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NEW RECORDS OF MOLLUSCA FOR GRAND CANYON NATIONAL PARK AND ARIZONA

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The malacofauna of the Grand Canyon, Arizona, has been virtually unstudied since 1911, when Pilsbry and Ferriss (1911) published what has been the only comprehensive systematic and ecological study of Mollusca in the region. Their studies were based on surveys made during two trips across the Grand Canyon on Bass Trail in 1906 and 1909, before the canyon was made a national park. All other accounts have been brief and taxonomically restricted, mostly reporting occurrences of new species or particular pathological conditions (Stearns, 1890; Ferriss, 1910; Pilsbry and Ferriss, 1910, 1918; Daniels, 1911, 1912; Henderson, 1914; Pilsbry, 1921, 1934; Cockerell, 1927; Marshall, 1929; Miller, 1984). Pilsbry's (1939-1948) treatise on land mollusks north of Mexico for the most part repeats the information given in Pilsbry and Ferriss (1911). The review of Arizona mollusks by Bequaert and Miller (1973) provides only a little additional information about the mollusks of this region, incorporating the data of Pilsbry and Ferriss.

Mollusks of the Colorado River corridor (including the lower extremity of tributaries) between Glen Canyon Dam and Lake Mead have been largely overlooked. Only a few government-sponsored survey reports briefly cite the occurrence of aquatic gastropods (Carothers and Brown, 1991). When mollusks are mentioned at all, they are grouped with miscellaneous (non-insect) aquatic invertebrates under generalized categories like "mollusks" or "snails"; if systematic names are used, they are identified only to taxonomic family, occasionally to genus, and never to species. The families Physidae and Lymnaeidae are the only families that have been mentioned; *Physa* and *Stagnicola* the only genera. *Stagnicola* probably is a misidentification of *Fossaria*: the two have similar shells and the range of *Stagnicola* does not reach into the Southwest. Only aquatic gastropods have been cited; bivalves and terrestrial gastropods have not previously been reported from the river corridor.

Since the 1970s, the biological resources of the

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Colorado River corridor through the Grand Canyon have been intensively studied to determine the environmental impact of operation of the hydroelectric powerplant at Glen Canyon Dam (24.8 km upstream from Lees Ferry). Daily fluctuations of river level, due to releases of water from the dam, have greatly influenced the physical and biotic character of the Colorado River through the Grand Canyon. The ongoing research, mostly under the auspices of Glen Canyon Environmental Studies (GCES, U.S. Bureau of Reclamation), is establishing a baseline understanding of biological, sedimentological, and hydrological conditions in the river corridor. From these studies, management decisions are made toward the methods of operation of the powerplant and toward other aspects of use and preservation of the ecosystem of the inner Grand Canyon.

The senior author joined a GCES research trip from 24 July to 4 August 1991, traveling on the Colorado River between Lees Ferry (Colorado River Mile 0.0; Km 0.0) and Diamond Creek (Mile 225.7; Km 363.2). Some data have been supplemented by examinations made by the senior author during 24–30 May and 4 June 1992. Mollusks were found at 14 localities in proximity to the Colorado River corridor and three localities some distance up tributaries. A separate survey also was made at Thunder River, a tributary to Tapeats Creek 3 km from the Colorado River. In addition, specimens were sent to the authors from GCES collections taken at Lees Ferry. The locations of all collecting sites are listed in Appendix 1. Since this first survey of river corridor mollusks was a reconnaissance, the number of specimens cannot be used to calculate taxonomic abundance or diversity of the Grand Canyon malacofauna.

In the Grand Canyon, 15 species are noted from the 1991 reconnaissance, representing 14 genera in 11 families (Table 1). Of these, 10 species are new records for localities inside the Grand Canyon, three species are new records for the Grand Canyon region, and two species and one genus are new records for the state of Arizona. Records are considered new for the Grand Canyon if the species has not been reported from inside the canyon itself, having previously been known from specimens collected on the surrounding plateaus. Mollusks from this reconnaissance were identified by diagnostic shell characters, but specimens of *Deroceras*, *Oreohelix* and *Oxyloma* were verified by anatomical dissections (by K. C.

Emberton and S.-K. Wu). All species were live collected except *Cionella lubrica*, *Gastrocopta pelucida*, *Discus cronkhitei*, *Hawaiiia minuscula*, and *Sonorella coloradoensis*. None of the dead shells were collected from stations in direct contact with the Colorado River. Specimens have been computer-cataloged into the collections of the Department of Malacology, Academy of Natural Sciences of Philadelphia.

