

MALACOLOGY DATA NET

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Studies on the Status of Endangerment of Terrestrial
Mollusks in Utah

Arthur H. Clarke and Peter Hovingh

SUMMARY

Field surveys were carried out from 1990 to 1993 for the purpose of assisting the U. S. Fish and Wildlife Service in determining the survival status of 14 nominal species and subspecies of terrestrial mollusks in Utah, all of which had been thought to be either rare or highly localized. All known localities for those taxa, and ecologically similar nearby areas, were extensively searched and observations on micro-distribution, ecology, and morphological variation were made. Based on that work Oxyloma haydeni kanabensis Pilsbry was listed in 1992 as federally Endangered. We also recommend that Oreohelix peripherica wasatchensis (Binney) be classed as federally Endangered, that Oreohelix eurekensis uinta Brooks and O. haydeni haydeni (Gabb) be listed as Threatened, and that O. eurekensis eurekensis Henderson & Daniels, O. haydeni corrugata Henderson & Daniels, O. parowanensis Gregg, and O. yavapai cummingsi Pilsbry be placed on the federal Watch List. The other nominal species and subspecies either do not require federal protection or are taxonomically invalid.

ACKNOWLEDGEMENTS:— We wish to extend special thanks to Judith J. Clarke for her assistance in the field and for her forbearance. Other important field assistance was also provided in Utah by Margo Hovingh, Jim Duckworth, Blaine Lunceford, and Jaime Holgate. We also thank the following museum curators and scientific staff who kindly allowed access to, or information about, collections under their care or who loaned specimens for study: Ms. Margaret Baker (Field Museum of Natural History, Chicago), Dr. Kenneth J. Boss (Museum of Comparative Zoology, Harvard University), Mr. Albert F. Chadwick (Delaware Museum of Natural History, Greenville, Delaware), Dr. George M. Davis (Academy of Natural Sciences, Philadelphia), Mrs. Raye Germon, Mr. Paul Greenhall, and Dr. Robert Hershler (all Smithsonian Institution, Washington), and Dr. David H. Stansbery (Museum of Zoology, Ohio State University). Appreciation is also expressed to the Navajo Nation Fish and Game Department for permission to work on Navajo Mountain, to the Uinta Indian Tribe for permission to search for mollusks on their land, and to the U.S Fish and Wildlife Service for financial support and for permission to publish these findings..

RESULTS

FAMILY OREOHELICIDAE

Remarks on Oreohelix

Oreohelix Pilsbry, 1906, commonly referred to as Rocky Mountain Snails, are conspicuous ground snails occurring only in southwestern Canada, western United States, and Mexico. Pilsbry (1939, 1948) recognized 24 species in the United States and Canada along with numerous subspecies and "forms". We follow Pilsbry in his opinion that only seven species (with numerous subspecies) of Oreohelix occur in Utah. The species are O. strigosa (Gould), O. peripherica

INTRODUCTION

In 1989 and 1991, ECOSEARCH, Inc. was awarded contracts by the United States Fish and Wildlife Service to carry out status surveys of 25 species and subspecies of terrestrial and freshwater mollusks in Utah and closely-adjacent areas. Based on the literature or on recent field experience all of these taxa were thought to be either very rare or highly localized.

The results of our subsequent field and laboratory research on terrestrial mollusks are presented here. The freshwater mollusks will be discussed in another report. Although some nomenclatorial changes were found to be necessary within Oreohelix, the names specified in previous literature are retained for taxon headings but are corrected, where necessary, in the text.

A reconnaissance trip was made to Utah by A.H. and Judith J. Clarke in June, 1989. Later, intensive field investigations were carried out, chiefly by the Clarkes and Peter Hovingh, between late May and early September, 1990, and between late April and early October in 1992. Several other collections of Oreohelix were also made during the summer of 1992 and the spring of 1993 by PH. Well over 100 localities were thoroughly searched for terrestrial mollusks using appropriate qualitative and quantitative methods (see Clarke, 1991 & 1993). Where possible numerous empty shells and a few live specimens of all species were collected and the live specimens were carefully relaxed, fixed, and preserved. All pertinent information regarding locations, dates, methods, habitats, etc. were written in field notebooks and on standard data sheets. The specimens were then returned to ECOSEARCH headquarters in Texas for critical examination. Verification of "problem" lots were made by AHC through comparison with specimens in the Smithsonian Institution.

(Ancey), O. haydeni (Gabb), O. subrudis (Reeve), O. eurekensis Henderson & Daniels, O. yavapai Pilsbry, and O. "parowanensis" [sic., = parowanensis] Gregg. The most abundant Oreohelix in Utah, by far, is O. strigosa depressa (Cockerell).

Pilsbry recognized these species on the basis of shell and penial characteristics and his great work should be used as the starting point for any further research on the group. The strigosa-haydeni-peripherica group was characterized by having the internally plicate part of the penis decidedly less than half the length of the penis whereas in the subrudis-eurekensis-yavapai group the plicate part was stated to be about half, or more than half, the penis length. The anatomy of O. parowanensis is unknown.

Analyses of shell characters in new, randomly-collected population samples have made it necessary to reevaluate some of Pilsbry's conchologically-based subspecies and "forms". We believe that it is inappropriate here, in a conservation-oriented ecological and distributional study, to reexamine the status of any of his anatomically-based species, however. Pilsbry was a brilliant and careful worker whose knowledge of North American land snails has never been equalled. Further, as shown by Solem (1975) for Oreohelix in Idaho, distinct species may coexist which have similar shells but dissimilar anatomical features and which also differ in subtle ecological requirements.

The following key, based on shell characters, is given here to assist field biologists in making preliminary identifications of the species of Oreohelix in Utah. The characters used to distinguish the subspecies considered in this paper are given in the text. It must be stressed, however, that these taxa are all highly variable and for positive identification of critical specimens Pilsbry's works should also be used.

**Key for Identification of Oreohelix
Species in Utah Using Adult Shell Characters**

- 1(a). Shell having coarse spiral sculpture.....
.....O. haydeni
- 1(b). Shell without coarse spiral sculpture.2
- 2(a). Shell with coarse striae, wrinkles, or ribs
parallel to lines of growth....O. peripherica
- 2(b). Shell smoothish or striate along lines of
growth.....3
- 3(a). Periphery angular in front and rounded
elsewhere, or rounded throughout.....4
- 3(b). Periphery strongly angular or carinate.....5
- 4(a). Shell height equal to, or less than, half
the diameter in most specimens....O. strigosa
- 4(b). Shell height more than half the diameter
in most specimens.....O. subrudis
- 5(a). Shell diameter of adults (4 whorls or more)
about 10 to 25 mmO. yavapai
- 5(b). Shell diameter of adults (4 whorls or
more) less than 10 mm.....6
- 6(a). Shell diameter about 3 1/2 times umbilical dia-
meter. In Pawowan Mountains...O. parowanensis
- 6(b). Shell diameter more than 3 1/2 times umbilical
diameter. Not in Parowan Mountains.....
.....O. eurekensis

Oreohelix eurekensis eurekensis Henderson & Daniels
Plate 1, Group 1

Oreohelix hemphilli eurekensis Henderson & Daniels, 1916: Proceedings of the Academy of Natural Sciences of Philadelphia (1916: 321, Pl. 10, figs. 7 & 8).
The type locality is "Eureka, [Utah], on the north side of Godiva Mountain, on Paleozoic limestone, under shrubs, etc.".

Partial Description.

"The shell is small, sublenticular, about equally convex above and below the peripheral keel, with a low conoid spire and an umbilicus contained 4.4 to 5 times in the diameter.... The last whorl is strongly carinate, the keel tending to weaken towards the aperture...[and] with rather coarse, unequal striae...[consisting], in the type, of 6 minute, beaded lines below the periphery, and very indistinct lines in the interspaces and in the edge of the umbilicus... On many specimens beaded spirals are weak, and visible only in places on the base...Height 5.5 mm, diameter 9.7 mm, 4 1/2 whorls (type); height 4.8 mm, diameter 8.8 mm, 4 1/3 whorls [paratype]." (Pilsbry, 1939: 533).

O. eurekensis may be distinguished from juvenile O. strigosa depressa, with which it often occurs, by its characteristic facies and by having more whorls than a juvenile O. s. depressa of the same diameter.

Revised Geographical Distribution.

Northern portion of East Tintic Mountains in Juab and Utah Counties, at least from Mammoth Peak to Godiva Mountain, and on Lime Peak, all in the general vicinity of Eureka, Juab County, Utah.

Ecology and Biology.

