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# *GILA BORAXOBIUS,* A NEW SPECIES OF CYPRINID FISH FROM SOUTHEASTERN OREGON WITH A COMPARISON TO *G. ALVORDENSIS* HUBBS AND MILLER

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*Abstract.—Gila boraxobius,* a new cyprinid fish, is described from a small spring-fed lake in the Alvord Basin of southeastern Oregon. This dwarf species of *Gila* is characterized by a large head with dorsal surface slightly concave in profile, large eyes, slender caudal peduncle, and reduced lateral line. *Gila boraxobius* is most closely allied to *G. alvordensis* Hubbs and Miller, with which it is compared. The restricted habitat of *G. boraxobius* is threatened by drilling associated with geothermal energy exploration.

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Fishes of the genus *Gila* Baird and Girard form a diverse assemblage of western North American cyprinids. Fifteen species and numerous subspecies of the genus currently are recognized. Many of these taxa have been described from allopatric populations in the Great Basin. The species described herein inhabits a small spring-fed lake, Borax Lake (T37S, R33E, Sec. 14), in the Alvord Basin of the Great Basin province. Snyder et al. (1964) reported that during Pleistocene times a lake of over 1,200 $km^2$ at its maximum extent was present in the Alvord Basin. As pluvial lakes, such as Lake Alvord, dried, fishes became isolated in remaining springs and creeks of the basins (Hubbs et al., 1974). Eleven allopatric populations of fishes of the genus *Gila* inhabit waters of the Alvord Basin of Oregon and Nevada. One of the 11 populations, from Trout Creek in Oregon, was named *G. alvordensis* by Hubbs and Miller (1972). In their diagnosis of *G. alvordensis,* Hubbs and Miller included the *Gila* from Borax Lake, although they reported it as "usually greatly dwarfed" in comparison to the Trout Creek *Gila.* Further investigation of the Borax Lake *Gila* demonstrated that this fish is separable from the Trout Creek *Gila* at the specific level.

Drilling associated with geothermal energy exploration threatens the Borax Lake *Gila* through possible interference with the hot springs that supply water to the lake. The Unique Wildlife Ecosystem Program of the U.S. Fish and Wildlife Service regards the Borax Lake area as the second most important and unique ecosystem in Oregon (Bruce Boccard pers. comm.). Because of restricted habitat and threats from geothermal exploration, the new species has been proposed for the federal threatened and endangered species list and is currently on the protected list of the Oregon Department

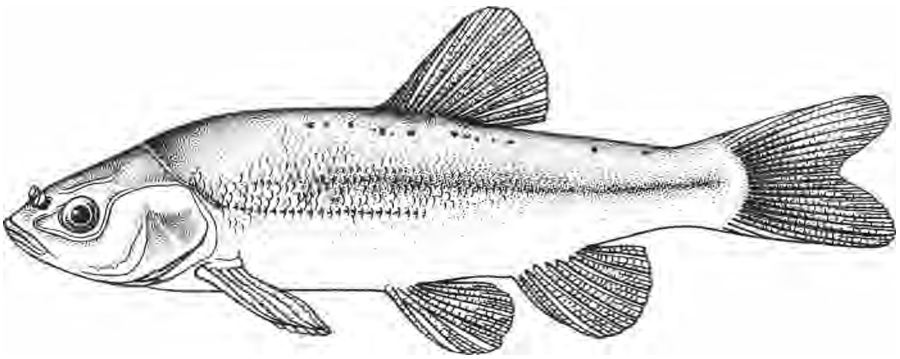

Fig. 1. Holotype of *Gila boraxobius,* UMMZ 203329, a tuberculate male 50.6 mm SL.

of Fish and Wildlife. The species is listed as threatened by the Endangered Species Committee of the American Fisheries Society (Deacon et al., 1979).

