

New Freshwater Snails of the Genus *Pyrgulopsis* (Rissooidea: Hydrobiidae) from California

by

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Abstract. Seven new species of Recent springsnails belonging to the large genus *Pyrgulopsis* are described from California. *Pyrgulopsis diablensis* sp. nov., known from a single site in the San Joaquin Valley, *P. longae* sp. nov., known from a single site in the Great Basin (Lahontan system), and *P. taylori* sp. nov., narrowly endemic in one south-central coastal drainage, are related to a group of previously known western species also having terminal and penial glands on the penis. *Pyrgulopsis eremica* sp. nov., from the Great Basin and other interior drainages in northeast California, and *P. greggi* sp. nov., narrowly endemic in the Upper Kern River basin, differ from all other described congeners in lacking penial glands, and are considered to be derived from a group of western species having a small distal lobe and weakly developed terminal gland. *Pyrgulopsis gibba* sp. nov., known from a few sites in extreme northeastern California (Great Basin), has a unique complement of penial ornament consisting of terminal gland, Dg3, and ventral gland. *Pyrgulopsis ventricosa* sp. nov., narrowly endemic in the Clear Lake basin, is related to two previously described California species also having a full complement of glands on the penis (Pg, Tg, Dg1-3) and an enlarged bursa copulatrix.

INTRODUCTION

The author recently reviewed the taxa belonging to *Pyrgulopsis* Call & Pilsbry, 1886, the second largest genus (65 Recent species) of freshwater gastropods in North America (Hershler, 1994). The focus of that paper was on previously described forms, although it was recognized that perhaps an equal number of undescribed species await attention in the western United States. While such novelties abound throughout many of the western states, California, which has only 10-11 currently recognized species (one may now be extinct in the state), may harbor an especially large group, given that this huge state is well-watered and has an extremely complex hydrographic history owing to tectonism and associated climatic factors (Minckley et al., 1986). Published taxonomic studies on hydrobiid snails and other small freshwater gastropods from California are few (Taylor, 1981), and collecting efforts have been largely concentrated in only four regions: Great Basin and Klamath system to the northeast, lower Sacramento system in the San Francisco environs, Death Valley region, and south-coastal and Salton Sea drainage to the southwest. Of these, only the Death Valley region hydrobiids have been thoroughly surveyed and documented

in the literature (Hershler & Sada, 1987; Hershler, 1989; Hershler & Pratt, 1990).

To gain a better understanding of the California *Pyrgulopsis*, the author recently collected material of this genus from various parts of the state. Represented among these collections were seven new species, which are described below. While these species are discussed within the context of the preliminary phylogenetic hypothesis proposed for the genus by Hershler (1994), a revised analysis incorporating these new data is deferred pending description of the many other new species known from the West.

MATERIALS AND METHODS

Institutional acronyms are USNM (National Museum of Natural History, Smithsonian Institution), and WBM (personal collection of Walter B. Miller, now housed [uncatalogued] at Santa Barbara Museum of Natural History). Anatomical study was of alcohol-preserved snails that had been relaxed with menthol crystals and fixed in dilute (about 4%) formalin. Methods of anatomical study, terminology, and characters are those of Hershler (1994). Anatomical illustrations were prepared from camera lu-

Table 1

Shell parameters for new species of *Pyrgulopsis*. μ = mean, s = standard deviation, SH = shell height, SW = shell width, HBW = height of body whorl, WBW = width of body whorl, AH = aperture height, AW = aperture width, W = whorl expansion rate, D = distance of generating curve from coiling axis, T = translation rate, AS = aperture shape. Measurements are in mm.

		WH	SH	SW	HBW	WBW	AH	AW	W	D	T	AS
<i>P. diablensis</i>												
USNM 883791	μ	4.90	3.76	2.36	2.73	2.07	1.70	1.28	1.80	0.54	5.64	1.34
n = 17	s	0.22	0.30	0.22	0.18	0.12	0.11	0.09	0.15	0.07	1.14	0.07
<i>P. eremica</i>												
USNM 858264	μ	4.03	1.90	1.28	1.42	1.15	0.82	0.68	2.28	0.56	5.29	1.20
n = 15	s	0.13	0.16	0.11	0.12	0.09	0.82	0.05	0.32	0.05	0.64	0.06
USNM 858265	μ	4.10	2.17	1.43	1.62	1.28	0.95	0.77	2.12	0.61	5.31	1.24
n = 15	s	0.16	0.18	0.09	0.11	0.07	0.07	0.04	0.26	0.04	0.92	0.06
USNM 858266	μ	4.48	2.66	1.73	1.95	1.54	1.20	0.94	2.12	0.57	5.72	1.27
n = 11	s	0.21	0.22	0.11	0.15	0.11	0.08	0.06	0.27	0.03	0.58	0.04
USNM 858267	μ	4.08	1.89	1.26	1.41	1.13	0.81	0.66	2.29	0.56	5.49	1.23
n = 12	s	0.20	0.12	0.07	0.07	0.05	0.05	0.04	0.42	0.03	0.47	0.06
USNM 858271	μ	4.18	2.67	1.99	2.12	1.70	1.33	1.03	2.43	0.55	4.09	1.30
n = 15	s	0.22	0.17	0.10	0.10	0.08	0.07	0.05	0.42	0.04	0.45	0.04
USNM 873138	μ	4.14	2.45	1.72	1.86	1.47	1.13	0.93	2.28	0.60	4.63	1.21
n = 14	s	0.16	0.15	0.11	0.11	0.08	0.09	0.06	0.23	0.04	0.32	0.05
<i>P. gibba</i>												
USNM 858275	μ	4.25	2.93	1.99	2.26	1.70	1.37	1.13	2.04	0.60	5.10	1.21
n = 10	s	0.20	0.16	0.12	0.13	0.10	0.09	0.08	0.13	0.05	0.70	0.03
USNM 858273	μ	4.33	3.34	2.28	2.54	1.94	1.60	1.30	2.09	0.58	5.02	1.24
n = 10	s	0.17	0.13	0.10	0.11	0.08	0.06	0.07	0.27	0.05	0.38	0.05
<i>P. greggi</i>												
USNM 874139	μ	4.38	2.31	1.47	1.68	1.27	0.99	0.82	2.06	0.60	5.24	1.21
n = 15	s	0.27	0.16	0.09	0.11	0.11	0.07	0.04	0.45	0.03	0.67	0.04
USNM 874140	μ	4.21	1.74	1.21	1.32	1.06	0.77	0.75	2.52	0.61	4.66	1.17
n = 13	s	0.33	0.10	0.07	0.07	0.05	0.77	0.72	0.60	0.06	0.55	0.06
<i>P. longae</i>												
USNM 858262	μ	4.23	2.76	1.79	2.03	1.53	1.24	0.97	2.30	0.57	5.25	1.30
n = 15	s	0.24	0.18	0.15	0.15	0.11	0.10	0.06	0.39	0.05	0.94	0.05
<i>P. taylori</i>												
USNM 883792	μ	4.63	2.28	1.28	1.59	1.11	1.05	0.73	1.71	0.56	6.00	1.44
n = 17	s	0.37	0.19	0.12	0.13	0.08	0.07	0.07	0.14	0.07	1.25	0.08
USNM 883789	μ	4.63	2.80	1.67	2.03	1.41	1.30	0.90	1.85	0.54	5.00	1.46
n = 16	s	0.37	0.24	0.15	0.13	0.10	0.10	0.09	0.18	0.05	0.84	0.10
<i>P. ventricosa</i>												
USNM 883790	μ	4.14	2.37	1.66	1.83	1.45	1.18	0.91	2.31	0.59	5.04	1.29
n = 16	s	0.16	0.12	0.12	0.10	0.09	0.09	0.04	0.38	0.05	0.72	0.08

cida drawings. Methods of shell measurements are those of Hershler (1989); data are presented in Table 1.

SYSTEMATICS

Family HYDROBIIDAE

Subfamily NYMPHOPHILINAE

Pyrgulopsis Call & Pilsbry, 1886

Type Species: *Pyrgula nevadensis* Stearns, 1883; original designation.

Diagnosis: The genus was recently diagnosed by Hershler (1994).

Pyrgulopsis diablensis Hershler, sp. nov.

(Figures 1–3, 5A)

Etymology: Referring to occurrence of this species in the Diablo Range of central California.

Diagnosis: Shell ovate- to narrow-conic, medium-sized, umbilicate. Penial filament medium length; lobe short.

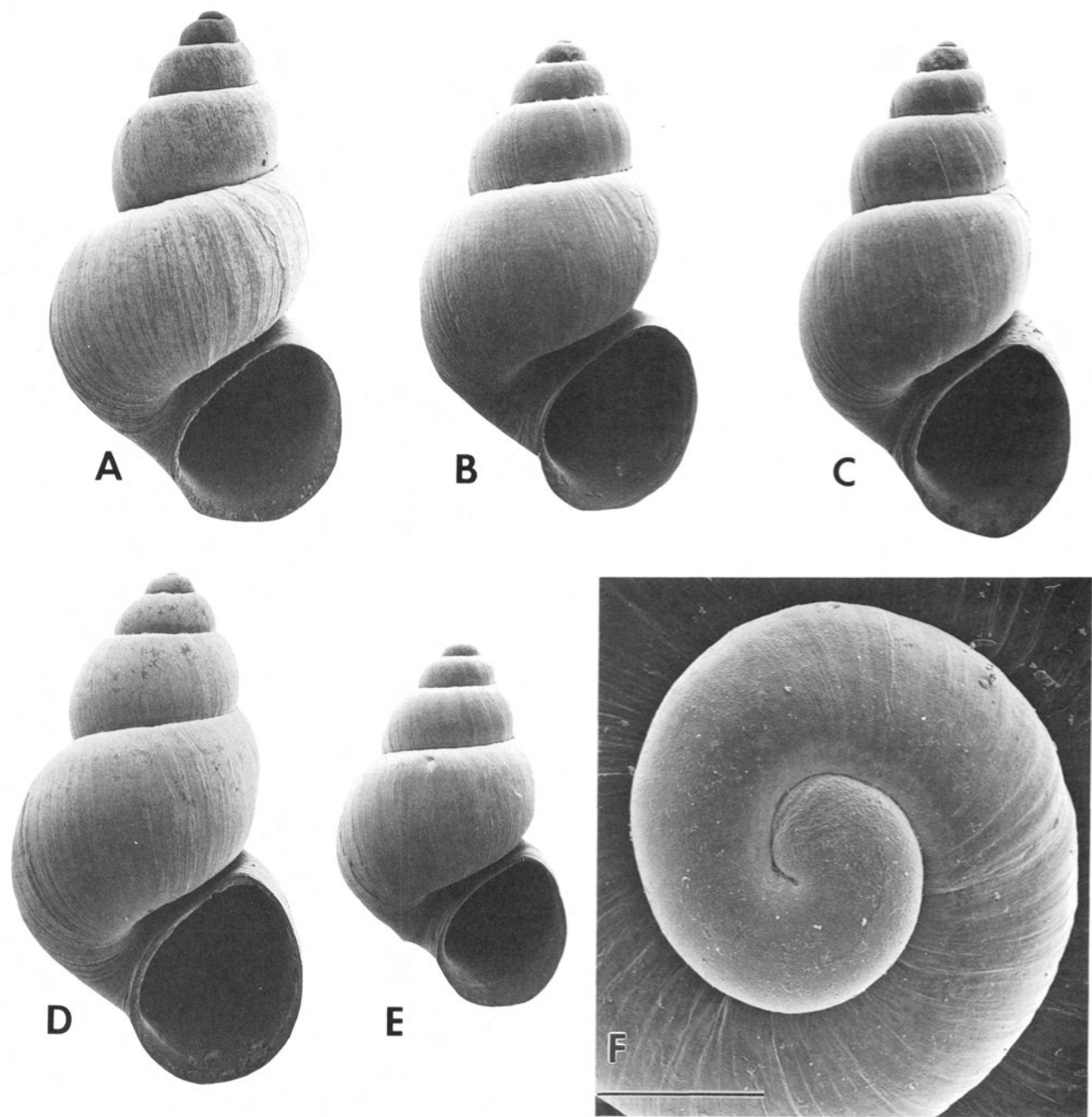


Figure 1

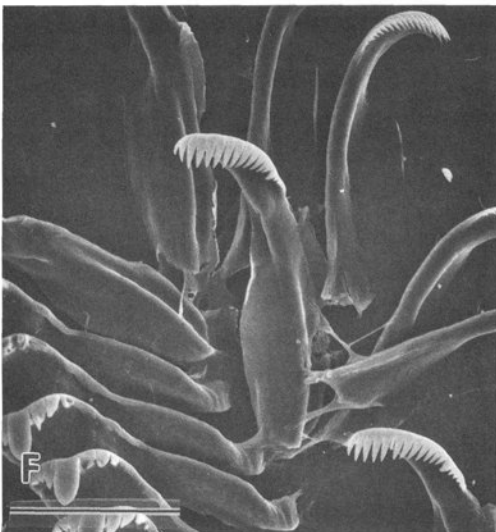
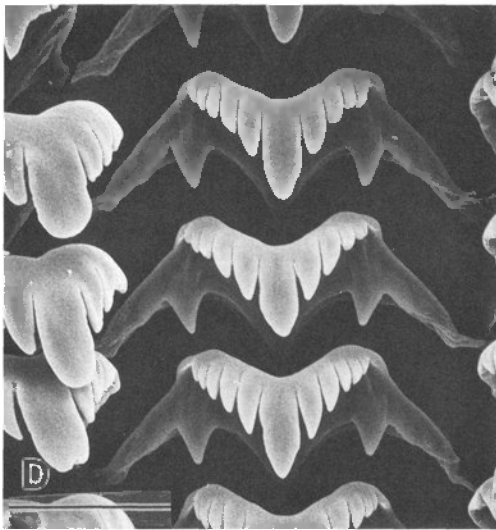
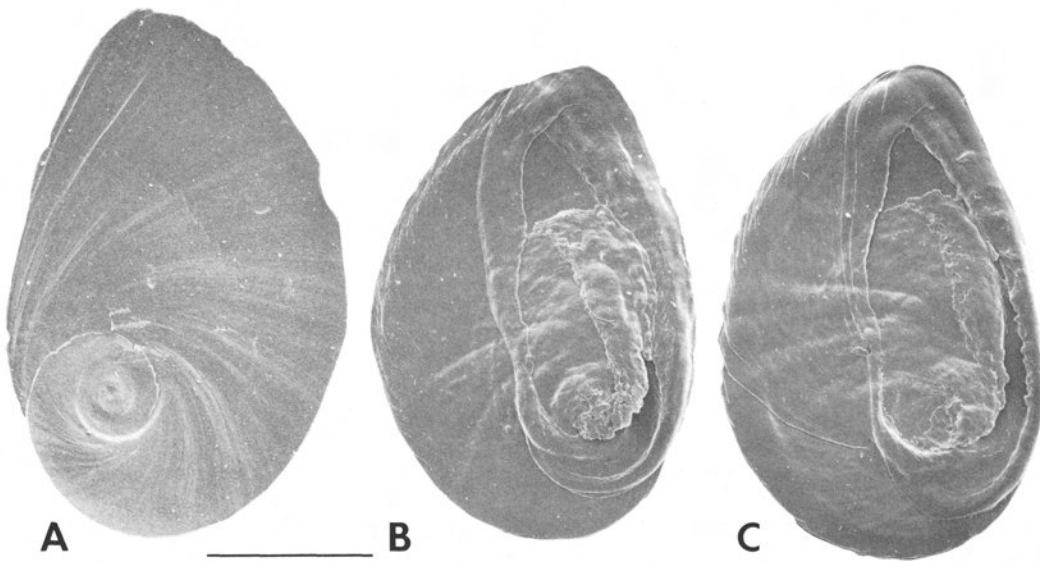
Scanning electron micrographs of shells of *P. diablensis* Hershler, sp. nov., USNM 883791. F. Protoconch, bar = 150 μ m. Shell "A" is 3.8 mm tall; other shells printed to same scale.