Found under pygmy sagebrush and at the bases of ledges on north-facing slopes at altitudes of about

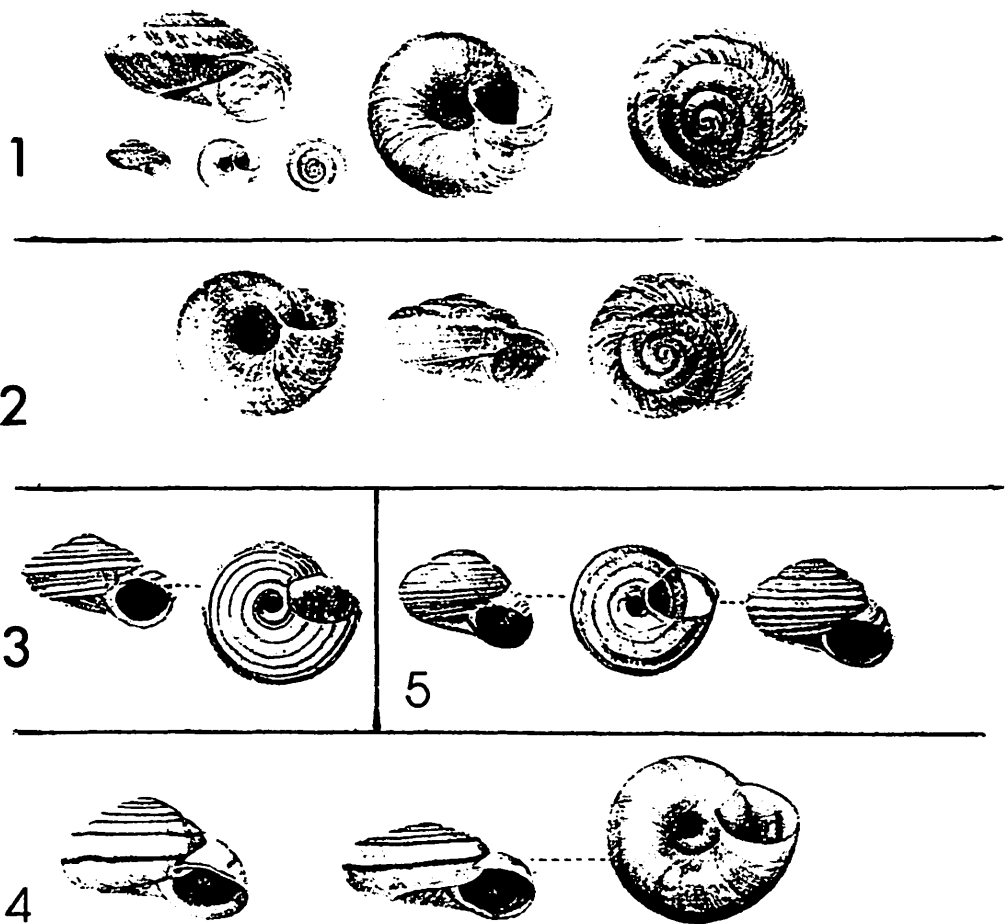


Plate 1. Group 1, O. eurekaensis eurekaensis, holotype, X 1 and X 3. Group 2, O. e. uinta, holotype, X 3. Group 3, O. haydeni haydeni, holotype, X 1. Group 4, O. h. corrugata, holotype, X 1. Group 5, left fig. is similar to specimens of "O. howardi" from type locality, right figs. are a depressed variant, all X 1. From Pilsbry (1939).

2200 to 2400 meters. Larger snails (O. strigosa depressa) occur under the large sagebrush. The Mammoth Peak-Godiva Mountain population is estimated to contain about 5×10^4 - 5×10^5 individuals. Only a single empty shell was found on Lime Peak so the population there must be very small. The species probably occurs elsewhere in the East Tintic Mountains as well.

Assessment of Vigor, Trends, and Status.

This is one of a small group of mountain species which occurs principally at high altitudes. No status of endangerment is recommended but insertion on the Watch List would be appropriate. Although we did not find the large population of this species seen on Godiva Mountain by Henderson & Daniels (1917), our findings there are quite similar to their earlier findings (Henderson & Daniels, 1916). Our work has also materially extended the known range of the species. We therefore believe that no general population decline has occurred. It should be kept in mind, however, that large-scale mining activities on mountains can endanger relict species of Oreohelix which may be confined to mountaintops.

Oreohelix eurekensis uinta Brooks Plate 1, Group 2

Oreohelix eurekensis uinta Brooks, 1939: The Nautilus, Vol. 52(3): 105-106. Types collected by E. R. Eller in 1933 "on Hominy Creek, R1W, T3S, 3 miles north of Uinta Special Meridian, near Whiterocks, Uinta County, Utah".

Partial Description.

"It resembles O. eurekensis Henderson and Daniels closely in shape, texture, color, and sculpture but differs by the somewhat wider umbilicus, contained about $3 \frac{3}{4}$ times in the diameter of shell.

Height 8 [sic., probably 2.8] mm, diam. 4.2 mm, 4 1/4 whorls. Type in coll. Carnegie Mus., paratype in coll. Acad. Nat. Sci. Philadelphia.

This race is so similar to that found by Henderson and Daniels near Eureka, about 125 miles south of west from Whiterocks, that it would hardly be thought distinguishable if it were not in a different mountain system. No *Oreohelix* has been reported before from the Uinta Mountains." (Brooks, 1939).

This is one of the group of small oreohelices which occurs mainly at high altitudes. When and if more material becomes available the need for formal taxonomic distinction between this and *O. eurekaensis* s. str. should be reevaluated.

Geographical Distribution.

Only known from the type locality. During a comprehensive molluscan survey of the Uinta Mountains in 1939-1941 by Woolstenhulme (1942) no specimens of this subspecies were found. The name Hominy Creek does not appear on topographic maps. We searched diligently near Whiterocks River (thought by an informant to have been called Hominy Creek in decades past) east of Whiterocks, and elsewhere in the area, but we could not find any species of *Oreohelix*. The mountainside vegetation north of Whiterocks has recently been destroyed by fire with the object of improving grass cover for sheep but the mountain slopes are now barren and the snails may have been extirpated.

Ecology and Biology.

No data are available. The land east of Whiterocks is xeric and flat with scattered sagebrush. North of Whiterocks hills occur and these are vegetated by sagebrush and erect juniper trees. Farther north the mountain vegetation has been burned away. Whiterocks and the adjacent countryside are in the Uintah and Ouray Indian Reservation and the land is managed by the Ute Indian Nation.

General Assessment of Vigor, Trends, and Status.

Burning of vegetation may have extirpated the snail population and this subspecies may be extinct. If it is eventually found such burning should be prohibited. Attribution of Threatened status is recommended because this will focus attention on the taxon and will lead to greater understanding of its status of endangerment.

Oreohelix haydeni haydeni (Gabb)

Plate 1, Group 3

Helix haydeni Gabb, 1869: American Journal of Conchology 5:24, pl. 8, fig. 1. Type locality: "Weber Canyon, Wasatch Mountains". Later E.G. Berry (1932) stated that the type locality is "Dry Creek Canyon, the first tributary to Weber Canyon south of the cement plant at Devil's Slide" [about 25 miles SE of the center of Ogden, Utah]. Dry Creek Canyon is the second major canyon west of the cement plant at Devil's Slide, however (USGS Devil's Slide Quadrangle, 7.5 Minute Series, 1929 (rev. 1991)). The first major canyon west of the cement plant, Quarry Cottonwood Canyon, was explored by one of us (PH) and revealed a large colony of O. h. haydeni, but other canyons in the region lacked that species. Quarry Cottonwood Canyon is therefore believed to be the type locality of O. haydeni.

Partial Description.

"The depressed shell has a low conoid spire and an umbilicus contained 5 times in the diameter; rather solid; white (bleached). The whorls are convex, the first very finely striate, the next with 2 or 3 spiral threads; the later whorls have coarse, irregular striae of growth and strong, raised spiral cords on

both the upper surface and the base, one at the periphery a trifle more prominent; in the type there are 3 cords above and 6 below the periphery; between some of them weak spiral lines appear. The last whorl descends moderately in front... Height 12.2 mm, diameter 20.7 mm; 5 1/2 whorls. Type." (Pilsbry, 1939: 463).

198 shells collected by us from Quarry Cottonwood Canyon were examined for variation in sculpturing: 127 had strong spiral sculpturing, 28 had weak or sporadic spiral sculpturing, and 43 had no visible spiral sculpturing.

Revised Geographical Distribution.

O. haydeni haydeni apparently occurs only in an area of about 60 acres at the east side, and near the mouth, of Quarry Cottonwood Canyon (near the north side of the Weber River) about 0.7 mi west of the village of Devil's Slide, Morgan County, Utah. Its coordinates are T4N, R3E, SE corner of Sec. 26.

Environment and Habitat.

E. G. Berry (1932) noted that living specimens were found "under dead leaves of Amelanchier alniflora Nutt. near the base of the shrub". We found O. haydeni only on a west-facing, xeric slope above the riparian zone. On the opposite east-facing slope only O. strigosa occurred. The greatest abundance of O. h. haydeni is seen on and around a limestone outcrop which begins at the mouth of the canyon and extends northward. The subspecies is also found above this outcrop associated with sagebrush (where it was rare) and oak (where it was more common). Some 30 acres, extending from about 5500 to 5800 feet elevation, were documented as harboring this snail. The same habitat extends for another 30 acres northward, however, and that is our basis for the estimate that about 60 acres is inhabited by O. h. haydeni. The upper elevation boundary beyond 5800 feet was not determined so it is possible that another 60 acres could also be occupied.

The population of O. h. haydeni has about 60 snails per square meter on and close to the limestone outcrop but only about 1 per square meter above the outcrop. We therefore estimate that the total population in 60 acres is of the order of 1×10^6 snails.

Evidence of Threats to Survival.

The area is impacted by sheep grazing and is bordered upstream along Weber River by a large limestone quarry. Fires, increases in grazing intensity, or expansion of quarry activities could endanger this, the only known population of O. haydeni haydeni. Threatened status therefore appears to be justified.

Oreohelix haydeni corrugata Henderson & Daniels.

Plate 1, Group 4

Henderson & Daniels, 1916: Proceedings of the Academy of Natural Sciences of Philadelphia, p. 337, Pl. 17, fig. 1. Type locality "on a small mountain of Paleozoic limestone, nearly isolated from the main chain, southeast of Webster Station, under the shrub Kuntzia tridentata and coarse leaved herbaceous plants, and in a rock slide [in Cache County, Utah]. The type locality is actually northeast of Webster Station (see below).