*Materials and methods.—Thirty* specimens each of *Gila* from Borax Lake and Trout Creek were examined to determine their morphometry and meristics. Counts and measurements followed the methods of Hubbs and Lagler (1958). In enumerating vertebrae from radiographs, the methods of Hubbs et al. (1974:90) were followed; the hypural plate was counted as one vertebra and the Weberian apparatus as four. In some specimens, the identification of the transitional vertebra between precaudal and caudal vertebrae was difficult and may have caused some inaccuracy. Measurements were made to the nearest 0.1 mm with precision dial calipers. In order to reduce the effects of allometry no specimens less than 40 mm SL were measured. Dyes and magnification were employed on counts involving scales and lateral line pores. Counts or measurements of *Gila alvordensis* refer to specimens from Trout Creek. Results reported in this study are based on preserved specimens from the Oregon State University Collection of Fishes (OS). Type material was deposited at Oregon State University and the University of Michigan Museum of Zoology (UMMZ).

*Gila boraxobius,* new species
Borax Lake Chub
Fig. 1

*Siphateles* sp. Hubbs and Miller, 1948 (zoogeography).

*Gila alvordensis* Hubbs and Miller, 1972 (diagnosis of *G. alvordensis* included "usually greatly dwarfed [form] in Borax Lake"). Bond, 1974 (rare status).

*Holotype.—Tuberculate* male, UMMZ 203329, 50.6 mm SL; collected by

Table 1.-Measurements, in thousandths of standard length, of 30 specimens each of *Gila boraxobius* and *G. alvordensis.*

| Measurement | *Gila boraxobius* | | | *Gila alvordensis* | | |
|---|---|---|---|---|---|---|
| | Range | Mean | SD | Range | Mean | SD |
| Standard length, mm | 41.7-90.4 | 48.9 | 9.1 | 47.4-119.5 | 64.8 | 22.1 |
| Predorsal length | 549-600 | 570.5 | 12.0 | 506-581 | 557.4 | 15.0 |
| Greatest body depth | 214-331 | 243.8 | 21.5 | 239-269 | 251.6 | 8.3 |
| Greatest body width | 144-197 | 157.8 | 29.5 | 128-191 | 160.8 | 14.8 |
| Anal to caudal length | 289-333 | 312.0 | 12.6 | 298-345 | 320.4 | 11.3 |
| Head length | 280-357 | 318.1 | 14.4 | 252-287 | 270.0 | 9.1 |
| Head depth | 173-208 | 194.3 | 7.5 | 169-189 | 177.1 | 5.3 |
| Head width | 159-201 | 179.4 | 11.1 | 140-172 | 158.9 | 9.5 |
| Orbit length | 48-79 | 64.3 | 6.4 | 37-59 | 49.9 | 5.7 |
| Snout length | 78-105 | 90.4 | 6.2 | 66-86 | 73.1 | 5.2 |
| Snout to nostril length | 50-70 | 58.4 | 5.3 | 42-61 | 50.1 | 5.5 |
| Length of upper jaw | 73-104 | 85.4 | 5.9 | 68-90 | 77.1 | 4.4 |
| Mandible length | 81-110 | 97.6 | 6.3 | 75-95 | 84.3 | 5.2 |
| Least bony interorbital width | 70-91 | 82.4 | 4.6 | 78-104 | 90.5 | 5.6 |
| Least caudal peduncle depth | 92-122 | 107.9 | 6.7 | 110-138 | 123.9 | 7.0 |
| Longest gill raker | 6-24 | 9.6 | 4.1 | 9-16 | 12.3 | 2.1 |

K. Howe and party from Borax Lake, Harney County, Oregon, 5 August 1977.

*Paratopotypes.-All* collected from Borax Lake, Harney County, Oregon. UMMZ 203330, 114 specimens (14.3-68.3 mm SL); OS 4137, 12 (34.1-90.4); OS 4138, 182 (25.8-61.8).

