but these differences were not readily detectable in fish we captured from headwater ponds. Miller (1963) observed that *L. vittata* males have longer pectoral fins than females, extending to the pelvic insertion or beyond in males and falling short of the insertion in females. We investigated this method to sex *L. albivallis* using twenty 1938 Flag Springs specimens (61 m to 96 mm FL) and confirmed gender by dissecting each fish.

RESULTS

Species Status and Adaptive Management Actions

North Fork snorkel surveys from November 1993 through March 1995 indicated *L. albivallis* were restricted to the upper 70 m, not reproducing, and declining in number. Counts were 12 on 16 November 1993, 31 on 2 March 1994, 26 on 23 May 1994, 6 on 14 July 1994 and 10 January 1995, and 0 on 30 March 1995. By March 1995 aquatic vegetation was so dense that we could not determine whether *L. albivallis* were still present. Nevada Division of Wildlife, U.S. Fish and Wildlife Service, and U.S. Geological Survey decided that remaining *L. albivallis* be relocated 200 m downstream to an area of greater habitat diversity, thus enhancing the probability of reproduction. We captured 20 fish (9 apparent females and 5 males in spring 1995, and 2 females and 4 unsexed in spring 1996). No *L. albivallis* were captured in spring 1997 after trapping and electrofishing, and we concluded that none remained. Relocated fish were large (≥75 mm FL), one measuring 165 mm FL, the largest *L. albivallis* ever reported.

On 6 September 1996 we documented that relocated *L. albivallis* had reproduced: 61 *L. albivallis* were counted. All were young and smaller than fish captured in 1992 (Fig. 2). They were found exclusively in the South Fork. In September 1997 we counted 112 individuals, ranging from 18 mm to 73 mm FL (Fig. 2); 81 were in the upper 500 m of the South Fork and 31 in Sunnyside Creek. One year later 396 were counted, ranging from 20 mm to 110 mm FL, with most (305) in the South Fork, but extending up the North Fork and several hundred meters downstream into Sunnyside Creek (Fig. 1).

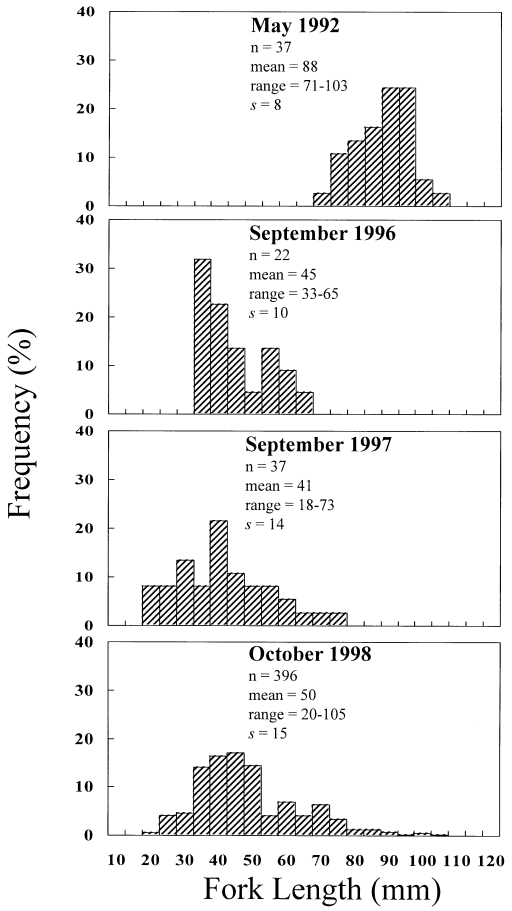

Fig. 2. Length frequency of *Lepidomeda albivallis* populations before (1992) and after (1996–1998) relocation, Flag Springs, Nevada.

Age and Growth

Museum specimens collected from Flag Springs ranged from <1 year to 12 years of age (Fig. 3). Fish 1 year of age ranged from 42 mm to 65 mm FL and at 5 years from 70 mm to 98 mm FL. Growth was logarithmic with age, and there was a high correlation between length and age ($r = 0.92$). The longest (107 mm FL) and oldest fish (12 years) were female; the longest and oldest male was 92 mm FL and 5 years of age. Relocated fish of both sexes were presumed to be at least 11 years old.