Partial Description.

"Shell rather globose, spire elevated, one or two examples tabulate; whorls 5 to $5 \frac{1}{2}$, ample, convex, last one scarcely carinated at the periphery on elevated specimens; spiral sculpture strong, closely resembling that of typical haydeni and the subspecies betheli, consisting of an average of about 13 strong, sharp ridges (in a few examples scarcely stronger than the riblets), the interspaces

much broader and occupied by from 3 to 6 spiral riblets or threads; numerous crowded, irregular, transverse riblets and growth lines roughen the shell and give to the spiral ridges and riblets a knobbed appearance under the lense; color pinkish white to white, first 2 or 3 whorls dark horn-color. Umbilicus deep and very narrow, almost cylindrical, exhibiting whorls to the apex" (Henderson & Daniels). Pilsbry added "and contained fully 7 times in the diameter". Height 14 mm, diameter 18 mm (type); height 14 mm, diameter 19.7 mm.

"The shell is more globose, the whorls of greater caliber and the umbilicus much narrower than in typical haydeni, and typical betheli is even more depressed and widely umbilicated" (Henderson & Daniels). O. h. betheli is a localized Colorado subspecies.

Revised Geographical Distribution.

O. h. corrugata occurs only on Richmond Knoll, 1.5 mi NE of "Webster Station" (now abandoned), 3.1 mi NNE of the junction of routes U.S. 91 and Utah 142 (which is in Richmond), Cache County, Utah. Coordinates are T14N, R1E, Sec. 12.

Ecology and Biology.

The area occupied on Richmond Knoll, about 300 acres in area, extends from near the top of the mountain at about 1550 - 1640 m altitude to the base of the mountain on the west side. It is xeric, treeless, and fairly steep. The upper part of the area occupied is just above the maximum water level of Pleistocene Lake Bonneville (1550 m) and on its eastern side it is joined to the main Wasatch Mountain range by a wide ridge whose top is slightly below that Pleistocene water level. It is interesting that O. h. corrugata has not crossed that ridge, nor even ventured onto it, since the decline of Lake Bonneville about 13000 years ago, although it has spread in a downslope direction on the west side. The ridge vegetation is approximately the same as on Richmond Knoll.

The ridge and the adjacent mountain areas are populated only by a small morph of O. strigosa depressa.

Ecology and Biology.

O. h. corrugata was primarily associated with antelope bitter brush and with mule ear, and secondarily with giant sagebrush. Its population size is estimated as about 1×10^6 - 1×10^7 .

Evidence of Threats to Survival.

Although the area seems to be used occasionally for grazing sheep, and a gravel pit exists at the base of the knoll on its west side, there appear to be no threats at present. The subspecies should be placed on the federal "Watch List", however, because a change in land use could imperil it.

Oreohelix howardi Jones.

[= O. strigosa depressa (Cockerell)]

Plate 1, Group 5

Oreohelix howardi Jones, 1944 [1943]: Proceedings of the Utah Academy of Sciences, Arts, and Letters, Vol. 21, pp. 61-66. The date is often given as 1944 but according to the reprint catalog at the Museum of Zoology, University of Michigan, that publication appeared in 1943. Type locality: "Church Fork of Mill Creek Canyon, Salt Lake City, Utah". Jones (p.61) also states that "this is the common Oreohelix of Mill Creek Canyon and its branches".

Partial Description.

The shell of this species was described in great detail by Jones. It is large (up to about 25 mm in width, 15 mm in height, umbilicus 4 mm wide, and with 5 1/4 whorls) and has two conspicuous, brown bands on

the body whorl and one on upper surface of earlier whorls. In young specimens the periphery is carinated but in mature specimens it is rounded.

This nominal species is an ecophenotype of O. strigosa depressa (Cockerell, 1890) made possible by extremely favorable circumstances of moisture, food, cover, and availability of calcium carbonate. Such populations appear throughout the range of O. strigosa depressa. In our opinion, therefore, O. howardi does not deserve distinct taxonomic status.

Revised Geographical Distribution.

According to Jones O. howardi is found throughout Mill Creek Canyon, located just southeast of Salt Lake City, Salt Lake County, Utah. Our investigations indicated that it occurs, in typical robust form, only on north-facing slopes of that canyon.

Ecology and Biology.

Moist coniferous forests, which occur only on north-facing slopes in Mill Creek Canyon, appear to be necessary for expression on this ecophenotype. The population there is healthy, robust, and large, and probably numbers 1×10^7 - 1×10^8 individuals. On dryer south-facing slopes only a much smaller morph of O. strigosa depressa occurs.

Possible Threats.

Mill Creek Canyon is located in Wasatch National Forest and it highly valued as a beautiful day use and hiking area. Unless accidentally burned, which seems most unlikely, the snail population is certain to be preserved.

Oreohelix parowanensis Gregg

Plate 2, Group 1

Oreohelix parowanensis Gregg, 1941, The Nautilus 54(3): 95-96). Type locality: "a rock slide on the southwest slope of Brian Head, Parowan [sic., = Parowan] Mountains, Iron County, Utah at an elevation of about 11000 [feet]...[which is] above the timber line" (31 empty shells were collected). Since the proper spelling is Parowan the species name is here emended to Oreohelix parowanensis. Further, the header date of Gregg's paper should be 1941, not 1940.

Partial Description.

"Shell rather small, depressed, sublenticular, with a moderately carinate periphery and a perspective umbilicus. Whorls $4 \frac{1}{3}$, convex below the suture, prominent in the middle and then flattened above the keel... All whorls visible in the umbilicus which is contained about $3 \frac{1}{2}$ times in the diameter of the shell. The entire shell is marked by radial striations, with faint spiral striations over the base of the body whorl... A fairly well marked band of chestnut-brown above and one close below the keel are present while the rest of the shell varies from cinnamon-brown on the apex to a light buff on the later portion of the body whorl. Height 5.4 mm., diameter 10.5 mm., umbilicus 3.0 mm.

This species seems nearest related to O. eurekaensis, located some 160 miles to the north, and O. handi, located about the same distance to the southwest. From eurekaensis it is readily distinguished by its larger umbilicus and by its keel which is more prominent except on the last third of the body whorl. It is smaller than handi, has a larger umbilicus, is less strongly carinate and has its sculpture less strongly developed" (Gregg, 1941).

This appears to be another of a small group of mountain species (including O. eurekaensis and O. yavapai cummingsi) which occur chiefly at high

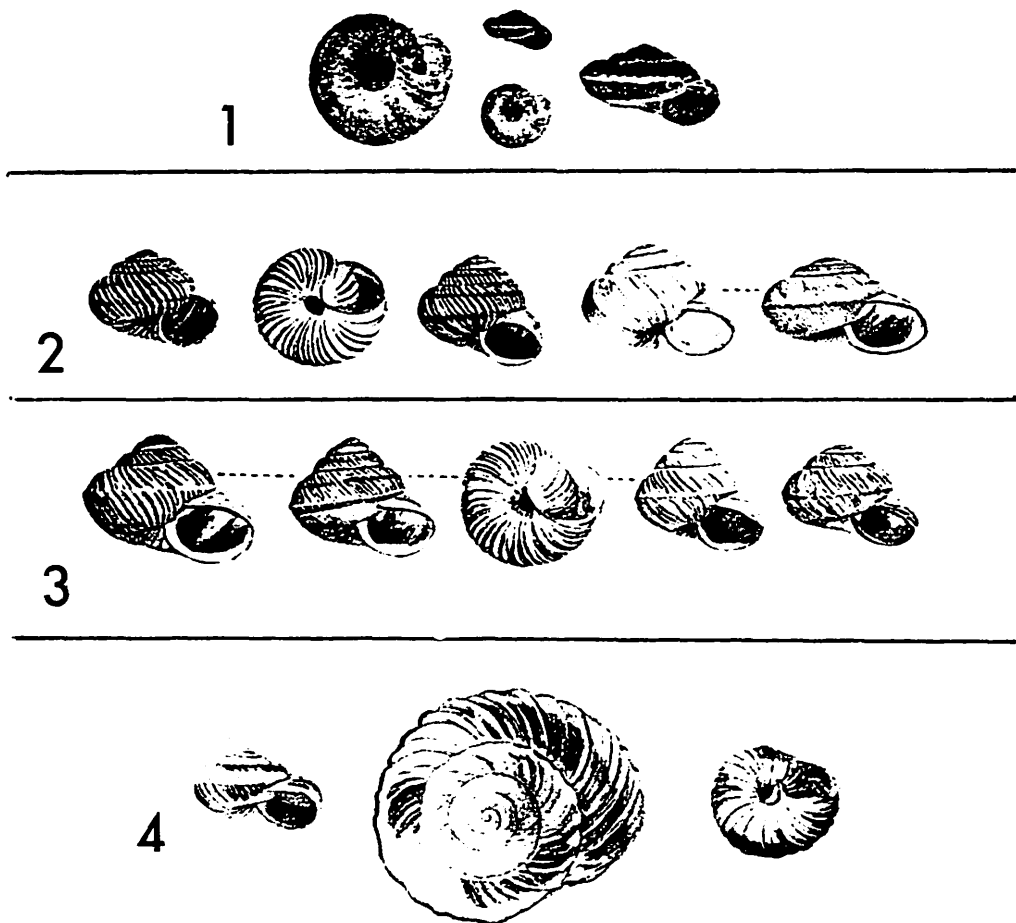


Plate 2. Group 1, O. parowanensis, holotype, X 1 and X 3. Group 2, O. peripherica newcombiana, X 1. Group 3, O. p. wasatchensis, X 1. Group 4, O. p. weberiana, holotype, X 1 and X 2. From Pilsbry (1939 & 1948).

altitudes, but since no live specimens have ever been collected its taxonomic relationships are not known with certainty.

