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OREOHELICES OF UTAH, II. EXTANT STATUS OF THE BRIAN HEAD MOUNTAINSNAIL, *OREOHELIX PARAWANENSIS* GREGG, 1941 (STYLOMMATOPHORA: OREOHELICIDAE)

George V. Oliver¹ and William R. Bosworth III¹

ABSTRACT.—The Brian Head mountainsnail, *Oreohelix parawanensis*, is reported for the 1st time as a living species, and for the 1st time its habitat is described. Preliminary determination of the very limited distribution of this species (≤2.3 ha inhabited in ~11 ha overall area) is presented. Morphometric data previously had been reported only for the holotype and for 1 topotype; measurements from 37 new specimens as well as 20 paratypes are provided here, and these data show that the lost holotype was not typical of the species. Sizes of reproductive snails and of embryos are also reported.

Key words: *Oreohelix parawanensis*, *Brian Head mountainsnail*, *gastropods*, *mollusks*, *Parowan Mountains*, *Utah*.

Oreohelix parawanensis, the Brian Head mountainsnail, was described by Gregg (1941a) based on 31 specimens, “all dead and many of them immature,” that he collected “from a rock slide on the southwest slope of Brian Head, Parawan [*sic*] Mountains, Iron County, Utah, altitude about 11,000 [ft].” It is likely that he collected these specimens during the summer of 1935, when he spent “nearly three months at Cedar Breaks National Monument” (Gregg 1941b), which is only about 2 km from Brian Head (Peak) and where he extensively collected mollusks.

Bickel (1977) searched for *O. parawanensis* and reported: “The type locality was collected June 27, 1975 at which time the rock slide holding the population was still covered by several feet of snow, and only a few empty shells were collected from its margin.” Clarke and Hovingh (1994), too, searched for *O. parawanensis* at the type locality, in 1992 (Clarke 1993), noting that “no live specimens have ever been collected.” They reported that they “searched this rock slide carefully and excavated the surface from one side to the other” and conducted “[c]areful searches elsewhere . . . in the vicinity,” but they were able to find only a single empty shell of *O. parawanensis*, and their efforts “failed to produce any live specimens.”

Despite the fact that the Brian Head mountainsnail, *O. parawanensis*, had never been

demonstrated to be extant and could have been extinct before the arrival of Europeans in North America, state and federal management agencies have shown considerable interest in the conservation of this species (as discussed below). Efforts to determine its current status had been inadequate, field investigations having been poorly timed seasonally and of insufficient duration, one such search (Bickel 1977) having been conducted too early in the season when the locality was under snow and apparently carried out for only part of a day, and the other search (Clarke 1993) having been made too late in the season—October, under conditions of “very strong wind & cold”—evidently involving only a little more than 4 person-hours of effort. Furthermore, none of the previous work (Gregg 1941a, Bickel 1977, Clarke and Hovingh 1994) had revealed any aspects of the biology of this species. As part of our continuing studies of mountainsnails in Utah (Oliver and Bosworth 2000), our goals were to attempt to find living examples of *O. parawanensis*, to make a preliminary assessment of its distribution and habitat, and to examine available specimens morphometrically.

METHODS

We scheduled our fieldwork to search for living examples of *O. parawanensis* to coincide with conditions favorable for finding active

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terrestrial mollusks, especially mountainsnails (*Oreohelix*). *Oreohelices* of other species are known to hibernate by burrowing beneath the surface of the soil (Jones 1935, 1940), and moderately warm conditions prevail for only a few weeks each year on Brian Head. We searched for *O. parawanensis* on 11, 12, and 13 August 1998 on Brian Head. During this time daytime temperatures ranged from $\sim 15^{\circ}\text{C}$ to $\sim 20^{\circ}\text{C}$, and summer storms produced brief, light rain showers each day. We established 14 collecting stations on the southern and western slopes of Brian Head, all within 0.7 km of the summit.

We made an effort to sample a variety of habitat conditions, but, because most members of the genus *Oreohelix* are strongly calciphilic (Henderson and Daniels 1916, Pilsbry 1916, 1939, Jones 1940), we focused efforts in areas where we could locate exposed limestone. From the summit of Brian Head, we scanned the slopes, using binoculars, looking for surface limestone to aid us in choosing suitable collecting stations. For each collecting station we noted plant association (dominant plant species present), substrate type, and other variables such as slope and aspect, as well as all mollusks that we found.