With the exception of the river reach between Glen Canyon Dam and Lees Ferry, aquatic gastropods have never been reported living in the Colorado River itself. That reach is clear and mostly sediment-free due to sediment entrapment behind Glen Canyon Dam. In the downstream reach through the Grand Canyon, sedimentation from major tributaries (Paria River, Colorado River Mile 0.0, Km 0.0; Little Colorado River, Mile 61.4, Km 98.8; Kanab Creek, Mile 143.4, Km 230.7) has a significant impact on the abundance and diversity of aquatic organisms in the Colorado River (Carothers and Brown, 1991). Limnological constraints—sedimentation particularly, but probably including other, unidentified ecological criteria—seems to prohibit colonization of the river by mollusks below Lees Ferry. The reach upstream from Lees Ferry, between there and Glen Canyon Dam, has been artificially stocked with physid gastropods and other aquatic invertebrates to support a successfully introduced trout fishery (J. L. Stone, in litt.).

The class Bivalvia is reported for the first time from the Colorado River in Grand Canyon National Park, represented by two species of *Pisidium* (Sphaeriidae) in a collection of only seven specimens from Lees Ferry. One species, *P. variabile*, is cosmopolitan in North America (Burch, 1975), but not reported before from Arizona (Bequaert and Miller, 1973); *P. walkeri* has been reported from Arizona (Bequaert and Miller, 1973), but is a new record for this part of Arizona. The cosmopolitan, introduced North American *Corbicula* (Corbiculidae) has not been observed in northern Arizona except near Temple Bar, Lake Mead (Counts, 1991).

An interesting ecological note is also made of one specimen of *P. variabile*. The 1.5-mm-wide shell was found slightly gaping, with the valves still firmly attached at the hinge. Upon opening the valves, the body was absent but inside the shell were a nematode (*Nemata* undet.), a juvenile of *Physella* sp., and an unidentified, orange-colored seed to which was attached two bacterial

TABLE 1—Mollusca taken from the Grand Canyon in 1991. Localities are listed in Appendix 1.

Taxon	Localities
Bivalvia	
Sphaeriidae	
<i>Pisidium variabile</i> Prime, 1852 ¹	Lees Ferry
<i>P. walkeri</i> Sterki, 1895 ²	Lees Ferry
Gastropoda	
Lymnaeidae	
<i>Fossaria obrussa</i> (Say, 1825) ²	Vasey's Paradise, Nankoweap Cr.
Physidae	
<i>Physella</i> sp.	Lees Ferry, Vasey's Paradise, Nankoweap Cr., Bright Angel Cr., Phantom Cr., Hermit Cr., Elves Chasm, Blacktail Canyon, Kanab Cr., Havasu Cr., Tuck-up Canyon, Lava Falls Spring
Cochlicopidae	
<i>Cionella lubrica</i> (Müller, 1774)	Thunder River
Pupillidae	
<i>Gastrocopta pellucida</i> (Pfeiffer, 1841) ³	Spring Canyon
Discidae	
<i>Discus cronkhitei</i> (Newcomb, 1865) ³	Thunder River
Succineidae	
<i>Catinella avara</i> (Say, 1824)	Vasey's Paradise, Saddle Canyon, Bright Angel Cr., Phantom Cr., Hermit Cr., Shinumo Cr., Tapeats Cr., Lava Falls Spring, Thunder River
<i>Oxyloma haydeni kanabensis</i> Pilsbry, 1948 ¹	Vasey's Paradise
Zonitidae	
<i>Glyphyalinia indentata</i> (Say, 1823)	Thunder River
<i>Hawaiiia minuscula</i> (Binney, 1841) ³	Vasey's Paradise, Spring Canyon
<i>Zonitoides arboreus</i> (Say, 1817) ³	Thunder River
Limacidae	
<i>Deroceras laeve</i> (Müller, 1774) ³	Thunder River
Oreohelicidae	
<i>Oreohelix strigosa</i> (Gould, 1846)	Thunder River
Helminthoglyptidae	
<i>Sonorella coloradoensis</i> (Stearns, 1890)	Thunder River

¹ New record for the state of Arizona.² New record for the Grand Canyon region.³ New record for localities in the Grand Canyon (previously reported from Kaibab Plateau).

colonies that probably were supported by a penetration of the seed coat and exudation of the nutrients (H. M. Reiswig, pers. comm.). It appears that the nematode had taken refuge in the shell, capturing and consuming small organic items that passed by the gaping aperture. Wheth-

er the nematode consumed the bivalve animal, alive or dead, is not known.