Revised Geographical Distribution.

Known only from the type locality, a rock slide near the windswept top of Brian Head, Parowan Mountains, Iron County, Utah.

Ecology and Biology.

Although no live specimens have been observed, O. parowanensis probably spends most of its life among rock crevices well below the surface in a large rock slide (basalt) near the top of Brian Head, Parowan Mountains, at an altitude of about 11200 feet in the tree line but not associated with it.

One of us (PH) searched this rock slide carefully and excavated the surface from one side to the other. Deep excavation was impossible because of the danger of causing a new rock slide. Only two fresh empty shells were found, one O. parowanensis (diameter 8.5 mm, height 5.0 mm, whorls 4 1/4) and one O. strigosa depressa (diameter 17 mm, height 9.5 mm, whorls 4 7/8). Careful searches elsewhere by both of us in the vicinity failed to reveal any live specimens. We believe that the species still lives on Brian Head but we have no basis for estimating its abundance.

Evidence of Threats to Survival.

Brian Head is on federal land in Dixie National Forest. A road leads to the top of the mountain and a parking lot and a shelter have been constructed there. The rock slide is about 100 feet below the summit on the strongly windswept side and the high altitude makes exertion there very difficult. The rock slide will probably remain undisturbed although future development could jeopardize it. We recommend that this species be placed on the federal Watch List of potentially endangered and threatened species.

Oreohelix peripherica newcombi (Binney)
[= O. peripherica (Ancey)]
Plate 2, Group 2

[Patula strigosa] "var. newcombi Hemph." Binney, 1886: Bulletin of the Museum of Comparative Zoology (Second Supplement), Harvard University, 13:32, Pl.2:8. Type locality: "Mountains north of Ogden, among bushes on steep sides of a gulch facing north, in continual shade."

Partial Description.

"This variety has numerous, separated, rough, heavy transverse ribs (44 on the first [sic., last] whorl in one individual, and two widely-separated, revolving bands of color...Some want the revolving band[s]" (Binney, in Pilsbry, 1939:455). Pilsbry goes on as follows: "A coarsely ribbed form having a faintly sketched peripheral carina or angle in many examples, not perceptible in some others. Intercostal intervals are distinctly to obsoletely striate spirally. In the same lot the bands may be distinct, faint, or wanting. The umbilicus is usually small but is variable, contained 5 1/2 times to nearly 9 times in diameter. Two measure: 14.6 x 17.3 mm and 15.3 x 19.5 mm. The locality is said to be farther north than where wasatchensis was found, the exact place unknown."

Examination of museum collections and the results of our field work have shown that the typical newcombi morph occurs as one morph among others in several polymorphic colonies of Oreohelix peripherica. As far as we are aware it does not occur in pure colonies. (See also O. p. weberiana).

Revised Geographical Distribution.

Typical O. peripherica newcombi (with heavy costae and narrow brown bands) were seen in polymorphic colonies (also containing unbanded shells) at one site 4.0 mi WNW of Coalville, Cache County; and at another site at the eastern edge of Ogden, south of

Ogden Canyon at T6N, R1W, Sec. 26 (NW part), Weber County. Specimens with heavy ribs but without spiral color bands were seen at a site behind Echo Church, Echo, Cache County; and at a locality east of North Ogden, Weber County, T7N, R1W, Sec. 34 (SE part). Specimens without heavy costae but with spiral color bands were seen at a station 500 ft W of Short Divide in Box Elder County, 3.5 mi SW of Clarkston, Cache County (T14N, R2W, Sec.4); and at another site on the east side of Ogden Canyon, Weber County.

Ecology and Biology.

Colonies exhibiting one or more attributes of newcombi occurred on mountainsides among trees or on more open ground among sagebrush.

Evidence of Threats to Survival.

No imminent threats exist but both sites where the typical newcombi morph occurred (Dikker Hill and the site east of Ogden) could be devastated if fires occur there. As stated above, however, these morphs occur not in pure colonies but only as one morph among others in polymorphic colonies of O. peripherica. The newcombi morph therefore does not merit subspecific status.

Oreohelix peripherica wasatchensis (Binney)

Plate 2, Group 3

[Patula strigosa] var. wasatchensis "Hemphill"
Binney, 1886: Bulletin of the Museum of Comparative Zoology (Second Supplement), 13: 34, Pl. 2, fig.7.
Type locality: "Wasatch Mountains near Ogden, among quartzite boulders, only found in a plot of about an acre". Later Henderson & Daniels (1917: 67-68) more accurately defined Hemphill's locality as the south side of the valley, about a mile below the mouth of

Ogden Canyon, at the base of the river terrace in "a scrub oak and mountain-maple thicket".

Partial Description.

"The shell is pyramidal, narrowly umbilicate; buff with dull fleshy upper whorls and some streaks, with two narrow dull brown bands or bandless. The last whorl is convex above and below a strong peripheral keel. Sculpture of very coarse, irregular wrinkles of growth and minute spiral striae in places. Topotypes from Hemphill measure: height 17 mm., diameter 23.3 mm.; height 18 mm., diameter 21.6 mm.; [and] height 15.4 mm., diameter 18 mm. "

"This race is one of Hemphill's most spectacular finds, typically very distinct by its high spire, keeled periphery, and its coarse, irregularly developed, sculpture. Henderson and Daniels' [1917] specimens are not typical, being lower, much less roughly sculptured and with the keel usually less prominent" (Pilsbry, 1939: 456).

Revised Geographical Distribution.

Well-marked wasatchensis were found only at one site, i.e. in a maple grove near houses south of the entrance to Ogden Canyon, Weber County, at an elevation of 4760 feet. (The precise location is not given here because the subspecies is endangered). These specimens resemble the topotypes from Hemphill and specimens from Henderson & Daniels' lower station (see first 2 figs., Pl. 2, Group 3). They are also similar to the shells (in ANSP) collected by M.L. Walton in 1947 from this or a nearby site. The shells are up to 13 mm high and 20 mm wide, are pyramidal, strongly carinate, and coarsely sculptured, although none are quite as large, nor proportionately as high, as Hemphill's most extreme specimens.

Ecology and Biology.

The snails were found in abundance in the small maple grove which was approximately 6 meters wide and

Oreohelix peripherica weberiana Pilsbry
[= O. peripherica (Ancey)]
Plate 2, Group 4

Oreohelix peripherica weberiana Pilsbry, 1939: Land Mollusca of North America, 1 (1): 414-415, fig. 255.
Type locality: "west side of Weber River four miles west [sic., NNW] of Coalville. [Utah]".

Partial Description.

"The shell is depressed, moderately umbilicate (about 6 1/2 times in diameter), with very coarse, unequal, and irregular ribs, and fine spiral striae locally developed. There are two wide, interrupted dark bands, the upper one reaching the suture...height 10.8 mm, diameter 17.5 mm, h/d index 61.7, 4 3/4 whorls... This is the roughest form of peripherica except O. p. wasatchensis...The largest of the lot ...has a diameter of 20.5 mm." (Pilsbry, loc.cit.).

Revised Geographical Distribution.

The colony containing the weberi morph occurs only on one northeast-facing mountain slope 4 mi NNW of Coalville, Cache County, Utah. The occupied area is elliptical, about 200 m long (subparallel with the nearby highway) and about 125 m wide (from near the highway up the mountainside to near a conspicuous powerline). It is centered at 40° 57'30"N and 111° 25'33"W, in the SW part of T3N, R5E, about 0.15 mi WSW of the Weber River, adjacent to a pull-off area along the southbound side of U.S. Highway 80.

Ecology and Biology.

The area is steeply sloping with sagebrush, coarse short grass, and juniper trees interspersed with areas of only coarse grass. The entire area is shaded throughout the day except in the early morning. Snails are absent on adjacent north- or east-facing slopes. The altitude is 5760 to 6000 feet.

Living snails were very difficult to find even after rains. Scree piles are rare but one scree pile near the top of the mountain (near a double powerline support) yielded two live specimens from a depth of 15 inches. One was of the weberiana morph and the other was of the newcombiana morph. Live specimens must be fairly common, however, because a four foot wide strip of ground, 150 feet long (adjacent to a fence leading uphill) which had been cleared of empty shells on May 10, 1990, had about 1 to 1.5 shells per meter on September 1, 1990. Based on that density estimate the population of O. peripherica on that mountainside is judged to be of the order of 20,000.

Variation and Taxonomic Status.

All of the snails from the presumed type locality of weberiana were sculptured with strong collabral riblets and were subcarinate, but there was great variation in relative height (with height / diameter varying from 0.55 to 0.81) and in banding. Of 50 fresh-looking shells collected on May 10, 1990, (mainly from the SE part of the area) 18% were of the wide-banded type (weberiana morph), 36% were of the narrow-banded type (newcombiana morph), and 46% were unbanded. All 65 fresh-looking shells from the September 1 collection (from the entire area) were also examined and were found to be 36% wide banded, 32% narrow-banded, and 32% unbanded. In view of the fact that the weberiana morph is but one of three morphs in a polymorphic colony it should be classes as a color morph of O. peripherica and not as a subspecies.