RESULTS AND DISCUSSION

We found *O. parawanensis* at 7 of our 14 collecting stations on Brian Head. At these 7 stations we found empty shells of *O. parawanensis*, and at 4 of the stations we discovered the 1st living examples of this species. *Oreohelix parawanensis* was overall the most common gastropod at the stations where it was detected. We found and collected 49 empty shells (as well as 5 embryos) of *O. parawanensis*, and we found 18 live individuals, of which we took 8. One of the living examples of *O. parawanensis* was active and extended when found under a rock between 0938 and 0948 hours on 13 August 1998; less than an hour earlier (at 0857 hours), air temperature at the locality was 16°C .

Of the new specimens, we have deposited 5 in the collection of the Academy of Natural Sciences of Philadelphia (ANSP 401984) and 5 in the collection of the Los Angeles County Museum (LACM 152567), these being the 2 collections that house all of Gregg's type material of this species that we have located.

Type Locality

The type locality of *O. parawanensis* stated by Gregg (1941a), while adequate and, for its time, rather precise, can now be stated even more precisely. The only problematic part of Gregg's (1941a) locality is his ambiguous phrase "a rock slide." While others (e.g., Bickel 1977, Clarke and Hovingh 1994) have referred to "the rock slide" as though there were no doubt about the location, many parts of the southern and western faces of Brian Head consist of talus material of varying dimensions, and various terms could be applied to these geological features, including the term "rock slide." Although the exact site of Gregg's collection of *O. parawanensis* may never be known, we believe the following is the most probable location: Utah, Iron County, Brian Head (Peak), below summit on SW face, T36S, R9W, section 13, NW $\frac{1}{4}$ of NW $\frac{1}{4}$ of NW $\frac{1}{4}$.

Distribution

The distribution of *O. parawanensis*, as revealed by our fieldwork, can be summarized as follows:

Utah, Iron County, Brian Head (Peak), below summit on SW face; T36S, R9W, section 13 (NW $\frac{1}{4}$ of NW $\frac{1}{4}$ of NW $\frac{1}{4}$), section 14 (E $\frac{1}{2}$ of NE $\frac{1}{4}$ of NE $\frac{1}{4}$), and section 11 (E $\frac{1}{2}$ of SE $\frac{1}{4}$ of SE $\frac{1}{4}$).

The 7 collecting stations in which we found this species are contained within an irregular, but somewhat triangular, polygon of about 11 ha. However, only small patches within this overall distributional area appeared to provide suitable habitat, and we found *O. parawanensis* in only 7 of these patches. The total area that we determined to be inhabited by this species is only about 2.3 ha or less, although this is a rather crude estimate and one that should be considered the minimal area of its occurrence. Because we found only dead shells of *O. parawanensis* at 3 of the collecting stations, it is possible that these represented extinct colonies, and the currently inhabited area may be even smaller than that stated above.

Habitat

The habitat of *O. parawanensis* has not previously been described (e.g., Gregg 1941a, Pilsbry 1948, Bickel 1977, Clarke 1993, Clarke and Hovingh 1994). Of the 7 stations where we found *O. parawanensis*, 4 were on limestone

substrates; 2 were in areas of primarily basaltic rock with some limestone and, in 1 case, a little sandstone; and 1—the highest location and probably the type locality—was almost entirely basaltic rock. Slope in the places where we found *O. parawanensis* varied from almost none to about 40°, and elevations of the inhabited patches ranged from 3255 m to 3340 m. All 18 live individuals of *O. parawanensis* were under surface rocks, mostly single individuals but rarely more, 4 being the largest number of live *O. parawanensis* we found under 1 rock. Most dead shells of this species that we found were also under rocks, though a few were lying exposed on the ground.

The stations inhabited by *O. parawanensis* almost without exception contained dense clumps of currants of 2 species, wax currant (*Ribes cereum*) and gooseberry currant (*Ribes montigenum*). Meadow rue (*Thalictrum* cf. *fendleri*) and Indian paintbrush (*Castilleja* sp.) were also typical of the places where we found *O. parawanensis*. Another plant that characterized several of the stations where *O. parawanensis* was present was ground juniper (*Juniperus communis*). Limber pine (*Pinus flexilis*), western bristlecone pine (*Pinus longaeva*), and Engelmann's spruce (*Picea engelmannii*) were present at some of the stations where we found *O. parawanensis*, which were at or slightly above tree line. Other species of forbs, a few grasses, and a few other trees also were present at some of the stations that yielded *O. parawanensis*.