Food Habits

Gut samples revealed that the species is omnivorous but tends toward carnivory. This was corroborated by gut length, which averaged only 71% ($s = 0.11$; $n = 31$) of total length. Invertebrates were in 90% of guts

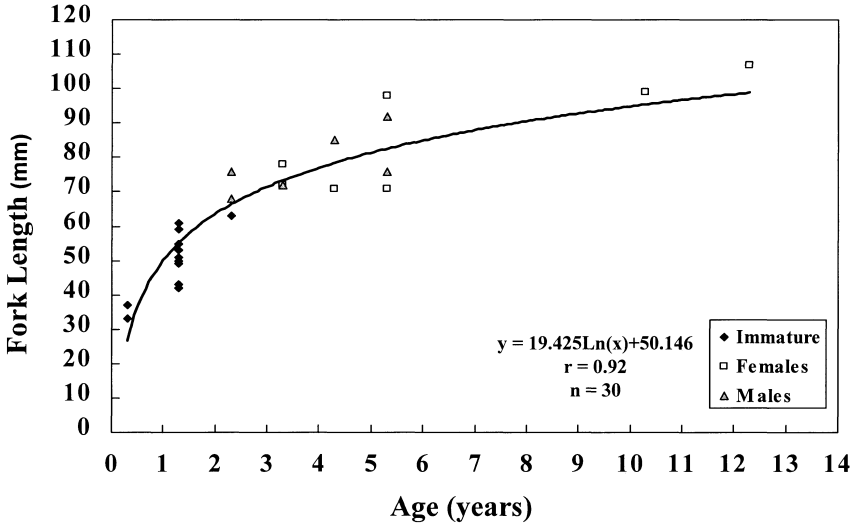

Fig. 3. Fork length and age of *Lepidomeda albivallis* collected from Flag Springs, Nevada, in 1938 (n = 30).

examined and represented 71% of the volume of items. Most were aquatic insects (Ephemeroptera, Trichoptera, Plecoptera, Hemiptera, aquatic Coleoptera, and aquatic Diptera), but Gastropoda and Turbelleria also were present. Plant material and algae were in 41% of guts but accounted for only 17% of the volume consumed, and detritus made up 7% by volume. We observed *L. albivallis* in the Flag Springs system feeding in or near flowing water where they struck at drift items. In Preston Big Spring, 2 of 14 specimens had consumed *Crenichthys baileyi*: a 91-mm FL male had taken a 25-mm FL *C. baileyi* and a 61-mm FL female had taken an 18-mm FL *C. baileyi*.

Habitat Use

Lepidomeda albivallis confined to the headwaters of the North Fork inhabited ponds where they were benthically oriented and generally in mean water velocities of <2.0 cm $\cdot$ s^{-1} (Table 1). In the outflow, adults inhabited higher water velocities (18.7 cm $\cdot$ s^{-1} mean water column and 14.9 cm $\cdot$ s^{-1} focal point) but were still benthically oriented; they generally oriented upstream but moved in various directions to strike at drift items. Juveniles inhabiting shallower water were closer to the water surface. Larvae occurred near the surface and in much shallower and slower water than that used by adults and juveniles.

Sexual Dimorphism and Reproduction

We found ova of 2 sizes in the egg skein, suggesting that reproduction occurs over a protracted period. This was corroborated by museum collections that included post-larvae <20 mm FL taken from spring through late August. We also observed 13-mm larvae on 18 May 1999, indicating reproduction in April. Thus, reproduction appeared to take place from at least April into July. The smallest female inspected was 61 mm FL (51 mm standard length), collected in April 1965. It contained 2 size classes of eggs, the largest of which was close to maturity. This fish was the smallest of 20 sexed by using position of the pectoral fin relative to the origin of the pelvic fin, and the only one for which the method was unsuccessful.

DISCUSSION

Status of *L. albivallis* was determined to be "critically imperiled" and conservation measures were implemented to avoid its extinction. In 1993 the only known *L. albivallis* were at the head of the North Fork of Flag Springs and were large, old, declining, and with no apparent recruitment for several years. One hypothesis for lack of recruitment was that *L. albivallis* were trapped upstream of the dam

TABLE 1. Characteristics of habitat used by 3 life stages of *L. albivallis* in North Fork ponds (1993–94) and South Fork/Sunnyside Creek outflow (1998–99), Nevada.