Physella (or *Physa*, sensu lato, of some authors) is the most abundant and most widely distributed of the Grand Canyon aquatic gastropods. The specimens are highly variable in shell form, but

anatomical dissections seem to show that they are one species (S.-K. Wu, pers. comm.). But just what species is present is uncertain. It depends on the systematic validity of the species of *Physella* and of taxonomic priority. Candidate species for the Grand Canyon physids are *Physella virgata* (Gould, 1855) and *P. humerosa* (Gould, 1855). *P. virgata* is not a recognizable species to some workers, while the similar *P. humerosa* is apparently founded upon subfossil specimens (the lectotype is held by the Academy of Natural Sciences of Philadelphia, ANSP 17279); and the absence of preserved bodies among the type material is an obstacle to the modern definition and recognition of the species (Wu, pers. comm.). Bequaert and Miller (1973) regard *P. virgata* as a valid species in Arizona, while querying the identity of *P. humerosa*. The systematics of the family Physidae remains in a state of flux, and the Grand Canyon specimens are not identified to species here.

Downstream from Lees Ferry, molluscan populations are restricted to tributaries. The only riverside locality not in a tributary canyon that hosted populations of mollusks was at Vasey's Paradise, where a perennial stream plunges from the canyon wall to the Colorado River. During 1½ hours on site, nearly 400 specimens of five species (four families) of aquatic and terrestrial gastropods were collected from above the high-water level of the Colorado River; greater numbers could have been collected. Included among the species at Vasey's Paradise is *Oxyloma haydeni kanabensis* Pilsbry, found and collected only at this locality during the 1991 reconnaissance.

The occurrence of *Oxyloma haydeni kanabensis* is especially noteworthy. It is the first record of the genus *Oxyloma* alive in Arizona although it is nearly cosmopolitan in the northern hemisphere (Pilsbry, 1948); previously it has been known in Arizona only from fossil deposits (Bequaert and Miller, 1973; Mead, 1991). *O. h. kanabensis* was named as a subspecies of *O. haydeni* (Binney), a species from Nebraska, by Pilsbry (1948), based on specimens collected in 1909 from "The Greens," near Kanab Creek, approximately 10 km northwest of Kanab, Utah. Until now, *O. h. kanabensis* had been known only from the type locality, and the Vasey's Paradise occurrence extends the known range 89 km to the southeast. Wu (pers. comm.), after dissecting some of the Vasey's Paradise specimens, believes that the anatomical features indicate that *O. haydeni*

and *O. h. kanabensis* are distinct and that *O. h. kanabensis* should be accorded specific rank; this is also suggested in an unpublished report cited by England (1991b), but this matter must be dealt with by workers in succineid systematics.

Recently, the U.S. Fish and Wildlife Service completed a status survey that indicated only two populations of *O. h. kanabensis* living near the type locality in Kane County, Utah, at Kanab Creek Canyon and Three Lakes Canyon, sites 2 km apart. The survey pointed out that "no other Kanab ambersnail colonies have been discovered" (England, 1991b:58021). One population had been "nearly extirpated"; the other "subjected to major habitat alteration and destruction" (England, 1991b:58020). The Service issued an emergency rule (England, 1991a), temporarily declaring the subspecies to be endangered. A proposal (England, 1991b) was subsequently published to accord the snail permanent Federal status as endangered. Although the Vasey's Paradise record extends the known distribution of this animal away from the type locality and into neighboring Arizona, this colony is restricted to the spring pour-out area, much as the distinct plant community there is also restricted to this small habitat. *O. h. kanabensis* was seen from the Colorado River high-water level up to the bottom of the waterfall that discharges from the limestone cliff, on vegetation alongside running water and pools. The entire locality, even though of very limited extent, was not examined during the reconnaissance because of time constraints, water level cutting off some areas from easy access, and because it also is one of just three localities in Grand Canyon National Park that host poison ivy (Phillips et al., 1987).

Terrestrial gastropods were not seen anywhere along the banks of the Colorado River between tributaries. Time and logistical constraints precluded much investigation in these reaches. It is not unreasonable to expect to find in the riverbank habitat mollusks that live under semiarid conditions; for example, calciphilous mollusks that favor limestone talus. Ever since 1963, Glen Canyon Dam has controlled river water levels, and the newly established high-water zone is never breached during normal powerplant operations. Molluscan habitats above the presently stable high-water zone thus are no longer scoured by seasonal floods.