Associated Gastropods

The diversity of gastropod species that we found on Brian Head was rather low, as could be expected at such a high, cold, and barren location. Most, but not all, other gastropod species we found on Brian Head were at stations shared with *O. parawanensis*. The gastropods we found at the same collecting stations as *O. parawanensis* were the Rocky Mountain column (*Pupilla blandi*), the crestless column (*Pupilla hebes*), a vallonina (*Vallonia* cf. *cyclophorella*), the Rocky mountainsnail (*Oreohelix strigosa*), and the western glass-snail (*Vitrina pellucida*). Most of these associated gastropods were found in small numbers. We found *O. strigosa* to be the most common associate of *O. parawanensis*, the 2 congeners occurring together in similar numbers.

All of these species were reported by Gregg (1941a) as associates of *O. parawanensis*, along with the multirib vallonina (*Vallonia gracilicosta*), the spruce snail (*Microphysula ingersolli*), the quick gloss (*Zonitoides arboreus*), and the forest disc (*Discus cronkhitei* [= *Discus whitneyi*]), although Gregg (1941a) did not indicate how close their association with *O. parawanensis* was. In the above list we have not included other species we found on Brian Head that were not at the same collecting stations that yielded *O. parawanensis*.

Conservational Considerations

O. parawanensis was formerly a Category 2 candidate for listing by the U.S. Fish and Wildlife Service, under provisions of the Endangered Species Act, until 28 February 1996, when Category 2 was eliminated. Furthermore, even though *O. parawanensis* had never been reported to be living and thus was not known to be extant, it was indicated as "declining" (U.S. Fish and Wildlife Service 1994). *Oreohelix parawanensis* is listed as a species of special concern by the state of Utah (Utah Division of Wildlife Resources 1998).

The area inhabited by *O. parawanensis* is within the Dixie National Forest. Because the stations supporting this species are at or above tree line, timber harvest is not a threat. Nearby ski resort operations (lifts, runs, buildings, etc.) to the west and northwest do not currently threaten the snail; however, if resort operations were to expand into the area where *O. parawanensis* occurs, its entire population could be destroyed. The high elevation of the site and the rather barren nature of the terrain afford relatively good protection for the snail from most other anthropogenic threats. An unpaved road, however, loops around the south side of Brian Head and up to the summit, where a small pavilion stands. Hikers and mountain bikers utilize the area, and we encountered rock collectors near some of the inhabited stations. Bones, apparently those of a domestic goat or sheep, were present near an inhabited station, and we observed large numbers of domestic sheep on U.S. Forest Service land less than 10 km away.

Type Specimens

Although Gregg (1941a) stated that the holotype of *O. parawanensis* had been deposited in

the collection of the Academy of Natural Sciences of Philadelphia (no. 176907), this specimen could not be located and is presumed lost (Edward S. Gilmore, ANSP, personal communication, 1998). Gregg (1941a) also indicated that the paratypes (presumably all of the other 30 specimens of *O. parawanensis* he collected) were retained in his own collection (no. 324). We located 20 paratypes in the collection of the Los Angeles County Museum (LACM 1660) and 1 paratype in the collection of the Academy of Natural Sciences of Philadelphia (ANSP 340315). Labels associated with both of these lots of specimens indicate they are paratypes, and the lot in the Los Angeles County Museum also has Gregg's catalogue number (324) on 1 of the labels. Although the Los Angeles County Museum catalogue indicates 19 paratypes are housed in that collection (Lindsey Groves, LACM, personal communication, 1999) and there are 19 specimens of moderate size in the lot, an additional tiny specimen, an embryonic shell, is contained in the same lot but is separated and protected in a clear gelatin capsule. Thus 20—or 21, if one includes the embryo—of Gregg's 30 paratypes have been located and examined.

Although Gregg (1941a) stated that all specimens of *O. parawanensis* he collected were dead, examination of the specimens in the Los Angeles County Museum suggests to us that some of the paratypes may actually have been alive when they were collected despite assertions (Gregg 1941a, Bickel 1977, Clarke 1993, Clarke and Hovingh 1994) that no living examples had ever been found. Of the paratypes we examined, 7 showed evidence of an epiphragm, and 1 other shell contained dried soft tissue. Such evidence, however, does not prove they were alive when Gregg collected them; these specimens may in fact be exactly as they were discovered at the time of collection.

Morphometric Data

Previously published morphometric data are available for only 2 specimens of *O. parawanensis*, the holotype (Gregg 1941a) and a shell collected by Clarke and Hovingh (1994), for which they reported "diameter 8.5 mm, height 5.0 mm, whorls 4 $\frac{1}{4}$."