Life stage	Mean velocity Mean ± *s* (cm · s^{-1})	Focal velocity Mean ± *s* (cm · s^{-1})	Total depth Mean ± *s* (cm)	Relative depth Mean ± *s* (%)	*n*
NORTH FORK PONDS					
Adult	1.6 ± 3.1	1.4 ± 2.4	57.5 ± 8.7	81.6 ± 10.9	62
NORTH FORK/SOUTH FORK/SUNNYSIDE CREEK					
Larva	0.9 ± 1.5	0.5 ± 0.6	27.0 ± 9.3	22.0 ± 17.5	13
Juvenile	19.1 ± 9.2	12.9 ± 7.8	53.7 ± 17.1	70.5 ± 30.4	68
Adult	18.7 ± 9.5	14.9 ± 7.1	63.5 ± 16.1	85.1 ± 17.5	209

when it was installed in 1984 and habitat was unsuitable for spawning. This suggests that headwater North Fork fish were ≥11 years when relocated downstream. Analysis of opercle bones from museum specimens indicated that *L. albivallis* does achieve this longevity, even though other Plagopterini are believed to live only 1 to 3 years (Minckley 1973). Tracking *L. albivallis* over 10 years in the upper North Fork suggests that they live well beyond 3 years. Only adults were observed from 1986 to 1988 (Donna Withers, U.S. Fish and Wildlife Service, personal communication) and from 1991 to 1996. Fishes inhabiting cool water tend to live longer (Reimers 1979), and cool conditions in headwater ponds of the North Fork may have contributed to the longevity. An alternate hypothesis is that the dam modified stream habitat such as substrate or velocity, thus limiting or preventing recruitment. A related species, *L. vittata* (Little Colorado River spinedace), does well in pondlike conditions but requires stream habitat with fine gravel in which to reproduce (Blinn et al. 1998). Regardless of the mechanism, it is likely the species would be extinct if remaining *L. albivallis* had not been moved downstream to habitat where they successfully reproduced.

Lepidomeda albivallis survives in both pond and stream habitat and consumes a variety of food items, which indicates that, like *L. vittata*, it is a habitat and dietary generalist (Runck and Blinn 1993). Results of both stomach content analyses and field observations have shown that *L. albivallis*, like several other Plagopterini, actively feeds on drift in streams (Minckley and Carufel 1967, Barber and Minckley 1983, Angradi et al. 1991). Furthermore, in the family Cyprinidae a gut length shorter than body length suggests carnivory (Nikolsky 1963), also consistent with drift feeding.

Although the range of *L. albivallis* has expanded since the early 1990s, its present habitat range and diversity represent a small fraction of what was previously available. Even with the habitat limitations of the Flag Springs/Sunnyside Creek system, the population was still increasing. Though we quantified habitat use seasonally, we are hesitant to draw conclusions on habitat preference because our data are from a period of rapid population expansion and distribution. Habitat use for each life stage in the Flag Springs/Sunnyside Creek system should be investigated again when population size, year class structure, and distribution have stabilized.

Additional populations of *L. albivallis* need to be reestablished within the species' historic range to avoid future threats. Requisites for successful *L. albivallis* transplanting include extirpation of nonnative fishes and habitat restoration. An important component of habitat restoration is lengthening spring outflows, which were cut short and diverted to artificial channels, leaving an insufficient stream length to sustain *L. albivallis.* Until other populations can be established, the Flag Springs system needs to be protected and closely monitored for reinvasion of *M. salmoides* and other nonnative species. As a hedge against this threat, the headwater pools of North Flag Spring should be managed as a *Lepidomeda albivallis* refuge.

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LITERATURE CITED

ANGRADI, T.R, J.S. SPAUDING, AND E.D. KOCH. 1991. Diel food utilization by the Virgin River spinedace, *Lepidomeda mollispinis mollispinis,* and speckled dace, *Rhinichthys osculus,* in Beaver Dam Wash, Utah. Southwestern Naturalist 36:158–170.