Penial ornament a short penial gland and small terminal gland.

Description: Shell (Figures 1, 5A) ovate- to narrow-conic; height 3.1–4.3 mm; whorls 4.25–5.0. Protoconch (Figure 1F) slightly less than 1.5 whorls, early portion strongly wrinkled. Teleoconch whorls convex, sometimes strongly shouldered; sculpture of strong growth lines. Aperture ovate,

usually slightly separated from body whorl. Inner lip complete, thin, without columellar shelf. Outer lip thin, slightly prosocline. Umbilicus rimate to perforate. Periostracum light brown.

Operculum (Figure 2A–C) ovate, amber with brown to red attachment scar region; nucleus eccentric; dorsal surface frilled. Attachment scar thickened, often strongly so, all around. Callus large, well developed.



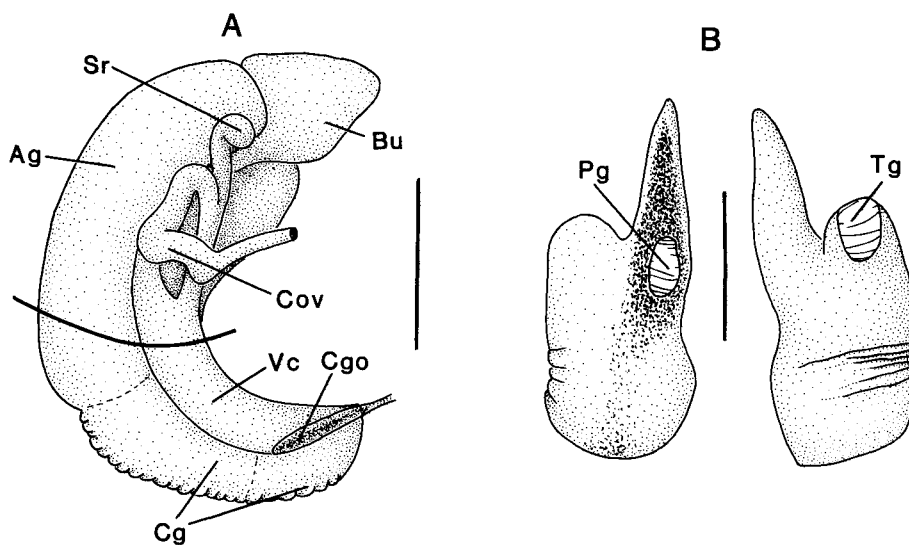


Figure 3

Genital morphology of *P. diablensis* Hershler, sp. nov., USNM 883791. A. Distal female genitalia (left side). Bar = 0.5 mm. B. Penis (dorsal aspect, left; ventral aspect, right). Bar = 0.5 mm. Ag = albumen gland, Bu = bursa copulatrix, Cg = capsule gland, Cgo = capsule gland opening, Cov = coiled oviduct, Pg = penial gland, Sr = seminal receptacle, Tg = terminal gland, Vc = ventral channel.

Buccal mass large; radular sac protruding behind buccal mass as short coil. Radula ribbon elongate, about 0.89×0.11 mm, with about 60 rows of teeth. Central radular tooth (Figure 2D) trapezoidal, with medium to highly indented dorsal edge; lateral cusps 4–5; central cusp slightly pointed, considerably broader and longer than laterals; basal cusps 1, medium-sized, with medium dorsal support. Basal process medium width; basal sockets deep. Lateral margins slightly thickened, with weakly developed neck. Lateral tooth (Figure 2E) formula 3-1-3(4); neck weakly developed; basal tongue well developed; outer wing about 140% of cutting edge length. Marginal teeth (Figure 2F, G) with about 15–19 (inner) and 16–23 (outer) cusps; cusps extending onto outer edge of teeth. Stomach caecum small.

Cephalic tentacles pale, but with light grey internal pigment proximally. Snout, foot grey to black. Opercular lobe black along inner edge, sides; outer edge pale to black. Neck pale to grey. Pallial roof black, somewhat lighter on pallial gonoducts. Visceral coil black.

Ctenidial filaments 25, medium height, width; ctenidium ending slightly anterior to pericardium. Osphradium medium-sized, centered slightly posterior to middle of cten-

idial axis. Kidney with medium pallial bulge; renal gland longitudinal-slightly oblique; kidney opening white. Rectum straight, broadly overlapping genital ducts. Hypobranchial gland medium thickness; overlapping rectum, pallial gonoducts, narrow section of posterior pallial roof adjacent to rectum.

Distal female genitalia shown in Figure 3A. Ovary 1.5 whorls, slightly overlapping posterior stomach chamber. Pallial albumen gland short. Capsule gland considerably shorter than albumen gland. Genital aperture a broad slit, with short vestibule. Coiled oviduct circular-oblique, kinked at mid-point, augmented by proximal twist or small coil. Oviduct and bursal duct join slightly behind pallial wall. Bursa copulatrix broadly ovate-triangular, about one-fourth length of albumen gland, and about two-thirds width of gland, with three-fourths or more of length posterior to gland. Bursa duct narrow-medium width, about 150% of length of bursa copulatrix, shallowly embedded in albumen gland. Seminal receptacle a broad, folded pouch, about 50% of length of bursa copulatrix, usually overlapping proximal bursa duct. Seminal receptacle duct medium length.

Testis 2.0 whorls, overlapping stomach to posterior edge

←

Figure 2

Scanning electron micrographs of opercula and radula of *P. diablensis* Hershler, sp. nov., USNM 883791. A–C. Opercula; bars = 0.43 mm. D. Central radular teeth, bar = 15 μ m. E. Lateral teeth, bar = 20 μ m. F. Inner marginal teeth, bar = 30 μ m. G. Outer marginal teeth, bar = 20 μ m.



of style sac. Prostate gland fat bean-shape; oval in cross section; pallial section short. Pallial vas deferens with strong proximal twist. Penis (Figure 3B) large; base broadly rectangular, edges with several weak folds proximally; filament about two-thirds length of base, medium width, gently tapering, parallel or slightly oblique to long axis of base; lobe hemispherical, short. Terminal gland medium size, circular or elongate-transverse, usually restricted to ventral surface, rarely interrupted (two units). Penial gland short, medium width, restricted to base of filament. Filament darkly pigmented internally; pigment continuing weakly onto distal penis.

Type locality: Unnamed creek, Del Puerto Canyon, Del Puerto Road, 20 km west of HW 5, Stanislaus County, California, T. 6 S, R. 6 E, NE ¼ sec. 8 (Figure 4A). Holotype, USNM 860645; paratypes, USNM 883791, collected by R. Hershler, 4 May 1994. Snails were commonly found in this medium-sized (ca. 2 m wide, 0.5 m deep), poorly shaded stream, which was slightly disturbed from pastoral and recreational activities.

Remarks: The presence of a penial gland (Pg) in this species suggests affinity with a large group of western American species defined, in part, by this synapomorphy, and closely conforming to Taylor's (1987) "californiensis series" (see Hershler, 1994). Of the members of this group, however, only this species plus *P. longae* and *P. taylora* (both described below) lack a ventral gland (or any vestige thereof). *Pyrgulopsis diablensis* is similar to *P. longae* in configuration of the distal female genitalia (i.e., broad coiled oviduct, frequently pyriform or triangular bursa copulatrix), but differs in its more attenuate shell, stronger opercular attachment scar, stouter penis, and larger terminal gland.

This species is thus far known only from the type locality in the Diablo Range, northern San Joaquin Valley (Figure 6).

Pyrgulopsis eremica Hershler, sp. nov.

(Figures 5B, 7–9)

Fluminicola modoci [in part] Hannibal, 1912:187 (Fritter's spring, head of Willow Creek, Honey Lake basin; Troxel's spring, Eagle Lake).

Etymology: From classical Greek *eremos*, meaning solitary or lonely, and referring to occurrence of this species in the fairly remote Smoke Creek Desert and adjacent environs.

Diagnosis: Shell broad- to narrow-conic, small- to medium-sized, umbilicate. Penis a narrow blade; penial filament medium-elongate; lobe absent. Penial ornament absent.

Description: Shell (Figures 5B, 7) broad- to narrow-conic; height 1.7–3.2 mm; whorls 3.75–4.75. Protoconch (Figure 7K) about 1.5 whorls, early portion densely wrinkled and lined with scattered spiral striae. Teleoconch whorls convex, strongly shouldered; sculpture of weak growth lines and faint spiral striae. Aperture ovate, broadly adnate to slightly separated from body whorl. Inner lip complete, thin to slightly thickened, without columellar shelf. Outer lip thin, orthocone to slightly prosocline. Umbilicus narrowly rimate to deeply perforate. Periostracum tan to brown.

Operculum (Figure 8A–C) ovate, amber except for orange nuclear region; nucleus slightly eccentric; dorsal surface frilled. Attachment scar thickened all around, especially along inner edge. Callus sometimes well developed.

Buccal mass medium-sized; radular sac protruding behind buccal mass as short coil. Radula ribbon elongate, about 0.59 × 0.09 mm, with about 65 rows of teeth. Central radular tooth (Figure 8A, B) trapezoidal, with medium to highly indented dorsal edge; lateral cusps 5–6; central cusp spoonlike, slightly broader and considerably longer than laterals; basal cusps 1, medium-sized, with medium dorsal support. Basal process narrow; basal sockets deep. Lateral margins slightly thickened, with pronounced neck. Lateral tooth (Figure 8F–H) formula 3(4)-1-5; neck weakly developed; basal tongue weakly developed; outer wing about 200% of cutting edge length. Marginal teeth (Figure 8F, G, I) with about 21–23 (inner) and 23–28 (outer) cusps; cusps extending onto outer edge of teeth. Stomach caecum small.

Cephalic tentacles medium to black, sometimes pale distally. Snout medium-(more commonly) black. Foot pale to dark along sides, anterior and posterior edges usually dark. Opercular lobe broadly darkened along sides, somewhat lighter along inner edge. Neck pale to dark. Pallial roof, visceral coil black.

Figure 4

Photographs of type localities of new species of *Pyrgulopsis* from California. A. Unnamed creek, Del Puerto Canyon, Stanislaus County (*P. diablensis* Hershler, sp. nov.). B. Unnamed springs tributary to Willow Creek, Lassen County (*P. eremica* Hershler, sp. nov.). C. Unnamed springs west of Fee Reservoir, Modoc County (*P. gibba* Hershler, sp. nov.). D. Grapevine Creek, Kern County (*P. greggi* Hershler, sp. nov.). E. Unnamed spring, ca. 4.8 km west-southwest of Hallelujah Junction, Lassen County (*P. longae* Hershler, sp. nov.). F. Unnamed spring, 7.4 km south of HW 29 along Seigler Canyon Road, Lake County (*P. ventricosa* Hershler, sp. nov.). G. Unnamed spring, 4.8 km north of San Luis Obispo, east of HW 101, San Luis Obispo County (*P. taylora* Hershler, sp. nov.).

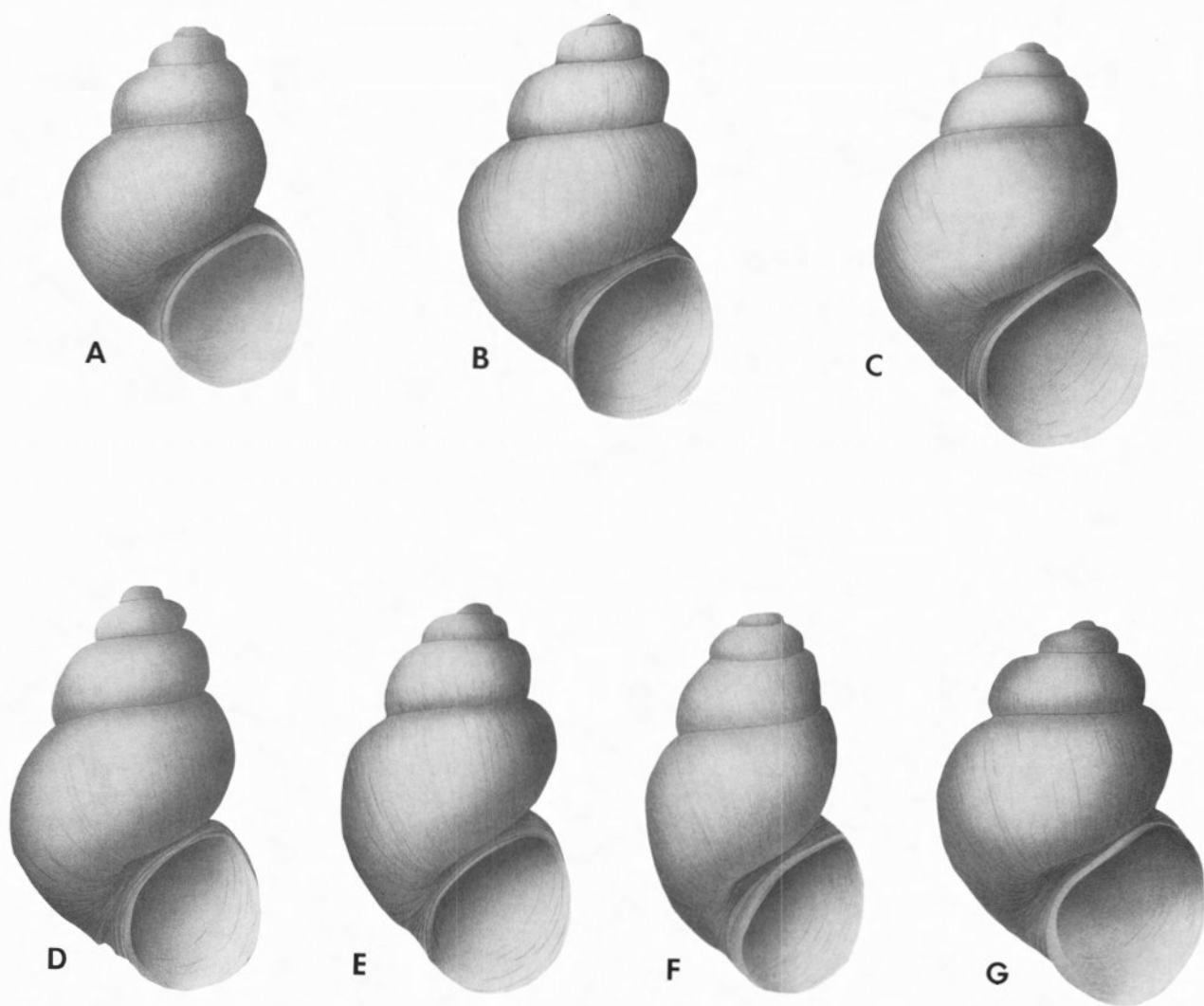


Figure 5

Shells (holotypes) of new *Pyrgulopsis* species. A. *P. diablensis* Hershler, sp. nov., USNM 860645 (3.1 mm tall). B. *P. eremica* Hershler, sp. nov., USNM 860644 (1.9 mm). C. *P. gibba* Hershler, sp. nov., USNM 860643 (3.1 mm). D. *P. greggi* Hershler, sp. nov., USNM 860641 (2.4 mm). E. *P. longae* Hershler, sp. nov., USNM 860642 (3.0 mm). F. *P. taylori* Hershler, sp. nov., USNM 860646 (2.0 mm). G. *P. ventricosa* Hershler, sp. nov., USNM 860647 (2.4 mm).