Gregg (1941a) considered many of his 31 specimens to be immature, presumably based on size. However, we know of no easily applied criterion that will distinguish mature from

immature shells of *O. parawanensis* (but see discussion below), there being no reflection of the lip and no apertural teeth in this species. Thus, we measured available intact shells large enough that they could be assigned to this species with confidence.

We measured shell diameter, height, and umbilicus width and counted whorls of 20 paratypes (19 LACM, 1 ANSP) and 37 intact examples among the new specimens of *O. parawanensis* that we collected (Table 1). Our sample of 37 new specimens and the sample of 20 paratypes were very similar for the 3 mensural characters (shell diameter, height, and umbilicus width), whorl counts, and the 2 proportions calculated from the mensural data; the similarity of the 2 data sets is apparent if one compares ranges and means of characters in Table 1. However, when morphometric data for the paratypes and the new specimens are compared with Gregg's (1941a) data for the now-lost holotype (Table 1), it can be seen that the holotype was quite dissimilar from the paratypes and new topotypes in its measurements and proportions. The holotype was larger in diameter and more depressed (low-spined, as shown by the diameter/height proportion) than any specimen examined by us. Also, the umbilicus was larger—both absolutely and relative to its diameter—in the holotype than in any examined shell. The exceptionally large umbilicus of the holotype is of particular interest since Gregg (1941a), in defining this species, claimed that the larger umbilicus of *O. parawanensis* is of importance in distinguishing it from the 2 species that he considered to be its closest relatives, *O. handi* and *O. eurekaensis*.

It would, of course, be desirable to reexamine the holotype, and especially to remeasure its umbilicus width, but this unfortunately is not possible, the holotype having been lost. However, Gregg (1941a) did publish 4 photographs of *O. parawanensis*, an umbilical (ventral) view and an apertural (frontal) view, both at approximately life size, and the same 2 photographs at greater than natural size. Pilsbry (1948) reproduced these photographs. The photographs were published again by Clarke and Hovingh (1994), who incorrectly credited them to Pilsbry (1948). Also, Clarke and Hovingh (1994) labeled the photographs as illustrations of the holotype, despite the fact that neither the original (Gregg 1941a) nor the secondary source (Pilsbry 1948) had indicated this

TABLE 1. Morphometric data for *Oreohelix parawanensis*.

Character	New specimens ($n = 37$)			Paratypes ($n = 20$)			Holotype ^a
	Range	Mean	$s_{\bar{x}}$	Range	Mean	$s_{\bar{x}}$	
Whorls (no.)	3.00–5.00	4.14	0.07	3.50–4.38	4.09	0.06	4.33
Diameter (mm)	3.72–9.62	6.81	0.20	5.28–8.26	6.79	0.19	10.5
Height (mm)	2.34–6.48	4.15	0.14	3.14–4.72	3.95	0.11	5.4
Umbilicus width (mm)	0.78–2.25	1.50	0.06	0.85–1.78	1.37	0.06	3.0
Diameter/umbilicus	3.93–5.78	4.66	0.09	3.79–6.21	5.06	0.13	3.50
Diameter/height	1.44–1.90	1.65	0.02	1.56–1.83	1.72	0.02	1.94

^aMeasurements and whorl count of the holotype reported by Gregg (1941a) and proportions derived from the reported measurements.

to be so—or even that the photographs represented only a single specimen.

Using Gregg's (1941a) published photographs, we measured shell diameter and umbilicus width for the shell shown in umbilical view and shell diameter and height for the shell shown in apertural view. Although we do not consider any of the originally published 4 photographs to be exactly natural size, our measurements of the photographed shells did allow us to calculate their proportions accurately. Using the photograph of the umbilical view, we arrived at a diameter/umbilicus proportion of 3.55. While not within the range for this proportion that we observed in 37 topotypes or in 20 paratypes, it is not quite so far out of the range as the proportion (3.50) calculated using the measurements for the holotype published by Gregg (1941a). In the photograph of the apertural view, diameter/height = 1.77, which does fall within the range observed in both the new specimens and the paratypes, unlike the proportion (1.94) calculated from Gregg's (1941a) reported measurements of the holotype.