*Diagnosis.—Gila boraxobius* is most closely allied to *G. alvordensis.* These species differ from other species of *Gila* in possessing the following combination of characters: uniserial pharyngeal teeth, radii in all fields of the scale, and typically seven dorsal and anal fin rays. A comparison of proportional measurements, in thousandths of SL, between *G. boraxobius* and *G. alvordensis* illustrates many interspecific differences (Table 1). The head of *G. boraxobius* is longer, wider and deeper than that of *G. alvordensis. Gila boraxobius* possesses a larger eye than does *G. alvordensis.* Orbit length of *G. boraxobius* is greater than snout to nostril length, but equal to or less than this in *G. alvordensis. Gila boraxobius* possesses a longer snout than does *G. alvordensis.* The length of the jaw in *G. boraxobius* is greater than in *G. alvordensis.* The caudal peduncle of *G. boraxobius* is quite slender in comparison to *alvordensis.* In profile, the dorsal surface of the head of *boraxobius* is concave, rather than convex as in *alvordensis.* The lateral line is reduced in *G. boraxobius,* but complete in *G. alvordensis;* lateral line pore counts averaged 13.2 (range 2-43) for 30 specimens from Borax Lake and 44.2 (30-66) in 30 specimens of *G. alvor-*

Table 2.—Sexual dimorphism of fin lengths, expressed in thousandths of SL, in Gila *boraxobius*. Ranges are given with means in parentheses.

| Measurement | 4 males | 28 females |
|---|---|---|
| Depressed dorsal fin | 220-243 (229.5) | 174-213 (190.8) |
| Depressed anal fin | 192-217 (204.0) | 156-182 (170.4) |
| Left pectoral fin | 223-233 (227.8) | 162-197 (183.5) |
| Left pelvic fin | 149-192 (172.3) | 129-154 (140.5) |

densis. The modal number of pectoral fin rays is 13 in G. boraxobius, and 14 or 15 in G. alvordensis.

Description.—Gila boraxobius is a dwarf species of Gila. Adult specimens are typically 33-50 mm SL. Of several hundred specimens from Borax Lake in the Oregon State University collection, only four fish are longer than 60 mm SL. These four specimens are all female, including individuals of 61.8, 68.3, 90.4, and 92.7 mm SL. The largest male collected was 50.6 mm SL (holotype). Males as small as 28.6 mm SL are highly tuberculate. Mature eggs were found in females as small as 31.8 mm SL. The head of G. boraxobius is large with the dorsal surface prominently concave in profile. The jaw is long; the mouth is quite oblique, rising to opposite the lower one-half of the eye. The eyes are large. The caudal peduncle is noticeably slender.

The anterior margin of the rather small dorsal fin is slightly rounded and the posterior margin is slightly convex. There are two rudimentary dorsal fin rays, the largest of which is approximately one-half the length of the first principal ray. The anterior margin of the anal fin is rounded and the posterior margin is slightly convex. When the dorsal and anal fins are depressed, the branches of the third principal ray are typically the longest. The posterior tips of the slightly forked caudal fin are rounded. All fins are proportionately larger in males than in females (Table 2). Gila boraxobius typically has 7

Table 3.—Frequency distribution of fin ray counts in Gila boraxobius and G. alvordensis.

| | Dorsal rays | | | | | | | Anal rays | | | | | | | Left pelvic rays | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6 | 7 | 8 | Mean | 7 | 8 | Mean | 7 | 8 | 9 | Mean | 7 | 8 | 9 | Mean |
| Gila boraxobius | | 17 | 3 | 7.0 | 21 | 9 | 8.3 | 3 | 25 | 3 | 8.0 | | | | |
| Gila alvordensis | | 25 | 3 | 7.2 | 28 | 3 | 8.1 | 3 | 25 | 1 | 7.9 | | | | |

| | Left pectoral rays | | | | | | | | Caudal rays | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12 | 13 | 14 | 15 | Mean | 17 | 18 | 19 | 20 | Mean |
| Gila boraxobius | | 4 | 16 | 6 | 4 | 13.3 | 3 | 3 | 23 | 17.7 |
| Gila alvordensis | | 1 | 6 | 3 | 0 | 14.1 | 4 | 24 | 3 | 18.9 |