Ctenidial filaments 14, short, narrow; ctenidium ending slightly anterior to pericardium. Osphradium medium-sized, centered slightly posterior to middle of ctenidial axis. Kidney with medium pallial bulge; renal gland longitudinal; kidney opening opaque. Rectum straight, broadly overlapping genital ducts. Hypobranchial gland thin; overlapping rectum, pallial gonoducts.

Distal female genitalia shown in Figure 9A. Ovary 0.75 whorl, overlapping posterior stomach chamber. Pallial albumen gland medium-sized. Capsule gland slightly shorter than albumen gland. Genital aperture a broad slit with short vestibule. Coiled oviduct of two oblique-circular,

broadly overlapping coils. Distal coil sometimes lightly pigmented. Oviduct and bursal duct join just behind pallial wall. Bursa copulatrix clublike, slightly less than half of length of albumen gland, narrow relative to width of albumen gland, with one-fifth to one-half of length posterior to gland. Bursa duct narrow, about as long as bursa copulatrix, slightly embedded in albumen gland. Seminal receptacle a narrow pouch, slightly less than one-half length of bursa copulatrix, overlapping anterior one-half of bursa copulatrix. Seminal receptacle duct medium length.

Testis 2.0 whorls, overlapping stomach to posterior edge of style sac. Prostate gland bean-shaped; narrow in cross

section; pallial section medium. Pallial vas deferens with proximal twist. Penis (Figure 9B) small, narrow; base rectangular, smooth along inner edge; filament slightly shorter to slightly longer than base, slightly narrower than base, gently tapering, parallel to long axis of base; lobe absent. Penial ornament absent. Virtual entirety of filament and distal base darkly pigmented internally.

Type locality: Unnamed springs tributary to Willow Creek, Willow Creek Valley, Lassen County, California, T. 32 N, R. 11 E, SE ¼ sec. 35 (Figure 4B). Holotype, USNM 860644 (Figure 5B); paratypes, USNM 858264, collected by R. Hershler and D. Sada, 4 August 1990. Snails were commonly found in watercress in this series of small, cool, relatively pristine springs draining to a small meadow alongside Willow Creek.

Remarks: This species and *P. greggi*, described below, differ from all other described members of the genus in lacking penial glands. I interpret this character state as secondarily reduced from a glandular condition, and given that these taxa conform to "typical" *Pyrgulopsis* in all other respects, place them in this genus rather than create a new higher taxon. It is likely that these species are allied to the group of western American forms having a small distal lobe and weakly developed terminal gland (described in Hershler, 1994): both the lobe and gland are extremely reduced and even sometimes absent in some members of this group (i.e., *P. bryantwalkeri* Hershler, *P. stearnsiana* [Pilsbry], and *P. thompsoni* Hershler). *Pyrgulopsis eremica* differs from *P. greggi* in its larger size, stronger basal tongue on lateral radular teeth, smaller ctenidium, larger albumen gland, and occasional pigmentation of coiled oviduct.

Both this species and *P. longae* (described below), which also occurs in the Honey Lake basin, differ from *P. melina* Taylor, 1981 (in Taylor & Smith, 1981), described from Pliocene Honey Lake fossils, by their much smaller size, more convex whorls, and weaker columellar callus.

Pyrgulopsis eremica is distributed among springs and spring brooks within the Great Basin of northeast California, including a portion of the Lahontan system (Honey Lake basin, Smoke Creek Desert) and smaller basins to the north (Eagle Lake basin, Horse Lake basin; Figure

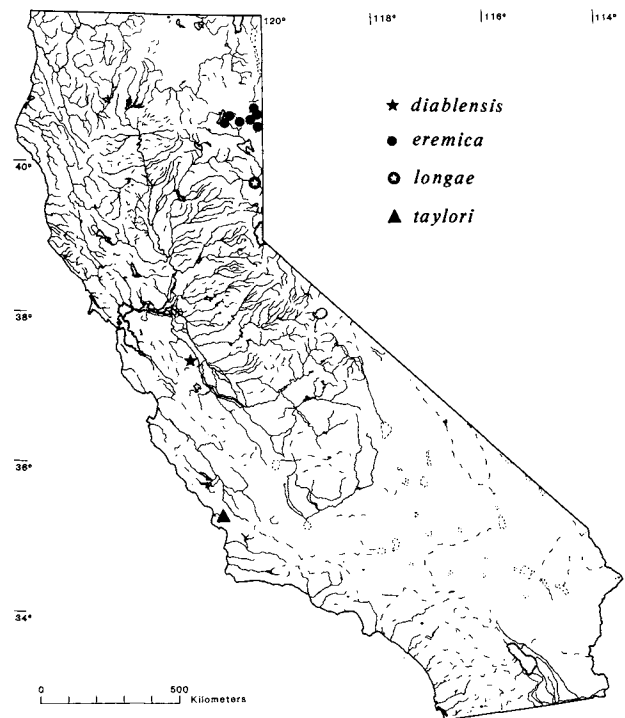


Figure 6

Map showing distributions of *P. diablensis* Hershler, sp. nov., *P. eremica* Hershler, sp. nov., *P. longae* Hershler, sp. nov., and *P. taylori* Hershler, sp. nov. Symbols may refer to more than one locality.

6). This snail probably also occurs in additional drainages within the above areas (Snowstorm Creek, northeast flank of Skedaddle Mountains, drainage west-northwest of Observation Peak, Van Loan Creek) that could not be thoroughly searched because of access problems.

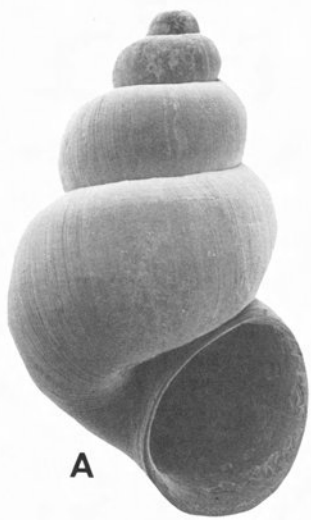
Material examined: CALIFORNIA. LASSEN COUNTY: unnamed springs, Murrers Lower Meadow, Willow Creek Valley, T. 32 N, R. 11 E, SW ¼ sec. 35, USNM 874026; unnamed spring east of Troxel Point, Eagle Lake basin, T. 32 N, R. 12 E, SW ¼ sec. 5, USNM 858265;

Figure 7

Scanning electron micrographs of shells of *P. eremica* Hershler, sp. nov. A-C. USNM 858264. D. USNM 858270. E, F. USNM 858267. G, H. USNM 858265. I, J. USNM 858271. K. Protoconch, USNM 858264, bar = 100 μ m. Shell "A" is 2.7 mm tall; other shells printed to same scale.

Figure 8

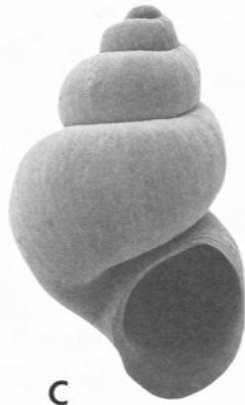
Scanning electron micrographs of opercula and radula of *P. eremica* Hershler, sp. nov., USNM 858264. A-C. Opercula, bars = 250 μ m, 231 μ m, respectively ("B" same scale as "A"). D, E. Central radular teeth, bars = 10 μ m, 13.6 μ m, respectively. F. Lateral, inner marginal teeth, bar = 23.1 μ m. G. Section of radular ribbon, bar = 38 μ m. H. Lateral teeth, bar = 17.6 μ m. I. Outer marginal teeth, bar = 20 μ m.



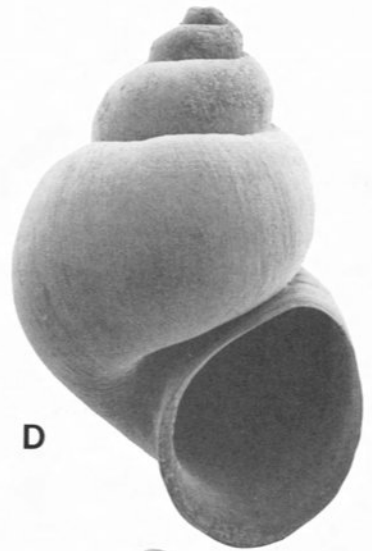
A



B



C



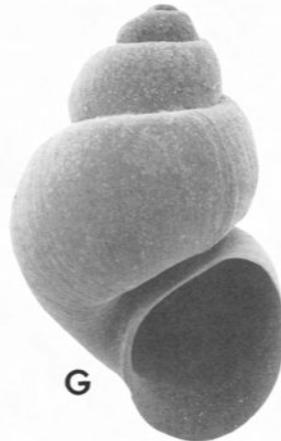
D



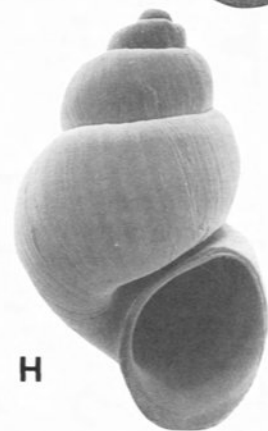
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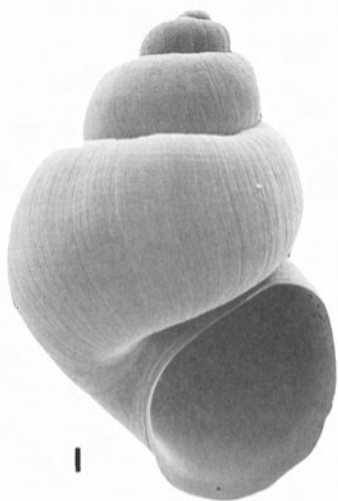
F



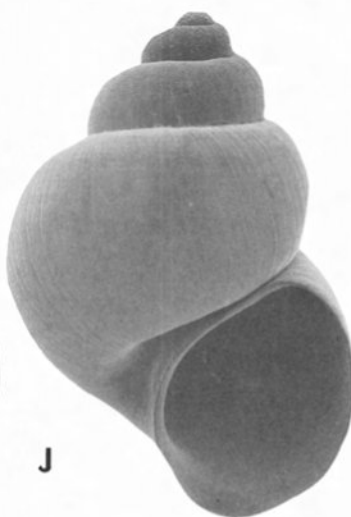
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H



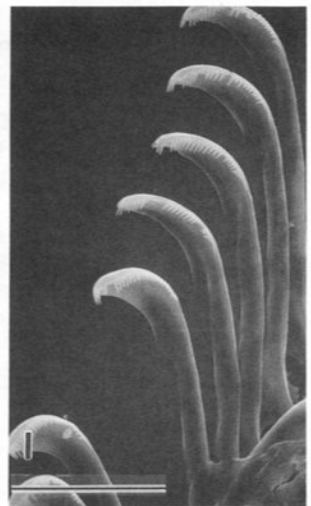
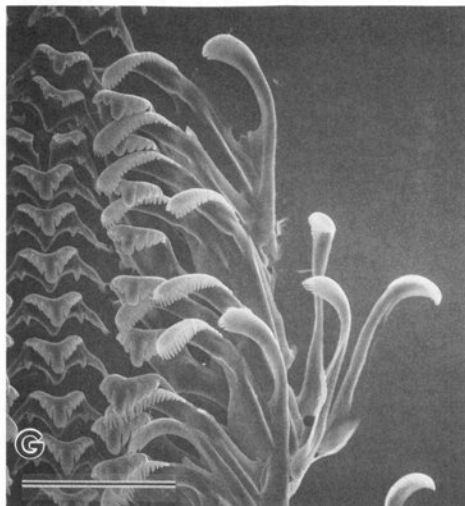
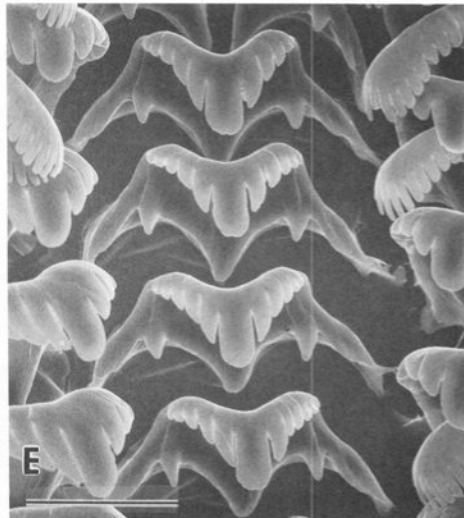
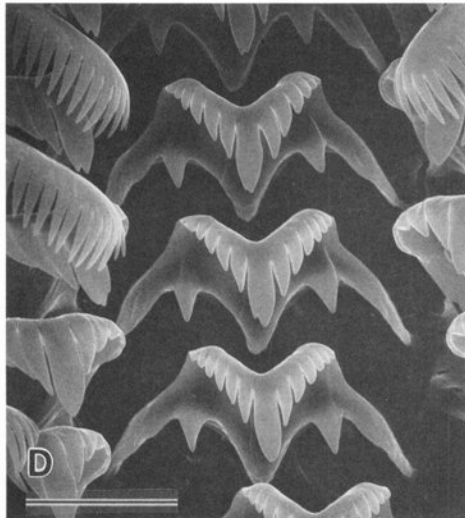
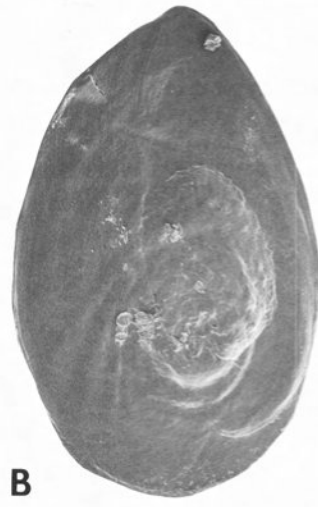
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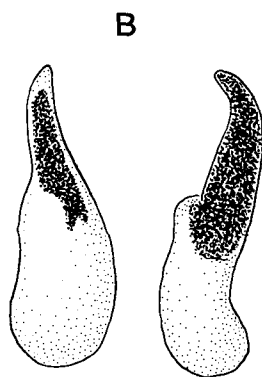
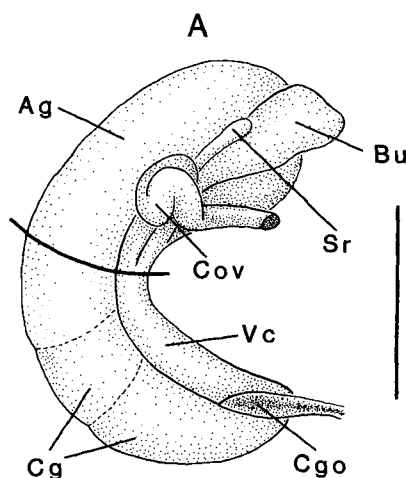


Figure 9

Genital morphology of *P. eremica* Hershler, sp. nov., USNM 858264. A. Distal female genitalia (left side). B. Penes (dorsal aspect). Bar = 0.5 mm. Ag = albumen gland, Bu = bursa copulatrix, Cg = capsule gland, Cgo = capsule gland opening, Cov = coiled oviduct, Sr = seminal receptacle, Vc = ventral channel.

unnamed springs northeast of Horse Lake, Horse Lake basin, T. 33 N, R. 13 E, NE ¼ sec. 14, USNM 873138; Tule Patch Spring, Secret Valley, T. 32 N, R. 15 E, SE ¼ sec. 10, USNM 854569, USNM 858267, USNM 874053; unnamed spring, northern Secret Valley, T. 31 N, R. 15 E, NE ¼ sec. 3, USNM 858272; Sellicks Springs, Secret Valley, T. 31 N, R. 15 E, NW ¼ sec. 7, USNM

873210, USNM 874917; unnamed spring, Karlo Road, Secret Valley, T. 31 N, R. 15 E, NE ¼ sec. 3, USNM 874912; Sage Hen Spring, Smoke Creek Desert, T. 33 N, R. 16 E, NE ¼ sec. 35, USNM 858270; unnamed spring east of Sage Hen Spring, T. 33 N, R. 16 E, SW ¼ sec. 25, USNM 873411; unnamed spring southwest of Sage Hen Spring, T. 33 N, R. 16 E, NE ¼ sec. 35, USNM 858269; Big Spring, Smoke Creek Desert, T. 33 N, R. 16 E, NW ¼ sec. 1, USNM 858271, USNM 873392; unnamed springs, Shinn Ranch, Smoke Creek Desert, T. 33 N, R. 16 E, SW ¼ sec. 36, USNM 858268, USNM 873403; unnamed spring, east of Rush Creek Ranch, Smoke Creek Desert, T. 31 N, R. 17 E, SE ¼ sec. 11, USNM 858266.