Evidence of Threats to Survival.

Sheep are allowed to graze in this area but none were seen during our visits there. Aside from possible fires (the area is posted as belonging to Dikker Hill Sportsman's Club) there seem to be no serious threats to this colony.

Oreohelix strigosa buttoni (Hemphill)

[= O. strigosa depressa (Cockerell)]

Plate 3, Group 1

Patula strigosa var. buttonii Hemphill, 1890 in W. G. Binney, 1890: Second Supplement, Bulletin of the Museum of Comparative Zoology (Harvard University) 19: 220. Type locality: "Boxelder County [Utah]". This was emended by Henderson & Daniels (1916) "Taylor Canyon, near Ogden, south of Ogden Canyon, about limestone ledges". Those authors also reported it from two other sites, one a "half hour's walk below Gateway in Weber Canyon, southeast of Ogden, in gneiss slide rock; and [the other] about half a mile above mouth of Weber Canyon".

Partial Description.

"Shell umbilicated, elevated or moderately depressed, nearly white or sometimes stained with light chocolate; whorls 5, convex, with numerous oblique striae; suture impressed, aperture circular; peristome thickened, not reflected, darker than the body of the shell; extremities nearly approached and joined by a callus; with or without a basal tooth; tooth when present very variable, generally consisting of a single tubercle; in some specimens it is nearly or quite square, as high as long; in other specimens it is long and bifid... " (Hemphill, as quoted in Pilsbry, 1939: 439).

Pilsbry continued: "Hemphill's shells are matt, dirty white with more or less brown suffusion above, mainly in streaks, usually bandless or with weak traces of bands, rarely with two distinct but uneven bands. In a series of 30, four have a distinct columellar tooth, several others a mere trace. The diameter runs from 11.9 to 23 mm., the toothed shells from 15 to 19.8 mm. Hemphill's printed labels give the locality "Sandstone ledges, altitude 4500 feet"

and Red sandstone ledges, alt. 5000 feet". Pilsbry found no anatomical differences between buttoni specimens from Taylor Canyon and strigosa specimens from two other localities.

We believe that buttoni is an ecophenotype which is expressed in some specimens living under xeric conditions but in the presence of abundant calcium carbonate.

Geographical Distribution.

Known only from the localities cited above. We searched for it at many sites and found no specimens with apertural teeth.

Ecology and Biology.

Aside from the information from Hemphill and from Henderson & Daniels that buttoni is associated with limestone ledges and sandstone ledges, and that the altitude was 4500 to 5000 feet, nothing is known about its ecology or biology.

Threats to Survival

None. We believe that the taxon is invalid.

Oreohelix strigosa fragilis (Hemphill)

= O. strigosa depressa (Cockerell)}

Plate 3, Group 2

Patula strigosa var. fragilis Hemphill, 1890: The Nautilus 4: 17. Type locality: "near Franklin [Idaho], among red sandstone". Later Henderson & Daniels (1916: 336, Pl. 16, fig. 1) designated a lectotype of fragilis and thereby restricted the type locality to "a small, isolated, barren-looking mountain about a mile west of Franklin, in the edges

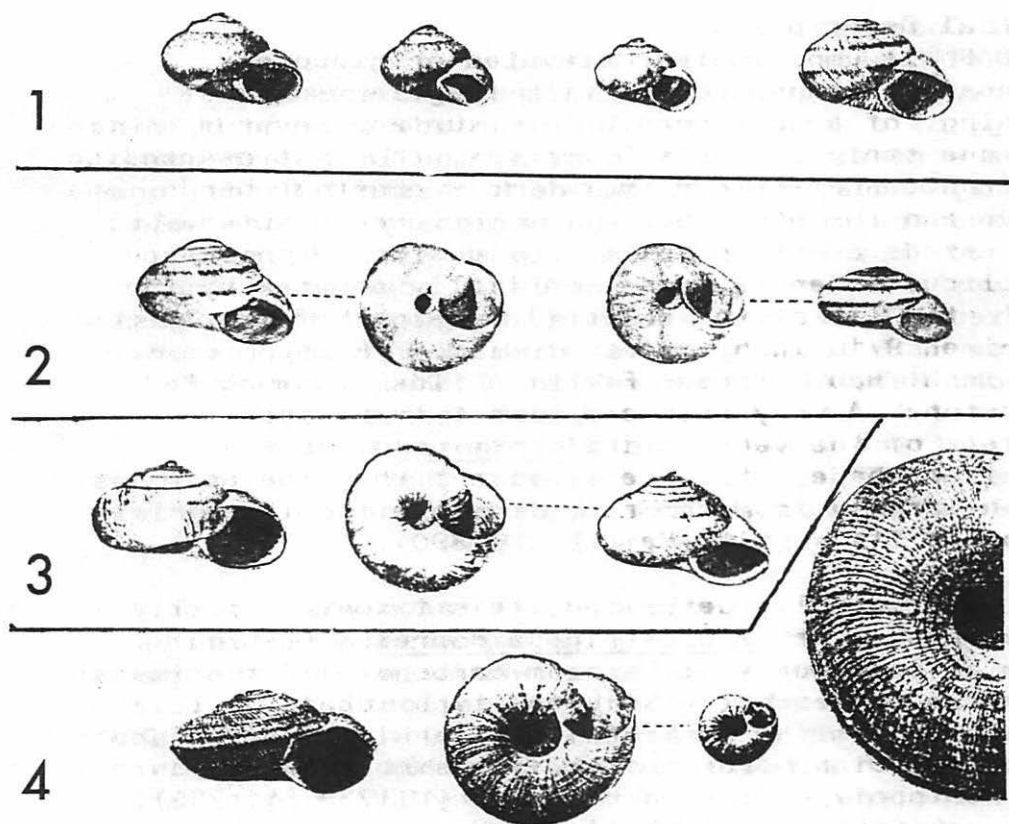


Plate 3. Group 1, *O. buttoni*, paratypes, X 1. Group 2, *O. strigosa fragilis*, left figs. paratype, X 1. Group 3, *O. subrudis rugosa*, X 1. Group 4, *O. yavapai cummingsi*, X 4, X 1, & X 6. From Piisbry (1939).

of Paleozoic limestone slides surrounded by sage brush" (Pilsbry, 1939: 438). As discussed below, designation of a lectotype from "the edges of Paleozoic limestone" has complicated the concept of this taxon.

Partial Description.

"Shell umbilicated, elevated or globosely depressed, translucent, thin, fragile, somewhat shining, of a dark horn color, surface covered by fine oblique striae; whorls 5, convex, the last descending in front, and striped by two dark chestnut bands, one above and the other below the periphery; suture well impressed; aperture oblique; lip simple, thickened, umbilicus moderate, deep, partially covered by the reflected lip at the columella. Height of the largest specimen 9/16 inch, greatest diam. 7/8 inch, lesser 3/4 inch. Habitat near Franklin, Idaho, among Red Sandstone. A very thin and almost transparent variety of the very variable strigosa. By its peculiar shade, it is very evident that the animal has drawn largely from the red sandstone for the material to build its shell" (Hemphill, 1890).

As originally described, this taxon was probably an ecophenotype of O. strigosa depressa resulting from an inadequacy of calcium carbonate. Our specimens from the subsequently selected type locality, Little Mountain, 2 mi NW of Franklin, Franklin County, Idaho (near the Utah border) closely resemble the syntype and neotopotype figured by Pilsbry (1939. Fig. 289). They are fairly thin-shelled and translucent when viewed against daylight sky, but are not transparent. It is probable that the site from whence Hemphill's specimens came was particularly wanting in calcium carbonate.

Revised Geographical Distribution.

We have revisited the two sites of Henderson & Daniels listed by Pilsbry (1939: 438), i.e. the small mountain near Franklin, Idaho (Little Mountain, T14S, R40E, Sec.18) and Prater's Gulch, about 6 mi SE of Franklin, in Utah (T14N, R2E, Sec.5 and Sec.7).

Oreohelix strigosa cf. "fragilis" was abundant at each location.

Ecology and Biology.

As originally specified, the snails came from a mountainside at moderate elevation (4500 - 5000 feet) and were associated with red sandstone ledges, not with limestone. Our Little Mountain specimens were concentrated near the bases of large rocks and under shrub bushes (chokecherry and skunk bush). They covered the mountainside below the first lake bench (from Pleistocene Lake Bonneville) but were absent on the bench. In High Creek Canyon (the Prater Gulch area) shells occurred at the bases of conglomerate cliffs and live snails were found under rocks, under antelope bitter brush, and in leaf litter.

The Little Mountain population was estimated at 200,000 to 400,000 snails. No size estimates were made for the two populations seen in High Creek Canyon but they were substantial.

Threats to Survival.

The Little Mountain area has been impacted by two old gravel excavations but they are now inactive. The High Creek Canyon sites are on steep mountainsides apparently unused by man.

The name Oreohelix strigosa fragilis is here regarded as a synonym of Oreohelix strigosa depressa. Further, the populations of "fragilis" which were seen are healthy and are neither endangered nor threatened.

Oreohelix subrudis rugosa (Hemphill)

Patula strigosa var. rugosa Hemphill, 1890: The Nautilus 4(2): 16). Type locality: "New [sic., near] Brigham City, Utah". According to Pilsbry (1939: 493) Hemphill's labels bear the words "near Boxelder Canyon, limestone ledges at 5000 feet".

Revised Description.