When we scaled the umbilical photographic view to the diameter reported by Gregg (1941a) for the holotype, 10.5 mm, the umbilicus then measured 3.00 mm, exactly the umbilicus measurement reported by Gregg (1941a), which strongly suggests that the photograph represents the holotype, as Clarke and Hovingh (1994) assumed. However, scaling the apertural-view photograph to a diameter of 10.5 mm, the height became 5.93 mm as opposed to 5.4 mm as reported by Gregg for the holotype. The specimen shown in apertural view, then, either was not the holotype or, if it was the holotype, was slightly mismeasured by

Gregg—off by ~0.5 mm. Not only is height the most difficult of standard shell measurements to make with accuracy, but good tools for measuring small specimens may not have been readily available to Gregg. Thus, we believe that possibly the photograph showing frontal view also may be of the holotype.

Embryos and Size at Maturity

Four (10.8%) of the 37 intact dead shells of *O. parawanensis* we collected contained embryonic shells, 3 with 1 embryo each and 1 with 2 embryos. These 5 embryos were 1.8 to 2.4 mm in diameter (mean = 2.2 mm), with 2 to 2.25 whorls (mean = 2.1). The embryo that was with the paratypes in the collection of the Los Angeles County Museum (LACM 1660) measured 2.3 mm in diameter and had 2.25 whorls, in close agreement with the 5 we found.

The discovery of embryos inside 4 dead shells provides information on the size of reproductive *O. parawanensis*. The 4 gravid snails measured 5.68 to 9.32 mm (mean = 6.98 mm) in diameter and had 3.67 to 4.75 whorls (mean = 4.14 whorls). This shows that maturity in *O. parawanensis* is reached by the time the snails are 5.68 mm in diameter or have 3.67 whorls. Only 3 of 20 paratypes (excluding the single embryo) we examined were smaller than the smallest of the gravid shells we found, and these 3 measured 5.28, 5.30, and 5.42 mm in diameter and had 3.67, 3.625, and 3.50 whorls, respectively—almost the size of the smallest shell we found that contained an embryo. Unless most or all of the 10 paratypes that we could not locate were smaller than the 20 that we have seen, Gregg's (1941a) statement that many of his 31 specimens were immature was not correct.

Nomenclature and Systematic Placement

Clarke and Hovingh (1994), noting Gregg's (1941a) misspelling—at least by current spelling convention—of the Parowan Mountains, declared: “Since the proper spelling is Parowan the species name is here emended to *Oreohelix parawanensis*.” The alternate spelling “Parawan,” however, has been used by various authors and has appeared in other malacological literature (e.g., Herrington and Roscoe 1953). Most importantly, Gregg's spelling of the specific epithet, *parawanensis*, is consistent with his spelling of the “Parawan Mountains” in the original publication (Gregg 1941a), and there is no evidence to suggest that it was not Gregg's intent to spell *parawanensis* as he did. Clarke and Hovingh's (1994) alteration of the name, then, is a violation of Article 32(a), concerning correct original spelling, and an unjustified emendation under Article 33(a) of the International Code of Zoological Nomenclature (Ride et al. 1999). Thus, the name correctly remains *Oreohelix parawanensis*.

Bickel (1977) stated that *O. parawanensis* is taxonomically “probably invalid, a synonym of *O. strigosa depressa*,” arguing that “*O. parawanensis* is a stunted population of the widespread, *O. strigosa depressa*.” As noted in the type description (Gregg 1941a), *Oreohelix strigosa depressa* occurs with *O. parawanensis*, and our work has corroborated this. To this we can add that the 2 species maintain their morphological distinctiveness where they coexist. These facts render implausible Bickel's (1977) suggestion that *O. parawanensis* could be a synonym of *O. strigosa*. However, Gregg's (1941a) assertion that *O. parawanensis* “seems nearest related to *O. eurekensis* . . . and *O. handi*,” both of which it closely resembles in size and shell morphology, is reasonable and almost certainly correct. Pilsbry (1948) placed *O. parawanensis* near *O. handi*, making it a member of the *O. yavapai* species group and not the *O. strigosa* species group as the genus was organized by Pilsbry (1933, 1939), who described the genus *Oreohelix*. Bickel's (1977) suggestion that *O. parawanensis* represents merely a “dwarfed colony” of *O. strigosa*, moreover, raises the question of whether his “few empty shells” were in fact *O. parawanensis* at all and not shells of immature *O. strigosa*, which possibly could be confused with *O. parawanensis* upon superficial inspection.

The atypical size and proportions of the holotype (discussed above), however, suggest that the taxonomic distinction of *O. parawanensis* from such species as *O. handi* and *O. eurekensis* should be reexamined.

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