Pyrgulopsis gibba Hershler, sp. nov.

(Figures 5C, 10–12)

Etymology: From Latin *gibber*, meaning swollen, and referring to enlarged penial lobe in this species.

Diagnosis: Shell ovate- to narrow-conic, medium-sized, umbilicate. Penial filament short; lobe enlarged. Penial ornament a terminal gland (often interrupted), Dg3 (sometimes absent), and ventral gland.

Description: Shell (Figures 5C, 10) ovate- to narrow-conic; height 2.7–3.5 mm; whorls 4.0–4.75. Protoconch (Figure 10H) about 1.5 whorls, early portion weakly wrinkled and incised with weak spiral grooves. Teleoconch whorls convex, slightly shouldered; sculpture of medium growth lines. Aperture ovate, narrowly adnate to or slightly separated from body whorl. Inner lip complete, thin, without columellar shelf. Outer lip thin, orthocone to slightly prosocline. Umbilicus narrowly rimate (near absent) to perforate. Periostracum tan-brown.

Operculum (Figure 11A–C) ovate, amber except for orange streaks in nuclear region; nucleus slightly eccentric; dorsal surface weakly frilled. Attachment scar margin often broadly thickened all around. Callus well developed.

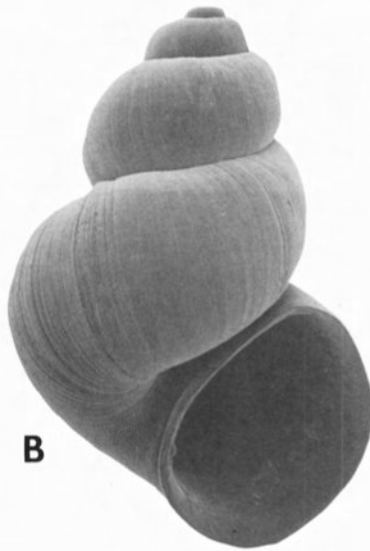
Buccal mass medium-sized; radular sac protruding behind buccal mass as short coil. Radula ribbon elongate, about 0.86 × 0.15 mm, with about 65 rows of teeth. Central radular tooth (Figure 11D) trapezoidal, with highly indented dorsal edge; lateral cusps 5; central cusp spoon-like, slightly broader and considerably longer than laterals; basal cusps 1, short, with weak dorsal support. Basal process medium width; basal sockets deep. Lateral margins thickened, with medium to pronounced neck. Lateral tooth

Figure 10

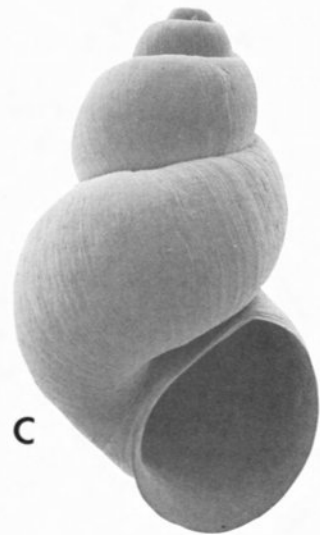
Scanning electron micrographs of shells of *P. gibba* Hershler, sp. nov. A–E. USNM 858275. F. USNM 858274. G. USNM 858273. H. Protoconch, USNM 858275, bar = 136 μm. Shell "A" is 2.7 mm; other shells printed to same scale.



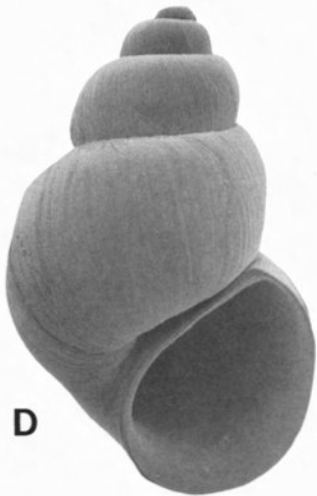
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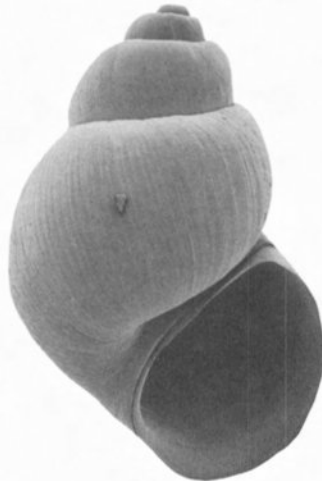
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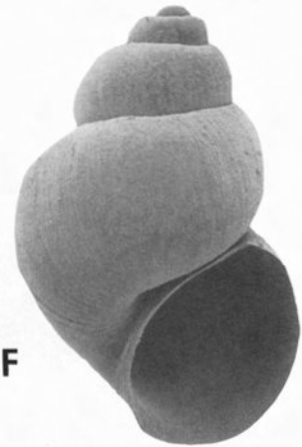
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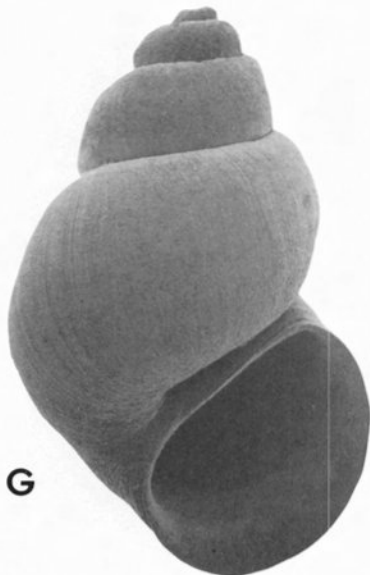
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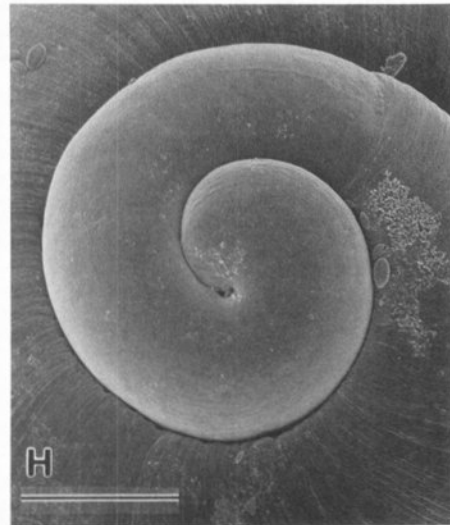
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H



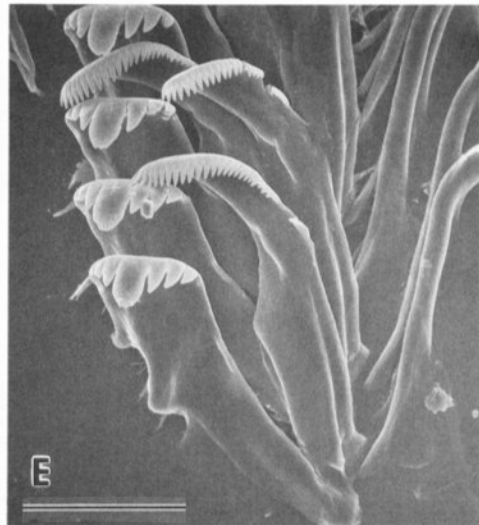
A

B

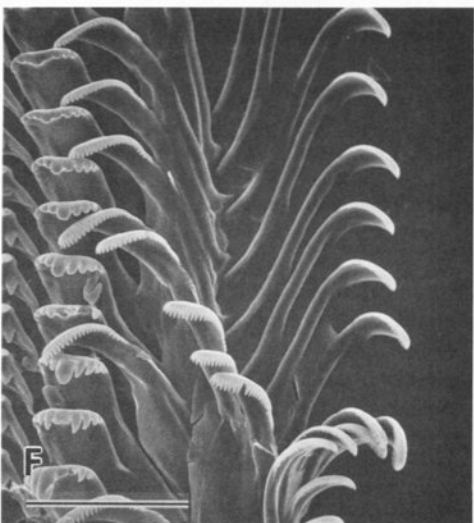
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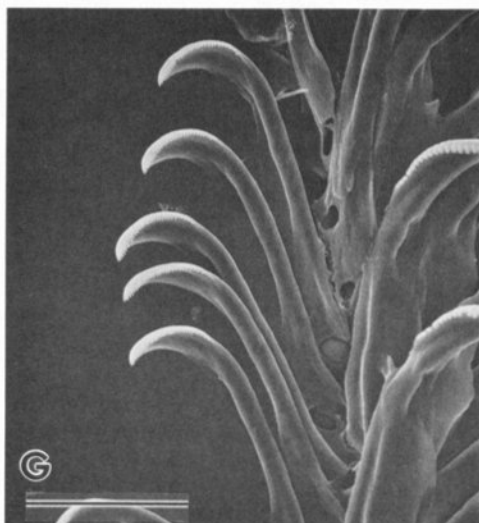
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E



F



G

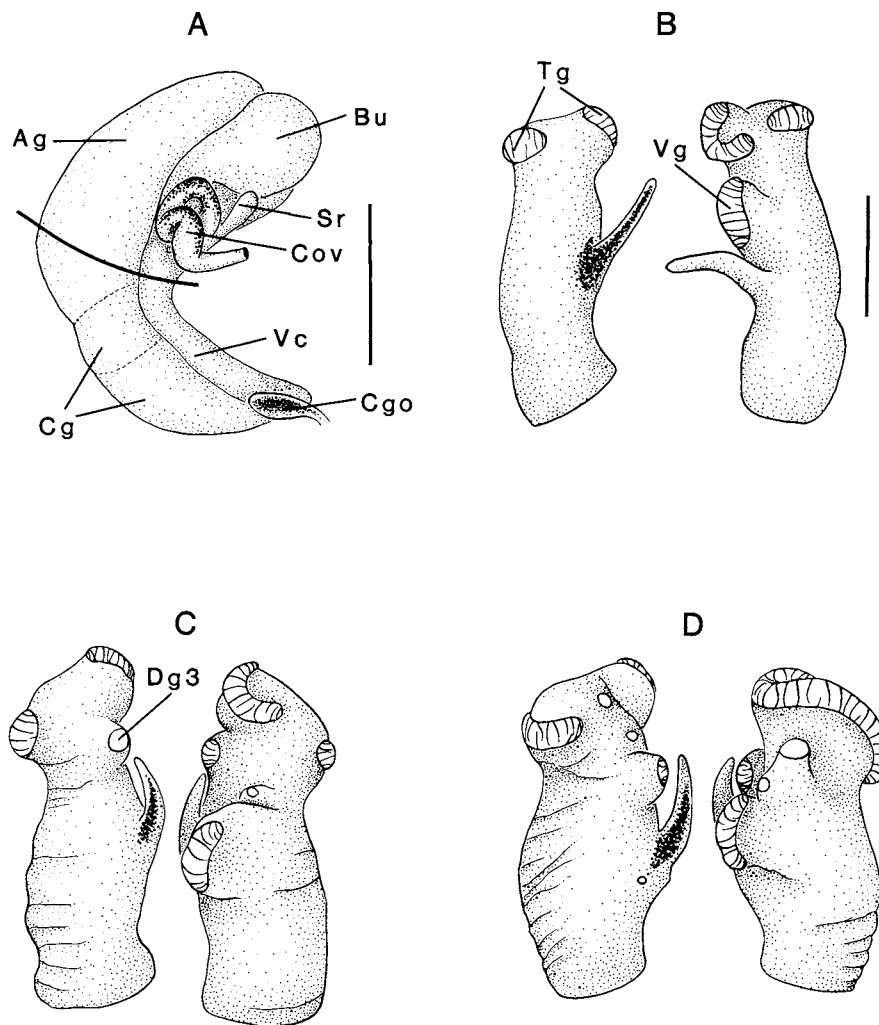


Figure 12

Genital morphology of *P. gibba* Hershler, sp. nov. A. Distal female genitalia (left side), USNM 858275, bar = 0.5 mm. B. Penis (dorsal aspect, left; ventral aspect, right), USNM 858275, bar = 0.5 mm. C. Ibid., USNM 858273. D. Ibid., USNM 858274. Ag = albumen gland, Bu = bursa copulatrix, Cg = capsule gland, Cgo = capsule gland opening, Cov = coiled oviduct, Dg3 = dorsal gland, Sr = seminal receptacle, Tg = terminal gland, Vc = ventral channel, Vg = ventral gland.

(Figure 11E, F) formula 3-1-1; neck weakly developed; basal tongue well developed; outer wing about 170% of cutting edge length. Marginal teeth (Figure 11E-G) with about 23-36 (inner) and 28 (outer) cusps; cusps extending onto outer edge of teeth. Stomach caecum small.

Cephalic tentacles near pale to dark brown to black.

Snout medium to dark; distal lips sometimes pale. Foot pale to light along sides; anterior/posterior edges sometimes medium to dark. Opercular lobe dark along perimeter. Neck near pale to dark. Pallial roof, visceral coil black.

Ctenidial filaments 18-20, broad and tall; ctenidium

Figure 11

Scanning electron micrographs of opercula and radula of *P. gibba* Hershler, sp. nov., USNM 858275. A-C. Opercula, bars = 0.33 mm, 0.38 mm, respectively ("C" same scale as "B"). D. Central radular teeth, bar = 17.6 μ m. E. Lateral, inner marginal teeth, bar = 25 μ m. F. Lateral, marginal teeth, bar = 38 μ m. G. Outer marginal teeth, bar = 27 μ m.

slightly overlapping pericardium posteriorly. Osphradium small, centered slightly posterior to middle of ctenidial axis. Kidney with medium pallial bulge; renal gland longitudinal; kidney opening white. Rectum straight, broadly overlapping genital ducts. Hypobranchial gland thin; overlapping rectum, pallial gonoducts, narrow portion of posterior pallial roof.

Distal female genitalia shown in Figure 12A. Ovary 0.5–0.75 whorl, overlapping posterior stomach chamber. Pallial albumen gland short. Capsule gland slightly shorter than albumen gland. Genital aperture a broad slit on slightly raised papilla, with short vestibule. Coiled oviduct lightly pigmented, of two short, oblique-circular, slightly overlapping coils. Oviduct and bursal duct join just behind pallial wall. Bursa copulatrix broadly ovate or saclike, slightly less than one-half of length of albumen gland, and slightly more than half of width of gland, with about 10–30% of length posterior to gland. Bursa duct narrow, about one-half of length of bursa copulatrix, well embedded in albumen gland. Seminal receptacle sometimes a slender pouch, sometimes lightly pigmented, about 20% of length of bursa copulatrix, overlapping or lateral to anterior portion of bursa copulatrix. Seminal receptacle duct medium length.