"Shell umbilicated, elevated or globosely depressed, of a dull brown ash color; surface rough, covered with coarse irregular oblique striae, and microscopic revolving lines; whorls 5, convex, with or without one or two narrow faint revolving bands... spire elevated, obtusely conical...; umbilicus large, deep; aperture nearly round, lip simple, thickened... Height of the largest specimen, 3/4 inch, greatest diam. 1 inch... A large rough robust form with very convex whorls..." (Hemphill, 1890).

Oreohelix subrudis is a widespread species (British Columbia to southwestern New Mexico), occurring mainly at high altitudes, and characterized by a relatively high, robust, and coarsely striate shell with a domed spire. Many specimens closely resemble the more abundant species Oreohelix strigosa, however, and according to Pilsbry such material can only be assigned to species by examination of their genitalia. The subspecies rugosa is much less pigmented than that of subrudis s. str., however, and it has a coarser and rougher surface.

In a recent study of Oreohelix in Colorado, Brandauer (1988) was unable to confirm the anatomical differences reported by Pilsbry and she therefore proposed that subrudis should be considered a synonym of strigosa. We are reluctant to accept that synonymy without more information, such as anatomical comparison of Colorado specimens with those from west of Clarkston, Cache County, Utah, specimens of which were dissected by Pilsbry and determined by him to be O. subrudis rugosa.

Revised Geographical Distribution.

Known with certainty from only a few sites in northeastern Utah, viz. west-facing mountain slopes 2 - 3 mi W of Clarkston, Cache Co., altitude 1650 - 1750 m.; Winter Canyon, open slopes W of a point 3/4 mi N and 2 mi W of Clarkston, altitude 1750 - 1850 m (both, this survey); Logan Canyon, 5000 ft [= 1524 m], Cache Co.; near Morgan, Morgan Co. (both Pilsbry, 1939); and Box Elder Canyon, 3.2 mi N of Brigham City, Box Elder Co., M.L. Walton, 1947 (ANSP). Pilsbry (1939) also cites specimens from Book Cliffs, Carbon Co., as probably belonging to this subspecies although he saw only empty shells. We collected at four sites in the Book Cliffs area and large oreohelices were found at each site. All of the sites were in coniferous or coniferous - deciduous forests, however, not on open land as at the sites near Clarkston. Based on shell characters we have tentatively identified them as the large morph of O. strigosa depressa (see "O. howardi").

Ecology and Biology.

Specimens which we believe are O. s. rugosa were found by us on mountainsides at 1650 to 1850 m on fairly open ground, strongly associated with antelope bitter brush (Kunzia tridentata) and sagebrush, but also in thickets of scrub maple.

The two sites west of Clarkston were estimated to have about 1×10^6 - 1×10^7 and at least 1×10^5 - 1×10^6 individuals, respectively. The Book Cliffs populations (which may belong to this subspecies) are probably even larger.

Possible Threats.

All of the populations known to belong to this subspecies, or even thought possibly (but doubtfully) to belong to it, are very large and are in remote locations which are not used for any commercial activity. They are not in danger and are unlikely to be in danger.

Oreohelix yavapai cummingsi Pilsbry.

Plate 3, Group 4

Oreohelix yavapai cummingsi "Ferriss" Pilsbry, 1934: Proceedings of the Academy of Natural Sciences of Philadelphia (for 1933) 85: 401, Pl. 15, figs. 18, 18a, 19, 19a). The original specimens were collected by Ferriss in 1919 on and around Navajo Mountain on the Arizona-Utah border. Type locality: "from reservoir of Yellow House Ruins, 2 miles south of Endishe Springs, [Navajo Mountain,] Arizona".

Partial Description.

Shell thin, brownish, with a darker band above and another close below the periphery. A peripheral keel extends to the aperture. The last whorl elsewhere is well rounded but the earlier whorls are flattened, the keel filling the suture. Shell thin, without much calcareous matter. The sculpture is of irregular, fine striae, and weak spirals which are granose at the striae, and often bear cuticular scales on the granules, especially prominent on the base. The holotype measures: height 6 mm., diameter 12 mm., umbilicus 3 mm., 4 1/2 whorls. (Compiled from a composite description in Pilsbry (1939: 521)). This is one of ten subspecies of O. yavapai recognized by Pilsbry (1939).

Revised Geographical Distribution.

Collected only (by J.H. Ferriss in 1919) from near and on Navajo Mountain on the Utah - Arizona border, and about 100 miles to the NE in the Blue Mountains near Monticello, San Juan County, Utah. In 1992 we searched these areas and failed to find this subspecies.

It is of interest that specimens which we collected from near Taggarts, Morgan County, in Weber Canyon (about 1 mi west of the type locality of O. haydeni haydeni) are subdiscoidal, carinate, barely sculptured and closely resemble O. yavapai, but some exhibit spiral sculpturing. Similar specimens from

that area have been identified as O. haydeni oquirrhensis form gabbiana (Hemphill) by Henderson & Daniels (1917).

Ecology and Biology.

Ferriss' Navajo Mountain collections of O. yavapai cummingsi were all from near its summit, near "War God's Spring", from "many fairy bowers, coves, and valleys [which] are hidden here" and among sandstone rocks in a large canyon west of Endische Springs. In the Blue Mountains they were from sandstone rock slides, among shale, and among aspen. At War God's Spring #1 and War God's Spring #2, both near the top of Navajo Mountain in San Juan County, Utah (altitude about 8800 ft.), we found the area to be heavily forested with ponderosa pine and aspen, and in the area where we searched in the Blue Mountains (altitude about 8530-9840 ft) aspen-spruce and aspen-oak forests and open ground occurred. These habitat observations agree with those of Ferriss (1920, The Nautilus 34: 1-14). Endische Spring is now confined in concrete and serves as the water supply for the village on Navajo Mountain. No oreohelices were found by us on Navajo Mountain and in the Blue Mountains only O. strigosa depressa were found. (We did not search in rock slides there, however).

Ferriss and his associates found O. yavapai cummingsi between July 1 and September 13 in 1919. In 1992 we searched on Navajo Mountain at the end of April and in the Blue Mountains in early June. The April dates may have been too early in such a high altitude on Navajo Mountain (a few small patches of winter snow were still visible), but since O. strigosa depressa was found in early June in the Blue Mountains that date was probably not too early for O. y. cummingsi. Further, it may be of some significance that Mr. Holgate, who has travelled frequently on Navajo Mountain for decades, has not noticed any snails there. We therefore conclude that O. y. cummingsi, which is probably inconspicuous, may also be uncommon or rare in both areas. Addition of

this taxon to the federal Watch List is therefore recommended.

Threats to Survival.

Navajo Mountain is administered by the Navajo Nation, assisted by the U.S. Department of Indian Affairs. The Blue Mountains are in the Manti-Lasal National Forest. War God's Springs are considered sacred by the Navajo people but during the summer sheep are grazed in the area and elsewhere on Navajo Mountain. (This information was supplied by Mr. Jaime Holgate, our Navajo guide. Mr. Holgate's father guided the last malacological expedition on Navajo Mountain, that of J.H. Ferriss in 1919). The Blue Mountains are managed by the U.S. Forest Service.

Although sheep grazing on Navajo Mountain and possible forest fires in both areas could impact the subspecies, there appear to be no current threats to its existence.

FAMILY SUCCINEIDAE

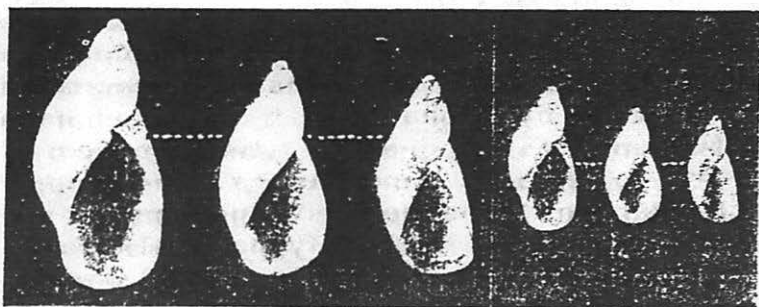
Oxyloma haydeni kanabensis Pilsbry.

Text Figure 1

Oxyloma haydeni kanabensis Pilsbry, 1948: Land Mollusca of North America, Vol.2 (Part 2), pp. 797-798, figs. 419a and 428. Type locality: "The Greens", 6 miles above Kanab, on Kanab Wash, on a wet ledge among moss and cyprid pediums (J.H. Ferriss, 1909".

Partial Description.

As in all species of Succineidae the shell is dextral, thin-walled, with an elevated spire, a large, inflated body whorl, and an ovate aperture. In O. h. kanabensis the shell in most specimens is pale ochraceous buff with salmon-colored spire, glossy,



Text Fig. 1. *Oxyloma haydeni kanabensis*. Illustrations on right are natural size. From Pilsbry (1948).

and with irregular wrinkles of growth. The spire is drawn out, of oblique, convex whorls, the last whorl flattened in the upper part, convex below. The aperture is ovate and the basal margin is slightly retracted but not deeply curved. Columella thin, curving into the parietal margin. Parietal callus very thin. The holotype measures: length 19 mm, diameter 9.3 mm, length of aperture 12.3 mm; it has 3 1/2 whorls (modified from Pilsbry (1948)).

In general the "pulled-up" spire (in most specimens), the obliquely-flattened upper half of the body whorl, and the broadly-rounded, almost truncated lower apertural margin, appear to be features which consistently distinguish this from other subspecies of *O. haydeni*. See Pilsbry (1948) for more details.