BARBER, W.E., AND W.L. MINCKLEY. 1983. Feeding ecology of a southwestern cyprinid fish, the spikedace, *Meda fulgida* Girard. Southwestern Naturalist 28:33–40.

BARBER, W.E., D.C. WILLIAMS, AND W.L. MINCKLEY. 1970. Biology of the Gila spikedace, *Meda fulgida,* in Arizona. Copeia 1970:9–18.

BLINN, D.W., J. WHITE, T. PRADETTO, AND J. O'BRIEN. 1998. Reproductive ecology and growth of a captive population of Little Colorado spinedace (*Lepidomeda vittata*: Cyprinidae). Copeia 1998:1010–1015.

CASSELMAN, J.M. 1974. Analysis of hard tissue of pike *Esox lucius* L. with special reference to age and growth. Pages 13–27 *in* T.B. Bagenal, editor, Proceedings of an international symposium on the ageing of fish. European Inland Fisheries Commission of FAO, The Fisheries Society of the British Isles and The Fish Biological Association, Unwin Brothers.

DOUGLAS, M.E., P.C. MARSH, AND W.L. MINCKLEY. 1994. Indigenous fishes of western North America and the hypothesis of competitive displacement: *Meda fulgida* (Cyprinidae) as a case study. Copeia 1994:9–19.

LA RIVERS, I. 1962. Fish and fisheries of Nevada. Nevada Fish and Game Commission, Carson City.

MILLER, R.R. 1961. Man and the changing fish fauna of the American Southwest. Papers of the Michigan Academy of Science, Arts, and Letters 46:365–404.

_____. 1963. Distribution, variation, and ecology of *Lepidomeda vittata,* a rare cyprinid fish endemic to eastern Arizona. Copeia 1963:1–5.

MILLER, R.R., AND C.L. HUBBS. 1960. The spiny-rayed cyprinid fishes (Plagopterini) of the Colorado River system. Miscellaneous Publication of the Museum of Zoology, University of Michigan 115:1–39.

MINCKLEY, W.L. 1973. Fishes of Arizona. Arizona Game and Fish Department, Phoenix.

MINCKLEY, W.L., AND L.H. CARUFEL. 1967. The Little Colorado spinedace, *Lepidomeda vittata*, in Arizona. Southwestern Naturalist 13:291–302.

NIKOLSKY, G.U. 1963. The ecology of fishes. Academic Press, London and New York.

REIMERS, N. 1979. A history of a stunted brook trout population in an alpine lake: a lifespan of 24 years. California Fish and Game 65:196–215.

RINNE, W.E. 1971. The life history of *Lepidomeda mollispinis mollispinis* (the Virgin River spinedace), a unique western cyprinid. Unpublished master's thesis, University of Nevada, Las Vegas. 109 pp.

RUNCK, C., AND D.W. BLINN, 1993. Seasonal diet of *Lepidomeda vittata,* a threatened cyprinid fish in Arizona. Southwestern Naturalist 38:157–159.

SCOPPETTONE, G.G. 1988. Growth and longevity of the cui-ui and longevity of other catostomids and cyprinids in western North America. Transactions of the American Fisheries Society 117:301–307.

SOKAL, R., AND F.J. ROHLF. 1995. Biometry. 3rd edition. Freeman, New York.

U.S. FISH AND WILDLIFE SERVICE. 1985. Endangered and threatened wildlife and plants: determination of endangered status and designation of critical habitat for the White River spinedace. Federal Register 50: 37194–37198.

_____. 1994a. Endangered and threatened wildlife and plants: animal candidate review for listing as endangered or threatened species, proposed rule. Federal Register 59:58982, 59028.

_____. 1994b. White River spinedace recovery plan. U.S. Fish and Wildlife Service, Portland, OR.

_____. 1997. Title 50—Wildlife and fisheries. Part 17: Endangered and threatened wildlife and plants, CFR 17.11 & 17.12. Subpart B—List. U.S. Government Printing Office, Washington, DC.

WINDELL, J.T. 1971. Food analysis and rate of digestion. Pages 215–226 *in* W.E. Ricker, editor, Methods for assessment of production in fresh waters. IBP Handbook 3. Blackwell Scientific Publication, Oxford and Edinburgh.

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