Testis 1.5 whorls, overlapping posterior stomach chamber. Prostate gland bean-shaped; near-circular in cross section; pallial section short. Pallial vas deferens with proximal twist. Penis (Figure 12B–D) large; base folded along inner edge; filament considerably shorter than base, narrow, tapering, parallel or slightly angled relative to long axis of base; lobe broadly rectangular, about as long as base, often bifurcate or swollen distally. Terminal gland elongate-transverse, usually curving onto both dorsal and ventral surfaces (most of length on latter), often interrupted, with units restricted to inner and outer portions of lobe, sometimes with a third, intermediate (ventral) unit or sometimes fused as single, elongate unit. Dg3 often present, either as small papule (sometimes double) or large, raised unit. Dorsal surface rarely with a very small proximal gland possibly representing reduced Dg1. Ventral gland large, elongate, borne on pronounced swelling, often accompanied by one to two smaller distal glands. Proximal two-thirds of filament darkly pigmented internally.

Type locality: Unnamed springs west of Fee Reservoir, Surprise Valley, Modoc County, California, T. 46 N, R. 17 E, NE ¼ sec. 20 (Figure 4C). Holotype, USNM 860643 (Figure 5C); paratypes, USNM 858275, collected by R. Hershler and D. Sada, 9 August 1990. Snails were commonly found in mud and scattered watercress in a series of degraded springs draining to a small meadow.

Remarks: This species is unique among members of the genus in having penial ornament of terminal gland, Dg3, and ventral gland. Affinities of the snail may lie with the group of western American species conforming in part to *Natricola* Gregg & Taylor, 1965, but it differs in lacking

Dg1 (although a very weak papule, perhaps conforming to this gland, rarely is present).

This snail occurs in the Great Basin of northeastern California (northern Surprise Valley, Duck Lake Valley; Figure 13).

Material examined: CALIFORNIA. LASSEN COUNTY: Unnamed spring, Old Marr Ranch, Tulead Canyon, Duck Flat, T. 37 N, R. 17 E, NE ¼ sec. 31, USNM 858273. MODOC COUNTY: Unnamed spring, northwest side of Lake Annie, northwest of Lake Annie Road, Surprise Valley, T. 47 N, R. 16 E, SW ¼ sec. 26, USNM 858274.

Pyrgulopsis greggi Hershler, sp. nov.

(Figures 5D, 14–16)

Ammicola.—Cooper, 1869:217 (In and about Ft. Tejon).

Etymology: This species is named in honor of the late Wendell O. Gregg, in recognition of his extensive research on the genus *Pyrgulopsis* in California and for his recognizing the distinctiveness of this snail when he collected it in 1964.

Diagnosis: Shell conical, small, umbilicate. Penis simple, blade-like; filament medium length, lobe absent. Penial ornament absent.

Description: Shell (Figures 5D, 14) conical; height, 1.6–2.6 mm; whorls 3.75–5.0. Protoconch (Figure 14F) about 1.5 whorls, early portion punctate and with several widely separated spiral lines. Teleoconch whorls convex, shouldered; sculpture of medium growth lines. Aperture ovate, narrowly adnate to (more commonly) slightly separated from body whorl. Inner lip complete, thin, without columellar shelf. Outer lip thin, orthocone. Umbilicus small, chinklike to broadly rimate.

Operculum (Figure 15A–C) broadly ovate, amber except for orange nuclear region; nucleus slightly eccentric; dorsal surface frilled. Attachment scar margin often broadly thickened all around. Callus well developed.

Buccal mass medium-sized; radular sac protruding behind buccal mass as short coil. Radula ribbon elongate, about 0.5 × 0.08 mm, with about 52 rows of teeth. Central radular tooth (Figure 15D) trapezoidal, with highly indented dorsal edge; lateral cusps 5–7; central cusp pointed, considerably broader and slightly longer than laterals; basal cusps 1, medium length, with weak dorsal support. Basal process narrow; basal sockets deep. Lateral margins thickened, with pronounced neck. Lateral tooth (Figure 15E, F) formula 4-1-4(5); neck weakly developed; basal tongue well developed; outer wing about 180% of cutting edge length. Marginal teeth (Figure 15E–G) each with about 22–26 cusps; cusps extending onto outer edge of teeth. Stomach caecum small.

Cephalic tentacles pale to medium grey to black (on proximal half). Snout medium to black. Foot pale, medium

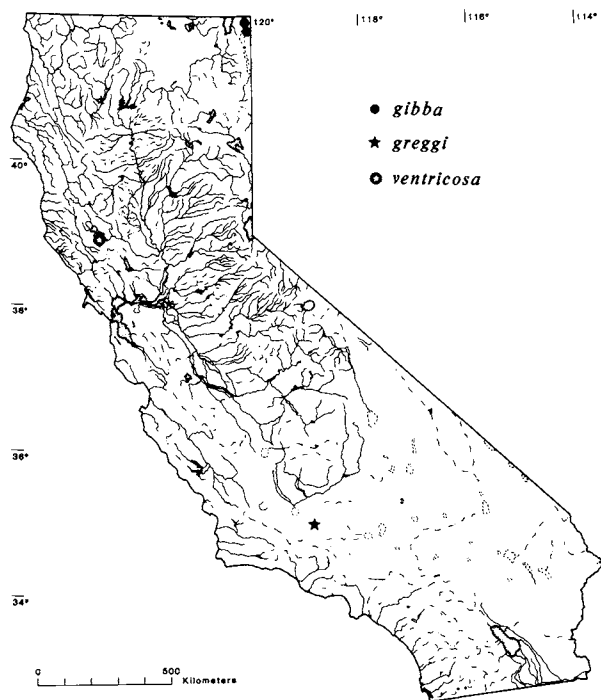


Figure 13

Map showing distributions of *P. gibba* Hershler, sp. nov., *P. greggi* Hershler, sp. nov., and *P. ventricosa* Hershler, sp. nov. Symbols may refer to more than one locality.

grey or black along sides, with pigment especially heavy on anterior and posterior edges. Opercular lobe dark along margins. Neck pale to medium. Pallial roof, visceral coil mottled to uniformly black dorsally; pigment lighter on genital ducts.

Ctenidial filaments 18, medium height and width; ctenidium slightly overlapping pericardium posteriorly. Osphradium medium-sized, centered slightly posterior to middle of ctenidial axis. Kidney with medium pallial bulge; renal gland longitudinal; kidney opening white. Rectum straight, broadly overlapping genital ducts. Hypobranchial gland thin; overlapping rectum, pallial gonoducts.

Distal female genitalia shown in Figure 16A. Ovary 1.0 whorl, partly overlapping posterior stomach chamber. Pallial albumen gland very short. Capsule gland slightly shorter than albumen gland. Genital aperture a broad slit with short anterior vestibule. Coiled oviduct of two small, overlapping, circular-oblique loops. Oviduct and bursal duct join just behind pallial wall. Bursa copulatrix ovate to clublike, medium length (33%) and width, with 20–25% of length posterior to albumen gland. Bursal duct medium width, about 150% of length of bursa copulatrix, partly embedded in albumen gland. Seminal receptacle pouchlike, sometimes folded, about 40% of length of bursa copulatrix,

anterior to or slightly overlapping bursa copulatrix. Seminal receptacle duct medium length.

Testis 2.0 whorls, overlapping entire stomach and extending to near edge of prostate gland. Prostate gland bean-shaped, narrow in cross section; pallial section medium. Pallial vas deferens with weak proximal bend. Penis (Figure 16B, C) small; base broadly to narrowly rectangular; filament about two-thirds of length of base, distally tapering, oriented parallel to long axis of base; lobe absent. Filament considerably narrower to sub-equal to base. Inner curvature of base lined with shallow folds. Proximal two-thirds of filament darkly pigmented internally.

Type locality: Grapevine Creek, Fort Tejon State Historical Park, Castac Valley, Kern County, California, T. 9 N, R. 19 W, NE ¼ section 16 (Figure 4D). Holotype, USNM 860641 (Figure 5D); paratypes, USNM 874139, collected by R. Hershler, 10 April 1991. Snails were commonly found in mud and watercress in this medium-sized, moderately impacted stream (ca. 1–2 m wide, 0.25 m deep).

Remarks: This species is restricted to Grapevine Creek drainage in the Upper Kern River basin (Figure 13).

Material examined: Topotypes, USNM 873418, WBM 4629, WBM 4689; Unnamed spring about 0.8 km north of above, T. 9 N, R. 19 W, NE ¼ sec. 9, USNM 873402, USNM 874140.

Pyrgulopsis longae Hershler, sp. nov.

(Figures 5E, 17–19)

Etymology: The species name refers to distribution of the snail within Long Valley.

Diagnosis: Shell ovate- to narrow-conic, medium-sized, umbilicate. Penial filament short, lobe medium-sized. Penial ornament a short penial gland and small terminal gland.

Description: Shell (Figures 5E, 17) ovate- to narrow-conic; height 2.2–3.0 mm; whorls 4.0–4.75. Protoconch (Figure 17F) 1.5 whorls, near smooth. Teleoconch whorls convex, slightly shouldered; sculpture of weak growth lines. Aperture ovate, usually slightly separated from body whorl. Inner lip complete, thin, without columellar shelf. Outer lip thin, orthocone. Umbilicus small, chinklike to broadly rimate. Periostracum dark tan.

Operculum (Figure 18A–C) narrowly ovate, amber except for reddish nuclear region; nucleus highly eccentric; dorsal surface weakly frilled. Attachment scar margin often well thickened all around. Callus well developed.

Buccal mass medium-sized; radular sac protruding behind buccal mass as short coil. Radular ribbon elongate, about 0.65 × 0.10 mm, with about 70 rows of teeth. Central radular tooth (Figure 18D, E) trapezoidal, with highly indented dorsal edge; lateral cusps 5; central cusp rounded, considerably broader and slightly longer than laterals; basal cusps 1, elongate, with moderate dorsal sup-

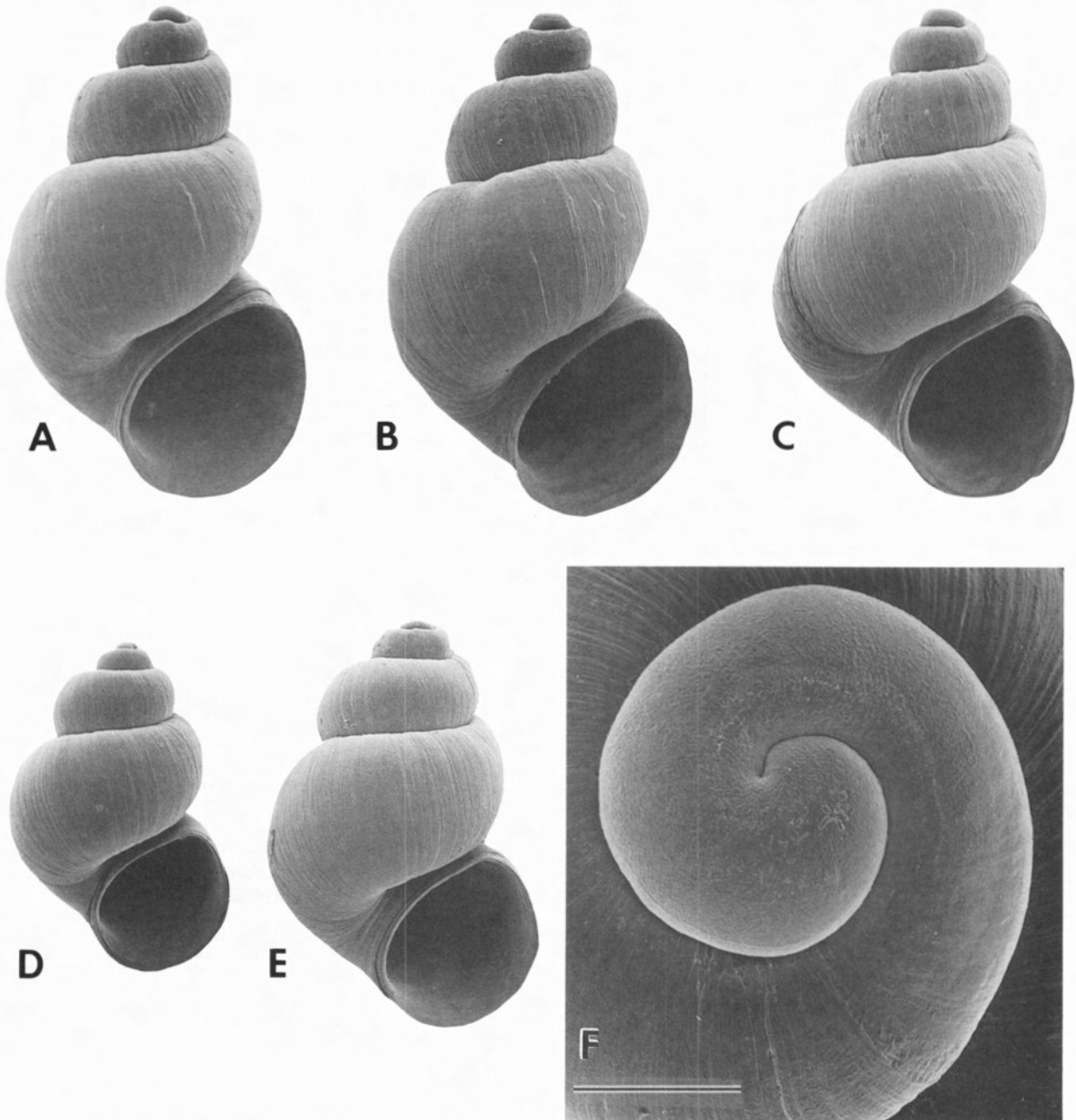
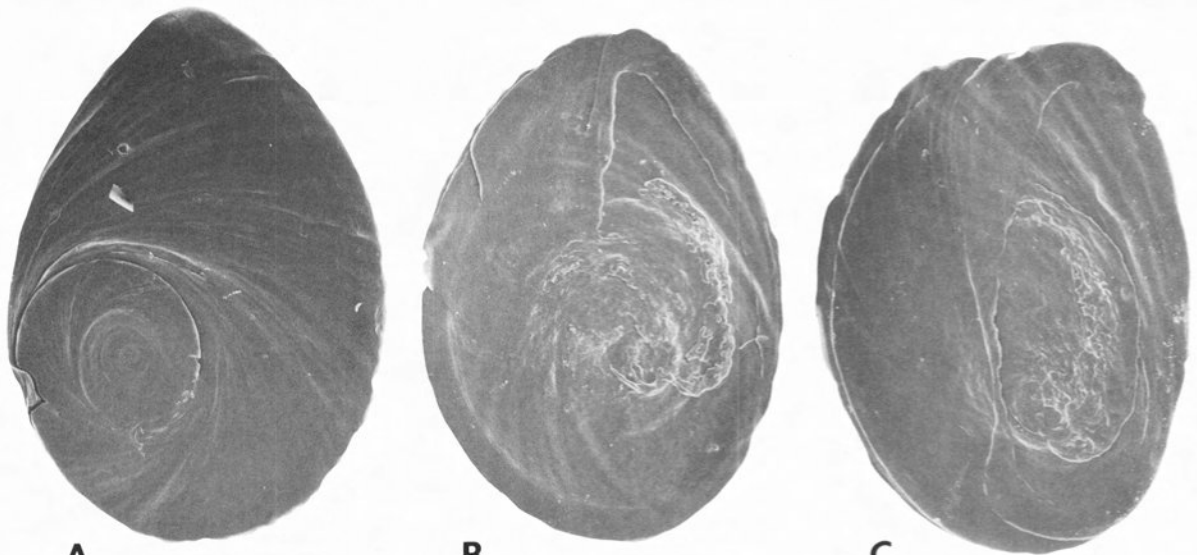


Figure 14

Scanning electron micrographs of shells of *P. greggi* Hershler, sp. nov. A-C. USNM 874139. D, E. USNM 874140. F. Protoconch, USNM 874139, bar = 120 μm . Shell "A" is 2.3 mm tall; other shells printed to same scale.