Table 4.—Frequency distribution of selected characters in *Gila boraxobius* and *G. alvordensis*.

| | Gill rakers | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | Mean |
| *Gila boraxobius* | 1 | 1 | 7 | 3 | 3 | 1 | 1 | 1 | | | 15.9 |
| *Gila alvordensis* | | | | | | 5 | 5 | 4 | 3 | 1 | 19.9 |

| | Caudal peduncle circumference scales | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | Mean |
| *Gila boraxobius* | 1 | 3 | 3 | 3 | 6 | 4 | 2 | 2 | | | 1 | 2 | 29.8 |
| *Gila alvordensis* | | | | 2 | 6 | 4 | 1 | 3 | 4 | 2 | 1 | 1 | 32.1 |

| | Precaudal vertebrae | | | | | Caudal vertebrae | | | | | Total vertebrae | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 18 | 19 | 20 | 21 | Mean | 16 | 17 | 18 | 19 | Mean | 36 | 37 | 38 | 39 | Mean |
| *Gila boraxobius* | 9 | 16 | 5 | | 18.9 | 3 | 14 | 13 | | 18.3 | 3 | 8 | 9 | 1 | 37.2 |
| *Gila alvordensis* | 8 | 19 | 3 | | 19.8 | 1 | 9 | 7 | 3 | 17.7 | | 3 | 16 | | 37.6 |

dorsal and anal fin rays, 8 pelvic rays, 13 pectoral rays, and 19 caudal rays (Table 3).

Gila boraxobius has fine, deeply embedded scales. Caudal peduncle scale counts averaged 29.8 (Table 4). Radii are well developed in all fields of the scale.

The lateral line in G. boraxobius is reduced. Twenty-seven of 30 fish examined had lateral line pores restricted to near the head; three possessed a moderately or well developed lateral line. The lateral line configuration of G. boraxobius, based on the specimens with this structure developed, originates at the dorsal margin of the opercle, descends at approximately a 30 angle to below the horizontal skeletogenous septum, then parallels the septum and continues posteriorly to a point just anterior to the midpoint of the dorsal fin base. At a point even with the midpoint of the dorsal fin base, the lateral line rises until it intercepts the horizontal septum slightly past the base of the dorsal fin. No specimens exhibited lateral line development on the caudal peduncle.

Pharyngeal teeth of G. boraxobius are uniserial and well hooked. Teeth are typically 5-4, occasionally 4-4. The tips of all teeth except the uppermost are hooked at a right angle or greater. The fourth and fifth teeth are usually hooked at greater than right angles. Grinding surfaces are weakly developed and occupy approximately one-third the length of the tooth. The lower limb of the arch is constricted below the last tooth and then expanded so that it appears nearly spatulate and then tapers to a blunt point. The upper limb shield is moderately expanded.

Gill rakers on the first arch averaged 15.9 for 16 specimens (Table 4). Gill

rakers are short, especially on the lower limb where they appear as mere bumps.

The intestine is of the simple sigmoid configuration. Intestinal length typically equals 80-90% of standard length. Peritoneum color is variable, but usually numerous black speckles result in a dark appearance.

Modal numbers of vertebrae are: precaudal, 19; caudal, 18 or 19; total vertebrae, 37 (Table 4).

*Color.—Live* specimens of *Gila boraxobius* are moderately dark, olive green on the dorsal surface of the head and body with a dark line extending along the length of the dorsal midline. Lateral surfaces are mostly silver with numerous small melanophores from the dorsal midline over approximately the upper three-quarters of the body. The sides of the body display a purple iridescence. The ventral surface is silver. The fins are colorless except for many melanophores along the rays of the dorsal and caudal fins and the first four rays of the pectoral fins. Occasional specimens possess melanophores along the anal fin rays. In preservative, some specimens display an uneven row of large melanophores, not usually visible in life, along each side of the dorsal midline.