Revised Geographical Distribution.

In 1990 a large population of this taxon occurred in Three Lakes Canyon about six miles WNW of Kanab, Kane County, Utah. A very small population also occurred at the foot of a cliff about six miles N of Kanab. (This subspecies is now listed as federally Endangered so precise locations are not given here). In 1992 another small population was found at "Vasey's Paradise", a spring in Marble Canyon, Grand Canyon National Park, Arizona (Spamer and Bogan, 1993).

Ecology and Biology.

The O. h. kanabensis population in Three Lakes Canyon lives in wet marsh habitat and is estimated (based on random quantitative samples) to contain about 100,000 individuals. The marsh is dominated in its wettest portion by Typha but it is also characterized by two species of grasses, two species of Carex, violets, plantains, and alders, the latter mostly at the margins. The densest aggregations of Oxyloma were found under fallen Typha stalks at the edges of thick Typha stands. The snails were also frequently seen just within the mouths of vole burrows. The presence of surface water, at least around the bases of the grass, appears to be necessary for survival of kanabensis because none were found in dryer areas even under logs or in other microhabitats commonly frequented by other land snails.

The small population 6 miles north of Kanab was restricted to a 6-inch wide strip of wet ground along the base of a damp cliff. A search of 150 feet of that habitat revealed only three live snails. The plants Mimulus guttatus, Dodocatheon pauciflorum, and Aquilegia micrantha occurred on the cliff and a tall grass was common at the base of the cliff, along with Juncus and Typha. According to Mr. Blaine Lunceford (a biologist with the U.S. Bureau of Land Management in Kanab), in 1986 the snail habitat there was much more extensive and snails were common but since then the water has been diverted for use by cattle.

On May 14, 1990, Oxyloma were found copulating. Snails found in ten one-foot-square quadrats had lengths of 6, 6, 8, 8, 8, 8, 9, 10, 11, 11, 11, 12, 13, and 13 mm. This indicates that these snails overwinter as juveniles, subadults, and adults. Mr. Lunceford has observed robins feeding on these snails at both localities.

Threats to Survival

Imminent development of Three Lakes Canyon, and the information developed from this survey, led the U.S. Fish and Wildlife Service in 1992 to list O. haydeni kanabensis as Endangered (Federal Register: 56: 13657).

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FRESHWATER MUSSELS OF THE CYPRESS BAYOU SYSTEM,
NORTHEAST TEXAS

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ABSTRACT

The Cypress Bayou system in the Red River drainage in Northeast Texas was surveyed for freshwater mussels during the period of 1981 - 1988. Twenty species of unionid mussels were found plus the Asiatic clam (Corbicula fluminea). Dominant species in the system include Fusconaia flava, Lampsilis hydiana, Toxolasma texasensis and Quadrula pustulosa. Eight species previously unreported from the system were found. Two species previously reported were not found.

INTRODUCTION

Because of pollution and dam building in North America, many freshwater mussel faunas have been altered, severely depleted or destroyed before adequate surveys had been accomplished. The Cypress Bayou system in Northeast Texas contains a diverse mussel fauna but has received little attention in the past. Vaughn (1893) lists only one species that can be definitely assigned to Cypress Bayou but doesn't indicate from which branch (Big Cypress, Little Cypress or Black Cypress). Shira (1913) lists 13 species but does not give specific localities. This study was initiated to assess the mussel fauna of the Cypress Bayou system upstream from Caddo Lake.

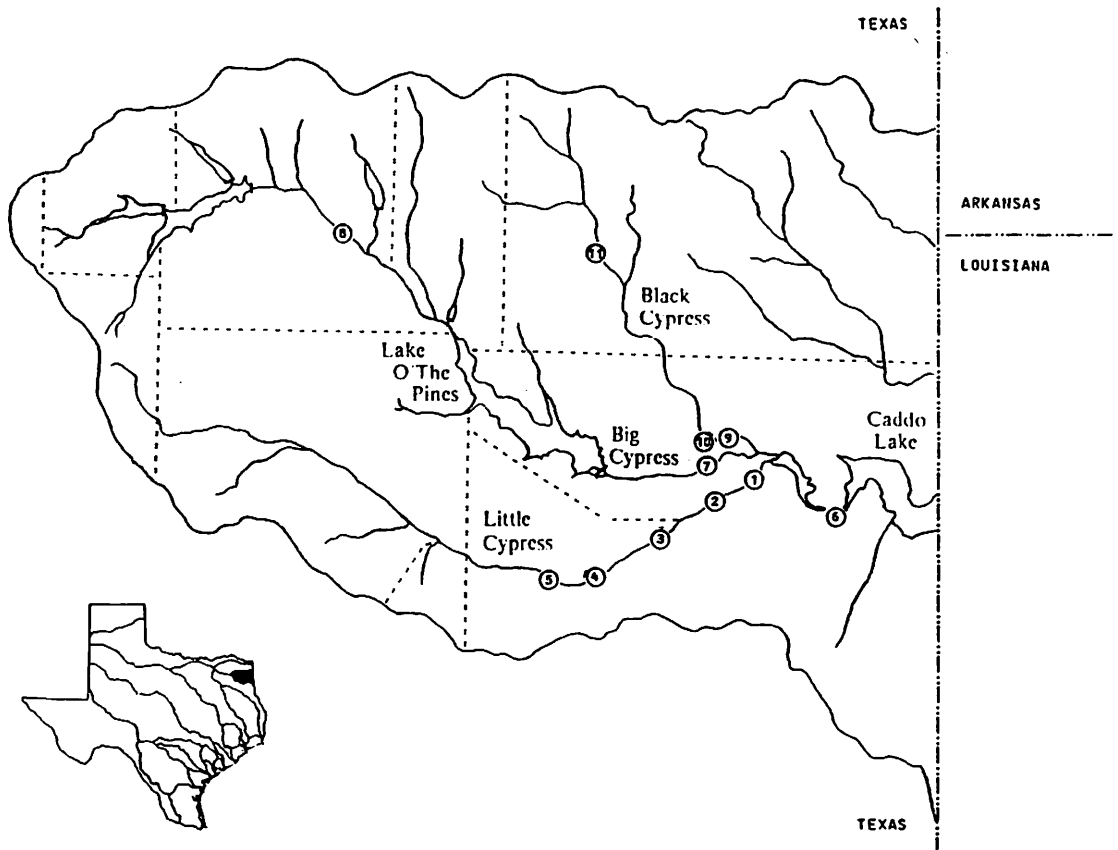


Figure 1. Collection sites on the Cypress Bayou System surveyed during 1981-1988.

THE STUDY AREA

The Cypress Bayou system begins in Wood, Franklin and Hopkins Counties, and extends through parts of Titus, Camp, Upshur, Gregg, Morris, Cass, Marion and Harrison Counties in northeastern Texas. The three main branches of the system in Texas are the Black Cypress Bayou, Big Cypress Creek and Little Cypress Bayou. These all enter Ferry Lake which in turn enters Caddo Lake on the Texas/Louisiana border. A system of bayous in turn drain from Caddo Lake into the Red River near Shreveport, Louisiana. As the names indicate, these streams are all rather sluggish and populated with bald cypress (*Taxodium distichum*). There are several reservoirs on Big Cypress Creek, including Lake Cypress Springs, Lake Bob Sandlin and Lake O' The Pines. Black Cypress and Little Cypress Bayous remain undamed above Ferry Lake (Figure 1).

METHODS

A total of eleven collection stations were sampled, five on Little Cypress Bayou, two on Big Cypress Creek, three on Black Cypress Bayou and one on Caddo Lake (see Table 1). Visits were made to the area in 1981, 1984 and 1988. Specimens were collected by examining sand bars and low areas along the streams and wading to collect both living and dead shells in the water. Specimens were placed in two categories. Living and fresh specimens were lumped together as the fresh specimens were assumed to represent living populations. Weathered specimens were separated but it can be assumed that they also represent extant populations. The acidic condition of the water and soils of the area result in a rapid dissolution of shells. As a result, even the most extremely weathered specimens have been dead for very few years.

Most live specimens were returned to the water. Voucher specimens were deposited in the mollusk collection at the University of Science and Arts of Oklahoma, Chickasha, Oklahoma.

RESULTS

Twenty species of unionid mussels were collected plus the Asiatic clam (see Table 2). All species represented were collected alive or fresh in some part of the system. All twenty species were present in Little Cypress Bayou, fifteen in Black Cypress Bayou, twelve in Big Cypress Creek and only four in Caddo Lake (no effort was made to thoroughly sample Caddo Lake). Considering only live and

Table 1. Collection stations on the Cypress Bayou system surveyed during 1981-1988.