Figure 15

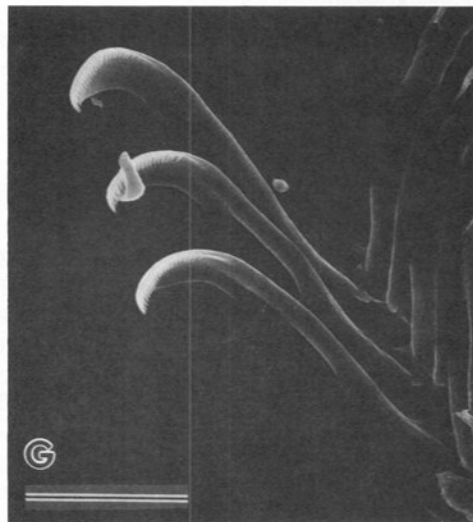
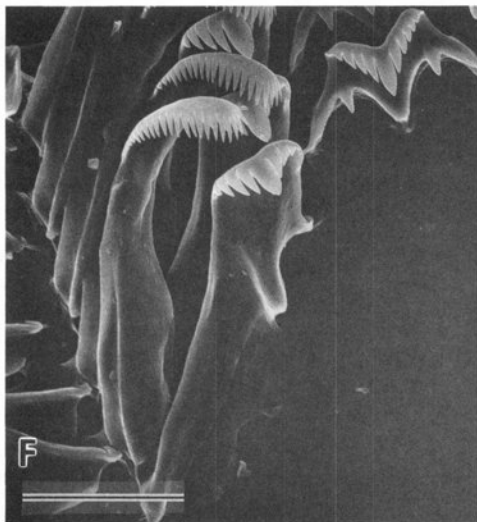
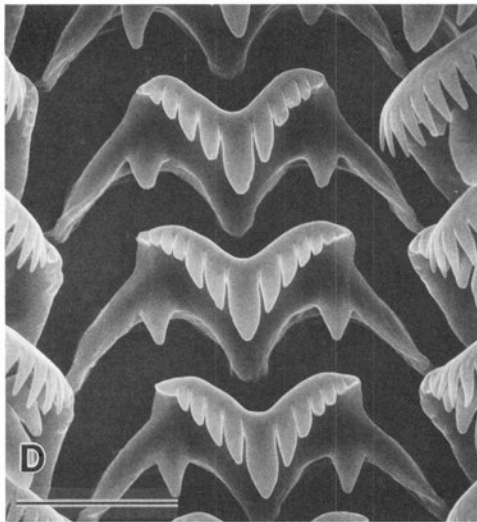
Scanning electron micrographs of opercula and radula of *P. greggi* Hershler, sp. nov., USNM 873418. A-C. Opercula, bars = 250 μm , 270 μm , respectively ("C" same scale as "B"). D. Central radular teeth, bar = 10 μm . E, F. Lateral, inner marginal teeth, bars = 17.6 μm . G. Outer marginal teeth, bar = 17.6 μm .



A _____

B _____

C



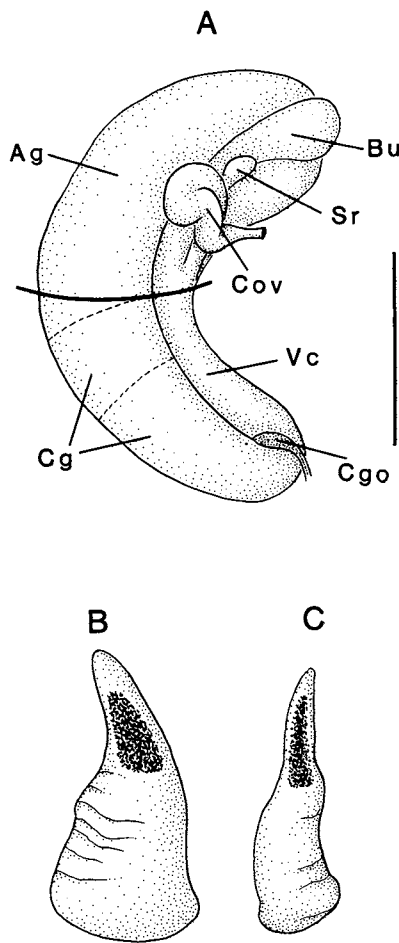


Figure 16

Genital morphology of *P. greggi* Hershler, sp. nov. A. Distal female genitalia (left side), USNM 874139. B, C. Penes (dorsal aspect), USNM 874139 (left), USNM 874140 (right). Bar = 0.5 mm. Ag = albumen gland, Bu = bursa copulatrix, Cg = capsule gland, Cgo = capsule gland opening, Cov = coiled oviduct, Sr = seminal receptacle, Vc = ventral channel.

port. Basal process narrow; basal sockets deep. Lateral margins thickened, with pronounced neck. Lateral tooth (Figure 18E) formula 4-1-4; neck well developed; basal tongue well developed; outer wing about 150% of cutting edge length. Marginal teeth (Figure 18E-G) with about 24 (inner) and 28 (outer) cusps; cusps extending onto outer edge of teeth. Stomach caecum small.

Cephalic tentacles with medium grey to black pigment proximally. Snout light to medium grey. Foot light along sides; anterior edge light to medium. Opercular lobe usually black along margins. Neck pale to light grey. Pallial roof, visceral coil uniformly black.

Ctenidial filaments 22, medium height and width; ctenidium slightly overlapping pericardium. Osphradium

medium-sized, centered slightly posterior to middle of ctenidial axis. Kidney with medium pallial bulge; renal gland longitudinal; kidney opening white. Rectum straight, broadly overlapping genital duct. Hypobranchial gland medium thickness; overlapping rectum, pallial gonoducts, roof of pallial cavity alongside rectum.

Distal female genitalia shown in Figure 19A. Ovary 0.75-1.0 whorl, overlapping posterior stomach chamber. Pallial albumen gland short. Capsule gland shorter than albumen gland. Genital aperture a broad slit without vestibule. Coiled oviduct a small proximal kink or twist followed by elongate horizontal coil. Oviduct and bursal duct join just behind pallial wall. Bursa copulatrix ovoid-pyriform, medium length and width, with about one-half of length posterior to albumen gland. Bursal duct narrow (broadening distally), about two-thirds of length of bursa copulatrix, partly embedded in albumen gland. Seminal receptacle globular-pyriform, sometimes folded, about one-half of length of bursa copulatrix, overlapping anterior half of bursa copulatrix. Seminal receptacle duct short.

Testis 1.25 whorls, overlapping posterior stomach chamber. Prostate gland bean-shaped, narrow in cross section; pallial section very short to absent. Pallial vas deferens without proximal twist. Penis (Figure 19B) large; base broadly rectangular; filament short, tapering distally; lobe medium-sized, tapering distally. Penial gland a short strip on base of filament. Terminal gland small, transverse-circular, usually borne on ventral surface. Proximal half of penial filament with dark internal pigment; distal half of penis base with scattered black granules.

Type locality: Unnamed spring about 4.8 km west-southwest of Hallelujah Junction, Long Valley, Lassen County, California, T. 22 N, R. 17 E, SW $\frac{1}{4}$ sec. 9 (Figure 4E). Holotype, USNM 860642 (Figure 5E); paratypes, USNM 858262, collected by R. Hershler and D. Sada, 3 August 1990. Snails were commonly found on stones and in watercrecess of this large spring, which was situated adjacent to a residence and had been recently excavated.

Remarks: This species is known only from the type locality in the southern end of the Honey Lake basin (Figure 6).

Pyrgulopsis taylori Hershler, sp. nov.

(Figures 5F, 20-22)

Etymology: This species is named in honor of Dwight W. Taylor, in recognition of his many years of fieldwork and associated research on hydrobiids both in California and throughout the western United States.

Diagnosis: Shell ovate- to narrow-conic or pupiform, small, umbilicate. Penial filament elongate; lobe short. Penial ornament a terminal gland and occasionally a small penial gland.

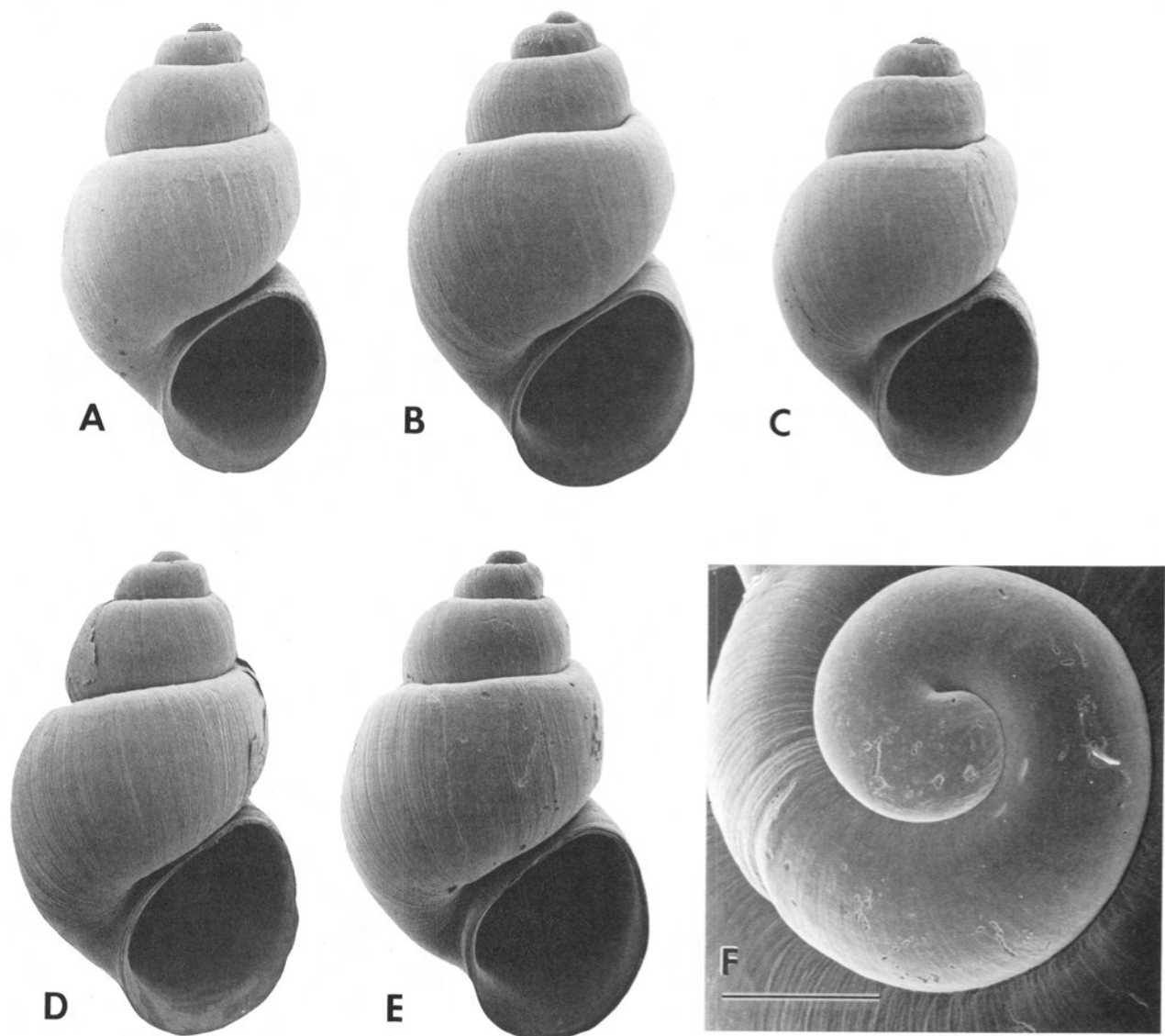


Figure 17

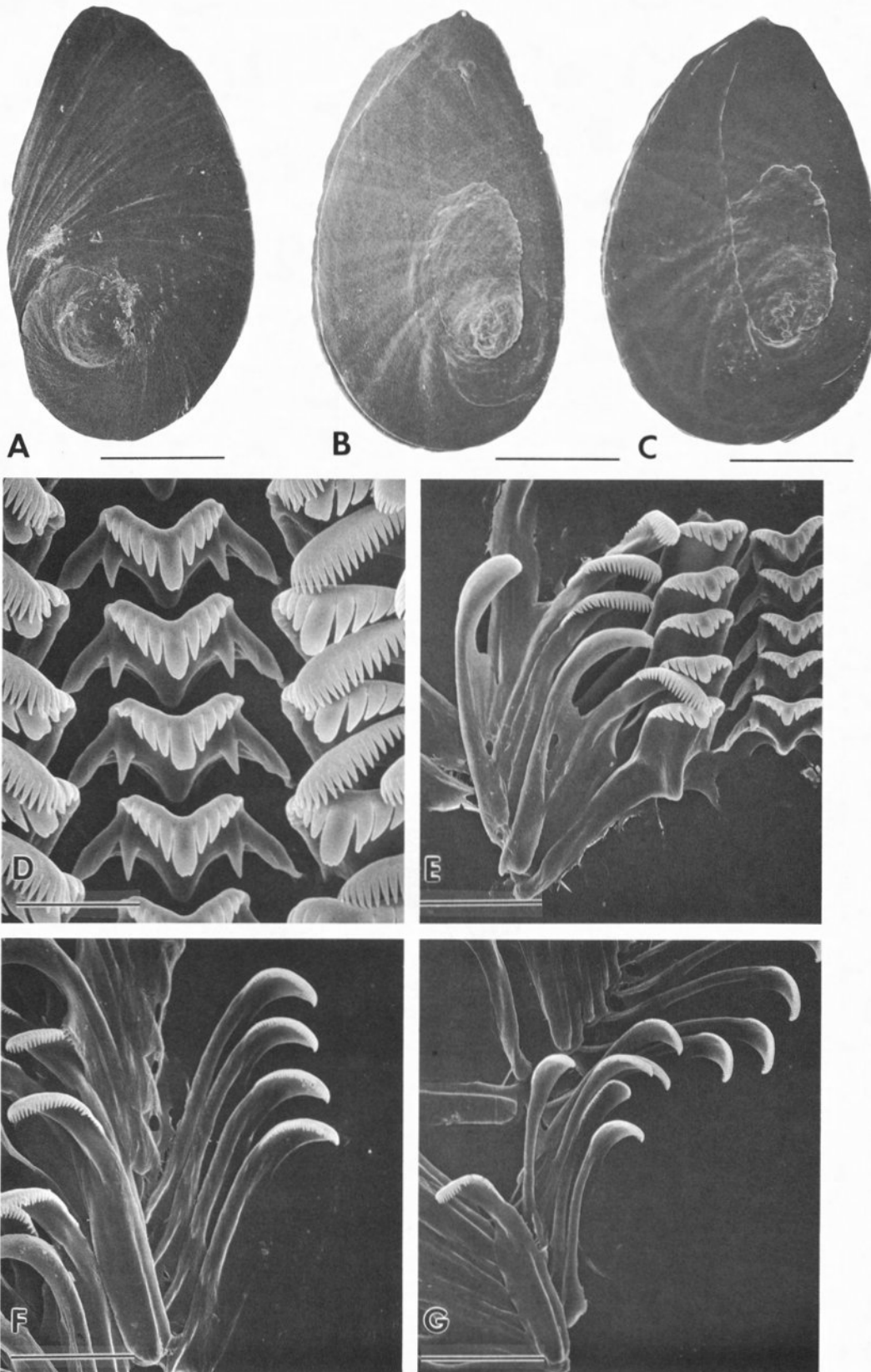
Scanning electron micrographs of shells of *P. longae* Hershler, sp. nov., USNM 858262. F. Protoconch, bar = 136 μ m. Shell "A" is 2.5 mm tall; other shells printed to same scale.