A separate reconnaissance was made at Thunder River, a perennial canyon-wall spring that is

a tributary of Tapeats Creek, which drops from 1,068 to 762 m in altitude over 0.9 km. During an hour of collecting, eight species (seven families) of terrestrial gastropods were obtained. The molluscan community seen at Thunder River is as interesting as is the floral community there, an admixture of species that favor semiarid and temperate conditions. Living together in this habitat are mollusks that are characteristic of semiarid environments such as that of the inner canyon (e.g., *Sonorella*, which tolerates a wide range in altitude) together with species that favor temperate conditions such as those found on the north rim of the Grand Canyon, on the Kaibab Plateau (e.g., *Deroceras*, *Zonitoides*, *Discus*, *Cionella*).

The Thunder River occurrences also present new elevational records for some species in the region. Bequaert and Miller (1973:146) state that *Zonitoides arboreus* is usually found above 5,000 ft. (1,525 m), "below 5,000 ft only as introductions by man under artificial conditions of moisture and shelter." The species was first reported from the Kaibab Plateau by Pilsbry and Ferriss (1911), at an altitude of approximately 6,200 ft. (1,900 m), but at Thunder River the species appears at its confluence with Tapeats Creek, at an elevation of about 762 m in sheltered natural conditions. The slug *Deroceras laeve*, also first reported by Pilsbry and Ferriss (1911; as *Agriolimax hemphilli ashmuni*) from the Kaibab Plateau at an altitude of approximately 6,900 ft. (~ 2,100 m), also is found at the confluence of Thunder River and Tapeats Creek. Bequaert and Miller (1973:149) record this species as a native in Arizona between 4,500 and 8,000 ft. (1,372–2,440 m), "at lower elevations in cultivated areas." Again, this is an elevational extension downward for a species occurring in natural conditions in Arizona. The Thunder River molluscan community is an indication of the potential for colonization by terrestrial mollusks of a riparian ecosystem of a semiarid environment, such as that along the Colorado River.

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- Colorado river corridor localities: Lees Ferry—Mile 0.0 (Km 0.0), 36°52'03"N, 111°35'40"W (3,107 ft., 946 m); Vasey's Paradise—Mile 31.8 (Km 51.2), 36°29'45"N, 111°51'36"W (2,900 ft., 884 m); Saddle Canyon—Mile 47.0 (Km 75.6), 36°22'00"N, 111°53'32"W (3,200 ft., 976 m; locality upstream along creek); Nankoweap Creek—Mile 52.1 (Km 83.8), 36°18'18"N, 111°51'28"W (2,790 ft., 851 m); Bright Angel Creek—Mile 87.8 (Km 141.3), 36°05'56"N, 112°05'33"W (2,425 ft., 740 m); Hermit Creek—Mile 95.0 (Km 152.8), 36°05'56"N, 112°12'32"W (2,340 ft., 714 m); Shinumo Creek—Mile 108.8 (Km 175.1), 36°14'15"N, 112°20'58"W (2,200 ft., 671 m; locality upstream along creek); Elves Chasm—Mile 116.6 (Km 187.6), 36°11'47"N, 112°27'00"W (2,300 ft., 702 m); Blacktail Canyon—Mile 120.1 (Km 193.2), 36°14'24"N, 112°28'17"W (2,090 ft., 637 m); Kanab Creek—Mile 143.4 (Km 230.7), 36°23'32"N, 112°37'45"W (1,880 ft., 573 m), on the Coconino-Mohave county boundary; Tuckup Canyon—Mile 164.5 (Km 264.7), 36°16'47"N, 112°52'30"W (1,750 ft., 534 m); Lava Falls Spring—Mile 179.4 (Km 288.6), 36°11'51"N, 113°05'00"W (1,670 ft., 509 m); Spring Canyon—Mile 204.3 (Km 328.7), 36°01'N, 113°21'W (1,500 ft., 458 m).
- Localities outside the river corridor: Phantom Creek, a tributary to Bright Angel Creek 3 km from the Colorado River—36°06'58"N, 112°05'14"W (2,760 ft., 841 m); Tapeats Creek (near Thunder River)—36°23'N, 112°27'W (2,400 ft., 732 m), downstream from Upper Tapeats Campground; Havasu Creek, 2.0 km up from confluence with Colorado River—approx. 36°17'30"N, 112°44'45"W; Thunder River—36°23'31"N, 112°27'02"W (2,500 ft., 762 m; confluence with Tapeats Creek) to 36°23'42"N, 112°27'35"W (3,280 ft., 1,000 m; near source).

APPENDIX 1

Location of collection sites in the 1991 reconnaissance. By convention, distances along the Colorado River are measured in miles from Lees Ferry, Arizona (see Stevens, 1983); kilometers are included by multiplying miles by 1.609 and rounding. Geographic coordinates measured from topographic sheets. All sites are within Grand Canyon National Park and within Coconino