SITE	COUNTY	LOCATION AND DATE
1	Marion/Harrison	Little Cypress Bayou FM134, 19 Aug 1984 94° 17' 00" x 32° 44' 30"
2a	Marion/Harrison	Little Cypress Bayou US59, 9 Aug 1981 94° 20' 40" x 32° 42' 30"
2b	Marion/Harrison	Little Cypress Bayou US59, 19 Aug 1984 94° 20' 40" x 32° 42' 30"
3	Harrison	Little Cypress Bayou FM3001, 20 Aug 1984 94° 25' 30" x 32° 40' 20"
4	Harrison	Little Cypress Bayou SH154, 20 Aug 1984 94° 31' 00" x 32° 37' 30"
5	Harrison	Little Cypress Bayou FM450, 20 Aug 1984 94° 34' 30" x 32° 37' 30"
6	Harrison	Caddo Lake, Caddo Lake St Pk, 19 Aug 1984 94° 12' 00" x 32° 41' 40"
7	Marion	Big Cypress Creek US59, 19 Aug 1984 94° 21' 00" x 32° 45' 00"
8	Titus	Big Cypress Creek SH11, 8 Aug 1988 94° 53' 00" x 33° 01' 20"
9	Marion	Black Cypress Bayou SH49, 8 Aug 1988 94° 20' 00" x 32° 47' 00"
10	Marion	Black Cypress Bayou US59, 8 Aug 1988 94° 21' 30" x 32° 46' 30"
11	Cass	Black Cypress Bayou SH11, 8 Aug 1988 94° 31' 00" x 33° 00' 00"

Table 2. Specimens collected in the Cypress Bayou system, 1981 - 1988.
 Numbers represent live or fresh dead specimens
 w = weathered specimens

SPECIES	COLLECTION SITE											
	1	2a	2b	3	4	5	6	7	8	9	10	11
<i>Amblema plicata</i>	-	w	w	-	-	-	-	1	-	-	-	-
<i>Anodonta grandis</i>	-	-	1	-	-	-	-	-	-	1	-	5
<i>Anodonta imbecillis</i>	-	-	1	-	-	1	-	-	-	1	-	-
<i>Fusconaia flava</i>	1	2	54	4	1	1	-	12	-	14	3	56
<i>Lampsilis hydiana</i>	5	8	22	4	14	6	-	8	-	3	3	40
<i>Lampsilis teres</i>	1	4	8	1	15	3	-	-	-	1	-	-
<i>Leptodea fragilis</i>	1	-	2	1	-	-	-	-	-	-	-	-
<i>Ligumia subrostrata</i>	-	-	2	-	-	-	11	-	-	5	-	-
<i>Megalonaias nervosa</i>	-	-	2	w	1	-	-	4	-	w	-	-
<i>Plectomerus dombeyanus</i>	w	6	8	-	-	-	w	3	-	-	-	-
<i>Pleurobema riddelli</i>	-	1	1	-	w	-	-	-	-	-	-	-
<i>Potamilus purpuratus</i>	1	-	1	-	1	w	-	-	-	w	1	-
<i>Quadrula pustulosa</i>	w	w	10	4	1	1	-	10	-	12	-	20
<i>Quadrula quadrula</i>	-	-	1	-	-	-	-	w	-	-	-	-
<i>Strophitus undulatus</i>	-	w	3	2	-	-	-	1	-	-	1	-
<i>Toxolasma texasensis</i>	3	4	21	2	5	26	18	-	-	w	1	12
<i>Tritogonia verrucosa</i>	w	w	2	2	-	w	-	2	-	3	-	1
<i>Truncilla truncata</i>	-	1	4	-	-	-	-	1	-	-	-	-
<i>Unio merus declivis</i>	2	-	5	1	-	1	-	-	-	w	1	1
<i>Villosa lienosa</i>	w	w	16	4	1	6	-	1	-	-	w	-
<i>Corbicula fluminea</i>	3	-	w	1	1	2	w	w	w	1	2	10

Table 3. Comparison of species collected by Vaughan (1893) and Shira (1913) with the present study.

Mather and Bergmann	Vaughan	Shira
<u>Amblema plicata</u>		
<u>Anodonta grandis</u>		<u>Anodonta corpulenta</u>
<u>Anodonta imbecillis</u>		
<u>Fusconaia flava</u>		<u>Quadrula undata</u>
<u>Lampsilis hydiana</u>		<u>Lampsilis luteola**</u>
		<u>Lampsilis claibornensis**</u>
<u>Lampsilis teres</u>		<u>Lampsilis fallaciosa</u>
<u>Leptodea fragilis</u>		<u>Lampsilis gracilis</u>
<u>Ligumia subrostrata</u>		
<u>Megaloniais nervosa</u>		<u>Quadrula heros</u>
<u>Plectomerus dombeyanus</u>		<u>Quadrula trapezoides</u>
<u>Pleurobema riddelli</u>		
<u>Potamilus purpuratus</u>	<u>Unio purpuratus</u>	<u>Lampsilis purpurata</u>
<u>Quadrula nodulata*</u>		<u>Quadrula pustulata</u>
<u>Quadrula pustulosa</u>		<u>Quadrula pustulosa</u>
<u>Quadrula quadrula</u>		<u>Quadrula fragosa</u>
<u>Strophitus undulatus</u>		
<u>Toxolasma texasensis</u>		
<u>Tritogonia verrucosa</u>		<u>Tritogonia tuberculata</u>
<u>Truncilla donaciformis*</u>		<u>Plagiola donaciformis</u>
<u>Truncilla truncata</u>		
<u>Uniomerus declivis</u>		
<u>Villosa lienosa</u>		
<u>Corbicula fluminea</u>		

* Species not collected in the present study.

** Since both L. luteola and L. claibornensis were both listed by Shira, it is assumed that the degree of raying on the shell was used to separate these but we would currently recognize these as L. hydiana.

fresh specimens collected in this study, four species including Fusconaia flava (27.3%), Lampsilis hydiana (20.9%), Toxolasma texasensis (13.7%) and Quadrula pustulosa (10.7%) made up 72.6% of the unionid fauna. Six species (Amblema plicata, Anodonta imbecillis, Leptodea fragilis, Pleurobema riddelli, Potamilus purpuratus and Quadrula quadrula) each made up less than 1% of the specimens collected.

Live or fresh specimens were collected at every collection station except station 8 on Big Cypress Creek, where only a single weathered Corbicula was found. A slough near that station yielded an additional species (Unio merus tetralasmus) not found in the Little Cypress Bayou, Big Cypress Creek or Black Cypress Bayou. Six other species were also found in the slough including Amblema plicata, Lampsilis teres, Megaloniais nervosa, Quadrula quadrula, Unio merus declivis and Villosa lienosa.

DISCUSSION

During the course of this survey, twenty unionid species plus the Asiatic clam were found. Vaughan (1893) reported only one species, Unio purpuratus Lamarck (= Potamilus purpuratus), that can definitely be traced to the Cypress Bayou system. Shira (1913) reported thirteen or fourteen species from the area (see Table 3). Two species reported by Shira but not found during the course of this survey were Quadrula pustulata (= Q. nodulata) and Plagiola donaciformis (= Truncilla donaciformis). Both species are in the Red River system. Eight unionid species plus the Asiatic clam were collected in this study that were not reported by Shira. These include Amblema plicata, Ligumia subrostrata, Pleurobema riddelli, Strophitus undulatus, Toxolasma texasensis, Truncilla truncata, Unio merus declivis and Villosa lienosa.

It appears that the Cypress Bayou system has retained its diversity. The two species reported by Shira but not found during this survey could still be present in the system, but were missed.

LITERATURE CITED

- Shira, A. F. 1913. The mussel fisheries of Caddo Lake and the Cypress and Sulphur Rivers of Texas and Louisiana. Bureau of Fisheries Econ. Circ. 6:1-10.
- Vaughan, T. W. 1893. Notes on a collection of mollusks from north western Louisiana, and Harrison County, Texas. The Amer. Nat. 27(323):944-961.

NOTES

NEW SUBSCRIPTION POLICY.

The long delays which often occur between publication of consecutive issues of this journal have made it desirable to change our subscription policies. Beginning with Volume 4, advance subscriptions to Malacology Data Net will not be necessary. All individuals and institutions who have received the journal in the past, and others who may wish to receive it, will be notified when each future issue becomes available.

OPPORTUNITY TO PARTICIPATE IN FIELD WORK.

During the summer of 1994 ECOSEARCH, Inc. will be carrying out three field investigations, viz. (1) a braill survey of mussel beds in the Ohio River between West Virginia and the river mouth, (2) a status survey of three rare species of Unionidae in the Spring, Neosho, and Verdegris Rivers in southeastern Kansas, and (3) a status survey of Leptodea leptodon (Unionidae) and Discus shimaki cockerelli (Endodontidae) in South Dakota. In addition to A.H. Clarke, Judith J. Clarke, and local assistants, we expect to be able to accomodate two students who may wish to receive training in malacological field methods or who wish to obtain material for study (consistent with permit provisions). Those who are interested may telephone Dr. A.H. Clarke at (512) 643-1689.

ERRATA

In Plate 1 (page 108 of this issue) the numerical identifiers for Group 4 and Group 5 are reversed. Further, on Plate 3 (page 127), in order to compensate for the loss of detail inherent in our duplicating process, partial outline delineations were inserted on some of the copies of Pilsbry's figures. Unfortunately some of those outlines are not accurate.

INFORMATION FOR CONTRIBUTORS

Malacology Data Net seeks to enhance progress in malacology by publishing significant new information about all aspects of marine, freshwater, and terrestrial mollusks. All scholarly contributions are welcome.

Editorial style used in this journal follows the Style Manual for Biological Journals available from the American Institute of Biological Sciences. Manuscripts should be submitted in duplicate as camera-ready copy, using "letter quality" type, with text in blocks 5 inches wide and 6 1/2 inches high. Use of a word processor is recommended. Each manuscript will be reviewed by at least two malacologists and, if necessary, will be returned to the author for revision.

A charge of ten dollars per page will be assessed for publication from authors with institutional or grant support. If half-tone illustrations (i.e. photographs) are included authors will be charged at cost for plate preparation and reproduction.

If a need for reprints is anticipated that fact should be mentioned in the original cover letter accompanying the manuscript. A price list of reprint charges will then be sent for consideration.