Description: Shell (Figures 5F, 20) ovate- to narrow-conic or pupiform; height 2.0–3.3 mm; whorls 4.0–5.25. Protoconch (Figure 20I) about 1.5 whorls, early portion wrinkled, with a few weak spiral striae. Teleoconch whorls near flat to medium convexity, narrowly shouldered; sculpture of strong growth lines crossed by very weak spiral striae. Aperture ovate-pyriform, often enlarged, broadly adnate to slightly separated from body whorl. Inner lip complete, thin or slightly thickened, columellar shelf often pronounced. Outer lip thin or slightly thickened, ortho-

cline. Umbilicus small, chinklike or perforate. Periostracum tan.

Operculum (Figure 21A–C) narrowly ovate, very thin, light amber; nucleus highly eccentric; dorsal surface weakly frilled. Attachment scar usually only weakly thickened along inner edge. Callus weakly developed.

Buccal mass medium-sized; radular sac protruding behind buccal mass as short coil. Radula ribbon moderately elongate, about 0.9×0.09 mm, with about 60 rows of teeth. Central radular tooth (Figure 21D) trapezoidal,



with well-indented dorsal edge; lateral cusps 5; central cusp pointed, considerably broader and longer than laterals; basal cusps 1, short, with weak dorsal support. Basal process narrow; basal sockets deep. Lateral margins thickened, with medium neck. Lateral tooth (Figure 21E) formula 3-1-3(4); neck very weakly developed; outer wing 150-180% of cutting edge length. Marginal teeth (Figure 21F, G) with about 17-22 (inner) and 19-20 (outer) cusps; cusps extending onto outer edge of teeth. Stomach caecum small.

Cephalic tentacles pale or with light grey patch proximally. Snout pale to medium grey. Foot pale or with light grey patch along anterior edge. Opercular lobe black along inner edge. Neck pale or very light grey. Pallial roof, visceral coil variably pigmented brown to black, rarely uniformly so.

Ctenidial filaments about 17, short, narrow, weakly pleated; ctenidium not overlapping pericardium posteriorly. Osphradium medium-sized, positioned centrally or slightly posterior to middle of ctenidial axis. Kidney with medium-sized pallial bulge; renal gland longitudinal; kidney opening white. Rectum straight, broadly overlapping genital ducts. Hypobranchial gland thin; overlapping rectum, pallial gonoducts.

Distal female genitalia shown in Figure 22A. Ovary 0.5-0.75 whorl, slightly overlapping posterior stomach chamber. Pallial albumen gland short. Capsule gland slightly shorter than albumen gland. Genital aperture a large subterminal pore, with very short vestibule. Coiled oviduct a small, near circular coil preceded by proximal twist. Oviduct and bursal duct join well behind pallial wall. Bursa copulatrix simply ovate, up to one-third length of albumen gland, and one-half width of gland, with about 50-65% of length posterior to gland. Bursa duct medium width, well embedded in albumen gland. Seminal receptacle pouchlike, sometimes folded, 50-70% of length of bursa copulatrix, partly overlapping anterior portion of bursa copulatrix. Seminal receptacle duct medium length.

Testis 1.5-2.0 whorls, overlapping posterior and portion of anterior stomach chambers. Prostate gland narrowly bean-shaped; oval in cross section; pallial section medium length. Pallial vas deferens with weak proximal bend. Penis (Figure 22B, C) medium-sized; edges unfolded; filament sometimes as long as base, narrow, tapering, parallel to strongly oblique to long axis of base; lobe hemispherical, short (rarely near absent). Terminal gland circular or ovate, usually positioned on ventral surface. Penial gland small (often absent), near circular, positioned near base of filament. Filament darkly pigmented internally.

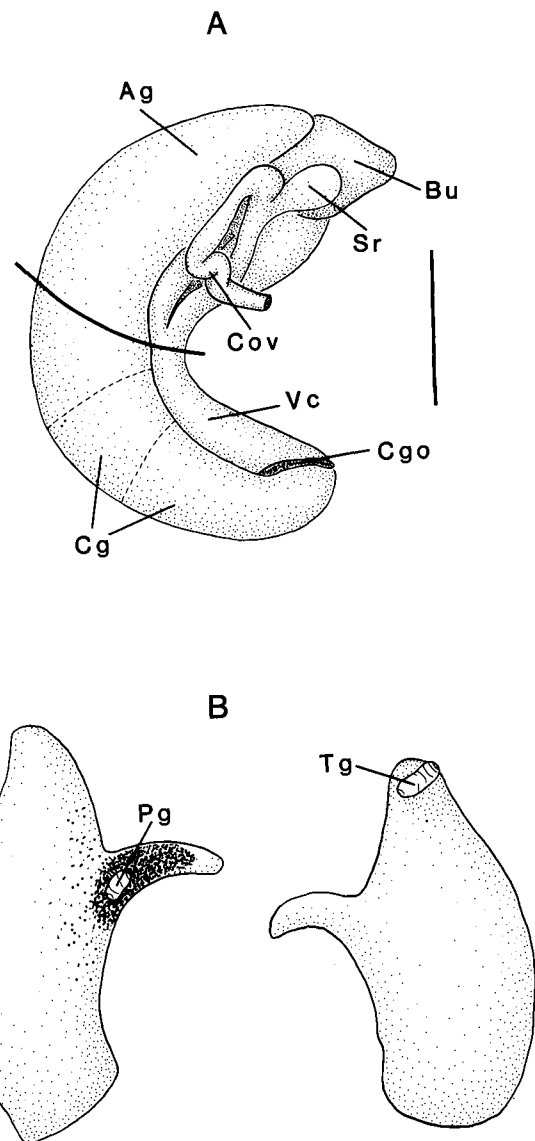
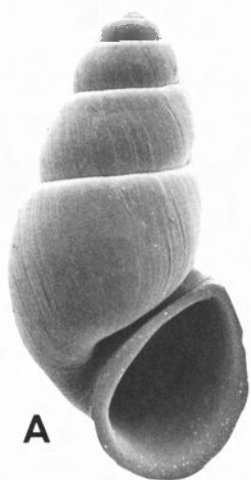


Figure 19

Genital morphology of *P. longae* Hershler, sp. nov., USNM 858262. A. Distal female genitalia (left side). B. Penis (dorsal aspect, left; ventral aspect, right). Bar = 0.5 mm. Ag = albumen gland, Bu = bursa copulatrix, Cg = capsule gland, Cgo = capsule gland opening, Cov = coiled oviduct, Pg = penial gland, Sr = seminal receptacle, Tg = terminal gland, Vc = ventral channel.

Figure 18

Scanning electron micrographs of opercula and radula of *P. longae* Hershler, sp. nov., USNM 858262. A-C. Opercula; bars = 0.33 mm, 0.38 mm, 0.30 mm, respectively. D. Central radular teeth, bar = 15 μ m. E. Central, lateral, marginal teeth, bar = 25 μ m. F, G. Marginal teeth, bars = 23.1 μ m, 30 μ m, respectively.



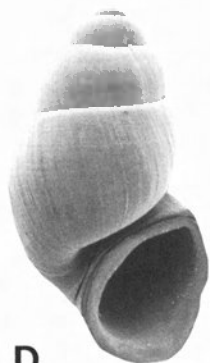
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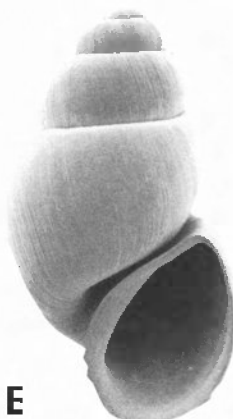
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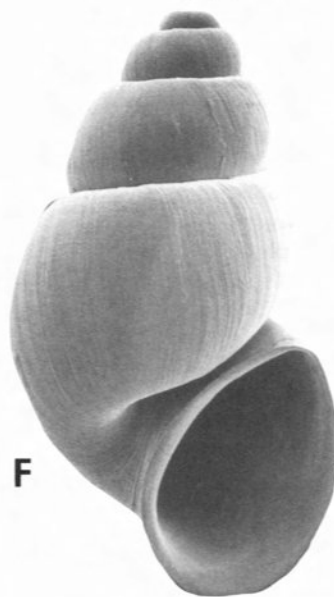
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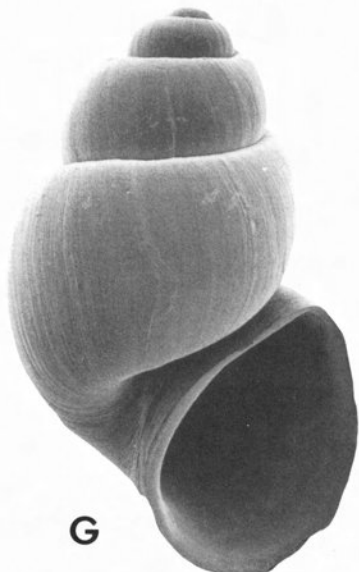
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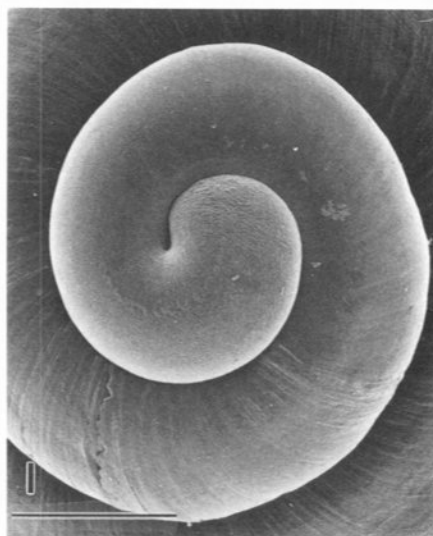
F



G



H



Type locality: Unnamed spring tributary to San Luis Obispo Creek, 4.8 km north of San Luis Obispo, east of HW 101, San Luis Obispo County, California, T. 30 S, R. 13 E, SE ¼ sec. 7 (Figure 4G). Holotype, USNM 860646 (Figure 5F); paratypes, USNM 883792, collected by R. Hershler, 6 May 1994. Snails were found in moderate abundance on rocks and in leaf litter along this small spring brook, which was in fairly good condition despite some recreational impacts and historic diversion near the source.

Remarks: This snail is known only from San Luis Obispo Creek drainage along the south-central California coast (Figure 6).

Material examined. CALIFORNIA. SAN LUIS OBISPO COUNTY: topotypes, USNM 874459, WBM 3865; Unnamed spring tributary to Brizzolari Creek, 1.6 km north of California Polytechnic State University, San Luis Obispo, T. 30 S, R. 12 E, unsurveyed, USNM 883789; Chorro Creek, Camp San Luis Obispo, T. 30 S, R. 12 E, NW ¼ sec. 3, USNM 854590; Unnamed spring tributary to Morro Creek, west side of HW 41, T. 29 S, R. 11 E, SE ¼ sec. 2, USNM 883788.

Pyrgulopsis ventricosa Hershler, sp. nov.

(Figures 5G, 23–25)

Pomatiopsis intermedia.—Cooper, 1876:36 ("near Clear Lake").

Etymology: From Latin *ventricosus*, meaning bulging, and referring to the well-developed ventral penial glands in this species.

Diagnosis: Shell ovate- to narrow-conic, medium-sized, umbilicate. Penial filament, lobe medium-sized. Penial ornament a transverse terminal gland, elongate penial gland, elongate Dg1, short Dg2, variable Dg3, an additional elongate dorsal gland, and two prominent ventral glands.

Description: Shell (Figures 5G, 23) ovate- to narrow-conic; height 2.2–2.6 mm; whorls 4.0–4.5. Protoconch (Figure 23F) about 1.25 whorls, early portion strongly wrinkled with occasional spiral lines. Teleoconch whorls convex, strongly shouldered; sculpture of weak growth lines and faint spiral striae. Aperture ovate, adnate to well separated from body whorl. Inner lip complete, thin, without columellar shelf. Outer lip thin, orthocline. Umbilicus

narrow. Periostracum tan; shell usually covered with thick organic deposits.

Operculum (Figure 24A–C) ovate, amber with reddish center of attachment scar; nucleus eccentric; dorsal surface frilled. Attachment scar margin broadly thickened all around. Callus well developed.

Buccal mass medium-sized; radular sac protruding behind buccal mass as short coil. Radula ribbon moderately elongate, about 0.65 × 0.11 mm, with about 50 rows of teeth. Central radular tooth (Figure 24D) trapezoidal, with medium to highly indented dorsal edge; lateral cusps 4–5; central cusp pointed, considerably broader and longer than laterals; basal cusps 1, short, with weak dorsal support. Basal process narrow; basal sockets deep. Lateral margins weakly thickened, with weak neck. Lateral tooth (Figure 24E) formula 3-1-4; neck weakly developed; basal tongue well developed; outer wing 160–180% of cutting edge length. Marginal teeth (Figure 24E–G) with about 16–20 (inner) and 20–23 cusps; cusps extending onto outer edge of teeth. Stomach caecum small.

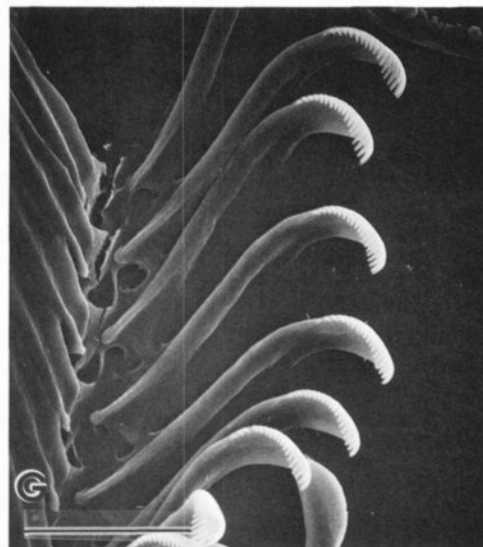
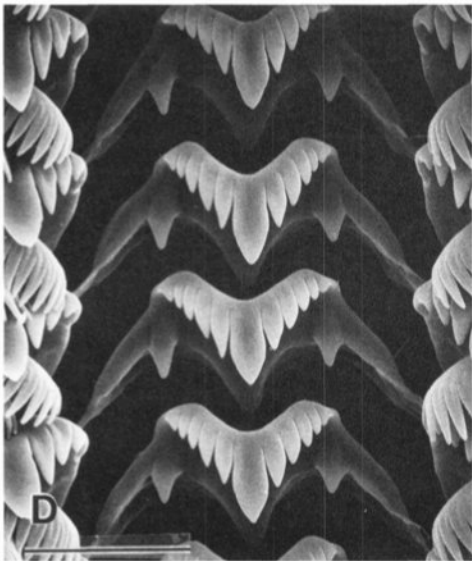
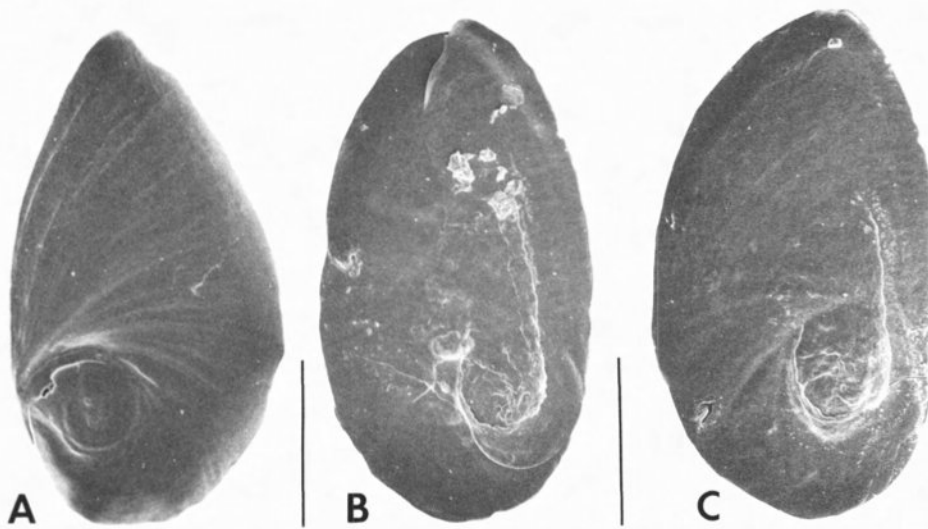
Cephalic tentacles light grey to black; pigment sometimes a longitudinal band on pale background. Snout grey to black, rarely red. Foot grey to black along anterior end, sometimes similarly pigmented along rest of margin, otherwise pale. Opercular lobe black along inner edge, lighter along rest of margin. Neck pale to near black. Pallial roof mottled to near uniform black; visceral coil slightly lighter.