*Sex ratio and sexual dimorphism.*—Fewer males than females were present in collections of *G. boraxobius* made during summer months. In a sample of 90 individuals greater than 39.0 mm SL collected in August, 24.4% were male and 75.6% were females. However, collections made during spring, autumn, and winter showed nearly equal numbers of adults of both sexes. Males are easily distinguished from females by the relative length of their fins, all of which are longer than those of females (Table 2). The pelvic fins of males reach to or past the origin of the anal fin; in females, the pelvic fins usually do not reach the anus. Nuptial tubercles are found only on males longer than 28 mm SL and are restricted to the body and paired fins. Numerous very small tubercles are present along the entire length of the body, more noticeably on the anterior one-half. On the moderately twisted pectoral fins, tubercles occur on the dorsal surfaces of the first seven or eight (occasionally nine) rays. The outermost rays are moderately thickened. Tubercles are borne along most of the length of the first six rays. They are strongest on outermost rays and smaller, blunter and fewer on inner rays. Each tubercle is restricted to a single ray segment, where it arises from a rounded base to form a strong prominent apex. Tubercles present on the pelvic fins are considerably smaller, blunter and fewer than those on the pectoral fins.

*Relationships.—Sixteen* species are now recognized in the genus *Gila. Gila boraxobius* is allied most closely to *G. alvordensis* Hubbs and Miller of which it is considered to be a dwarf relative. Hubbs and Miller (1972) referred *G. alvordensis* to the subgenus *Siphateles* but noted that several characters of *G. alvordensis* are distinct from the diverse *G. bicolor com-*

plex, which otherwise constitutes the subgenus. *Gila boraxobius* shares those characters with *G. alvordensis. Gila alvordensis* and *G. boraxobius* possess finer, more deeply embedded scales than does *G. bicolor.* Radii are well developed in all fields of the scales in *G. boraxobius* and *G. alvordensis,* whereas the radii are restricted to the posterior field in *G. bicolor.* Typically, seven dorsal and anal fin rays are present in *G. boraxobius* and *G. alvordensis. Gila bicolor* has eight or more rays in the dorsal and anal fins. Decisions on subgeneric classification of these species must await completion of a systematic study of the *Gila* inhabiting the Alvord and adjacent basins.

*Distribution and habitat.—Gila boraxobius* is restricted to Borax (=Hot) Lake, outflows in the immediate vicinity of the lake, and two small adjacent pools. No other species of fish inhabits these waters. *Gila boraxobius* is occasionally found in Lower Borax Lake, an artificial lake fed from outflow waters of Borax Lake. Lower Borax Lake usually dries during the summer and never harbors a viable population of *G. boraxobius.* Borax Lake is a relatively shallow and very clear 4.1-ha natural lake that receives water from several thermal springs. These springs issue from a fault into the lake at 35-40°C, and lake temperatures vary from approximately 17 to 35°C depending on season, weather, and distance from the spring sources. *Gila boraxobius* avoids water with a temperature above approximately 34°C. The water of the lake is slightly alkaline (pH near 7.3). Mariner et al. (1974) reported sodium to be the major cation while bicarbonate, sulfate, and chloride (listed in decreasing abundance) were the principal anions in Borax Lake. Specific conductance of the water is 2,410. A complete chemical composition of Borax Lake water can be found in Mariner et al. (1974, 1975). The lake is situated on salts that have been deposited by the lake waters resulting in increased elevation of the lake. By this process, which apparently has been proceeding for hundreds or thousands of years, the elevation of Borax Lake is now 10 m higher than the surrounding land.

*Material examined.—Gila boraxobius* collected from Borax Lake, Harney County, Oregon (in addition to the type material), as follows: OS 4105, 84 specimens; OS 4106, 11; OS 5498, 21. *Gila alvordensis* collected from Trout Creek, Harney County, Oregon, as follows: OS 2778, 62 specimens; OS 5511, 4; OS 6311, 10.

*Etymology.*—The specific epithet *boraxobius* is derived from borax and βιος (bios), life, referring to the life of the species in the borate waters of Borax Lake.

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