Ctenidial filaments 22, medium width, tall; ctenidium slightly overlapping pericardium posteriorly. Osphradium small, centered well posterior to middle of ctenidial axis. Kidney with medium pallial bulge; renal gland longitudinal; kidney opening white. Rectum straight, broadly overlapping genital ducts. Hypobranchial gland thin; overlapping rectum, pallial gonoducts.

Distal female genitalia shown in Figure 25A. Ovary 1.0 whorl, abutting posterior edge of stomach. Pallial albumen gland short. Capsule gland about as long as or slightly longer than albumen gland. Genital aperture a broad slit; vestibule absent or very weakly developed. Coiled oviduct circular-horizontal, simple or kinked near mid-point. Oviduct and bursal duct join slightly behind pallial wall. Bursa copulatrix ovate, sometimes with blunt anterior edge, 80–110% length of albumen gland, as wide or slightly narrower than albumen gland, with almost entire length posterior to gland. Bursal duct narrow, short (about one-fourth to one-third length of bursa copulatrix), weakly embedded in albumen gland. Seminal receptacle a small pouch, less than one-fourth length of bursa copulatrix, overlapping anterior portion of bursa copulatrix. Seminal receptacle duct medium length.

Figure 20

Scanning electron micrographs of shells of *P. taylori* Hershler, sp. nov. A–E, USNM 883792. F–H, USNM 883789. I. Protoconch, USNM 883792, bar = 136 μm. Shell "A" is 2.2 mm tall; other shells printed to same scale.



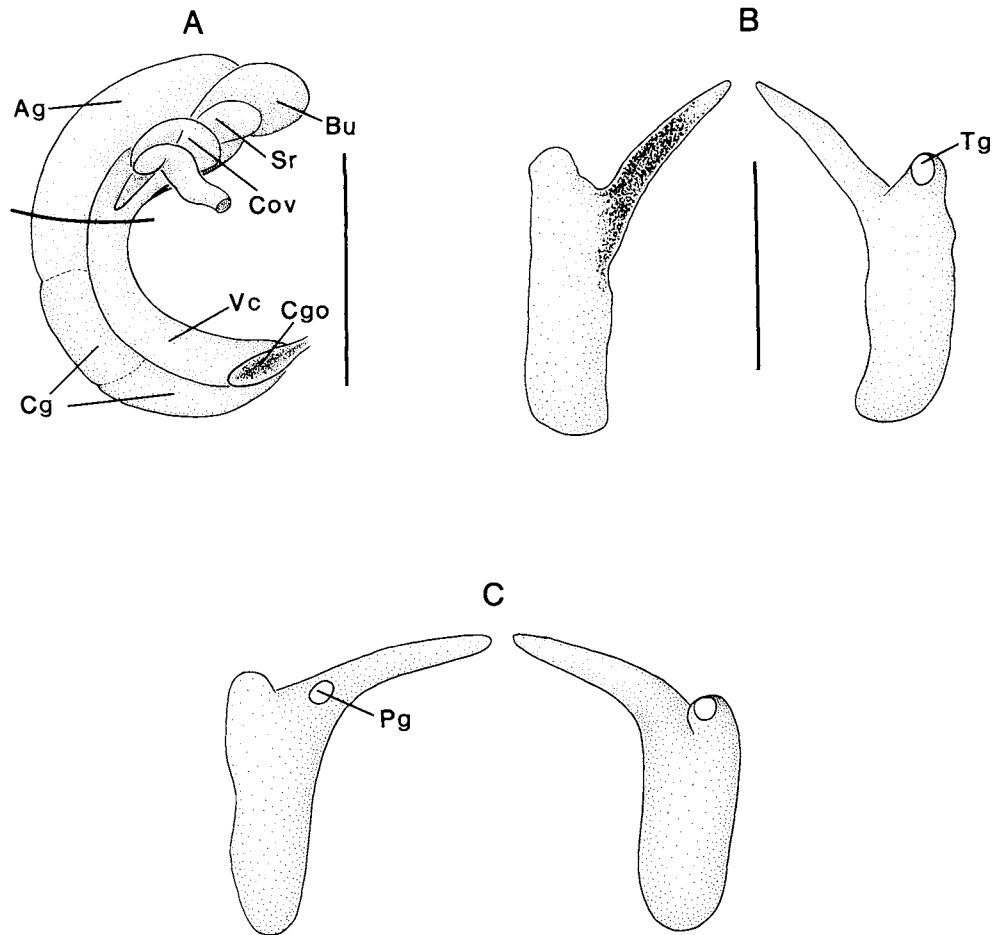


Figure 22

Genital morphology of *P. taylori* Hershler, sp. nov., USNM 883792. A. Distal female genitalia (left side). Bar = 0.5 mm. B. C. Penes (dorsal aspect, left; ventral aspect, right). Bar = 0.5 mm. Ag = albumen gland, Bu = bursa copulatrix, Cg = capsule gland, Cgo = capsule gland opening, Cov = coiled oviduct, Pg = penial gland, Sr = seminal receptacle, Tg = terminal gland, Vc = ventral channel.

Testis, 1.5 whorls, overlapping posterior and portion of anterior stomach chambers. Prostate gland bean shape; narrow oval in cross section; pallial section short. Pallial vas deferens with very large proximal loop. Penis (Figure 25B–D) large; base rectangular, weakly folded along inner edge; filament considerably shorter than base, medium width, tapering, slightly oblique to long axis of base; lobe slightly tapering distally, shorter than filament. Terminal

gland transverse, usually interrupted into two distinct units (rarely with third intermediate glandular dot), usually coursing over dorsal and ventral surfaces. Penial gland elongate, covering most of length of filament. Dg1 elongate, extending along length of base near outer edge, sometimes fused with either Dg3 or additional dorsal glands. Dg2 short. Dg3 dotlike to large, borne on pronounced swelling. Dorsal penis also with an additional elongate gland (as

←

Figure 21

Scanning electron micrographs of opercula and radula of *P. taylori* Hershler, sp. nov., USNM 883792. A–C. Opercula; bars = 231 μm , 250 μm . “C” printed to same scale as “A.” D. Central radular teeth, bar = 12 μm . E. Lateral teeth, bar = 15 μm . F. Inner marginal teeth, bar = 12 μm . G. Outer marginal teeth, bar = 17.6 μm .

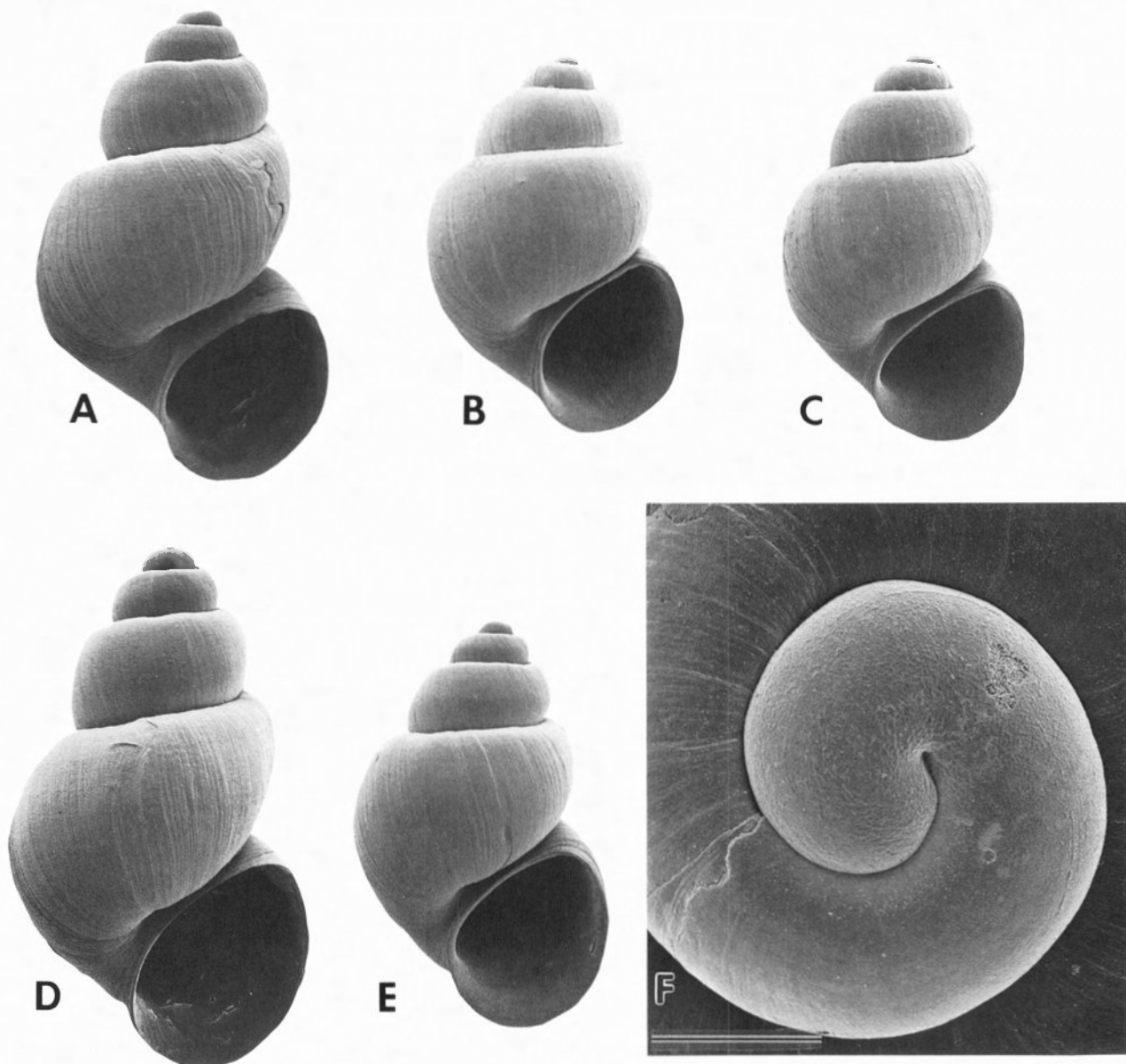
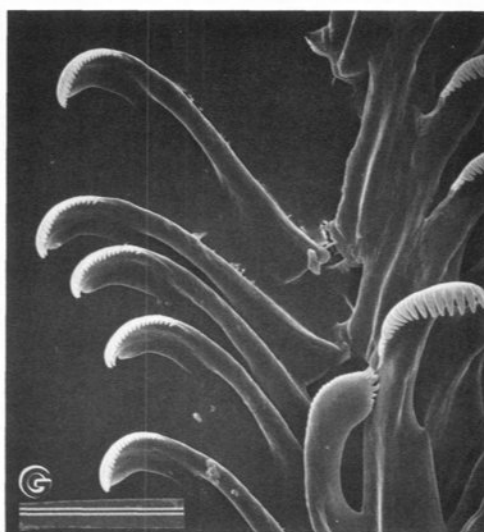
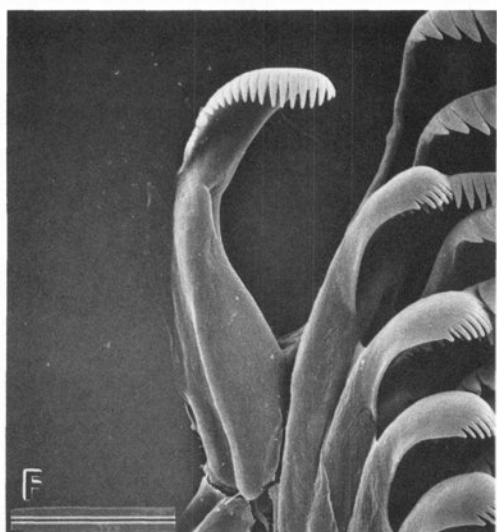
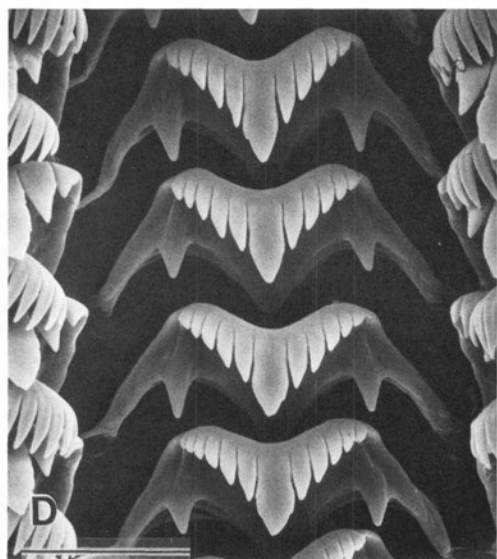
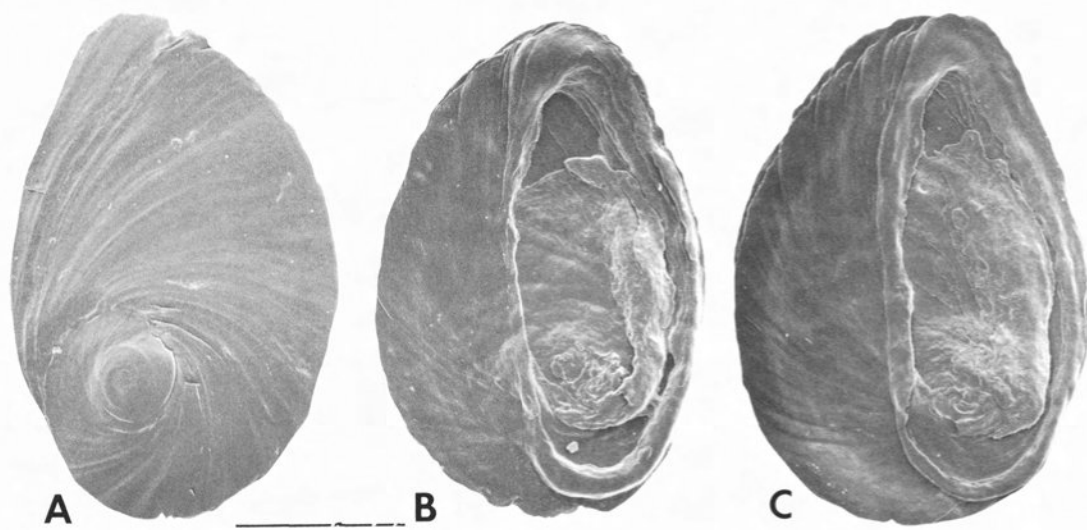


Figure 23

Scanning electron micrographs of shells of *P. ventricosa* Hershler, sp. nov., USNM 883790. F. Protoconch, bar = 120 μm . Shell "A" is 2.9 mm tall; other shells printed to same scale.

Figure 24

Scanning electron micrographs of opercula and radula of *P. ventricosa* Hershler, sp. nov., USNM 883790. A-C. Opercula, bar = 0.30 mm. D. Central radular teeth, bar = 12 μm . E. Central, lateral, inner marginal teeth, bar = 17.6 μm . F. Inner marginal teeth, bar = 17.6 μm . G. Inner and outer marginal teeth, bar = 23.1 μm .



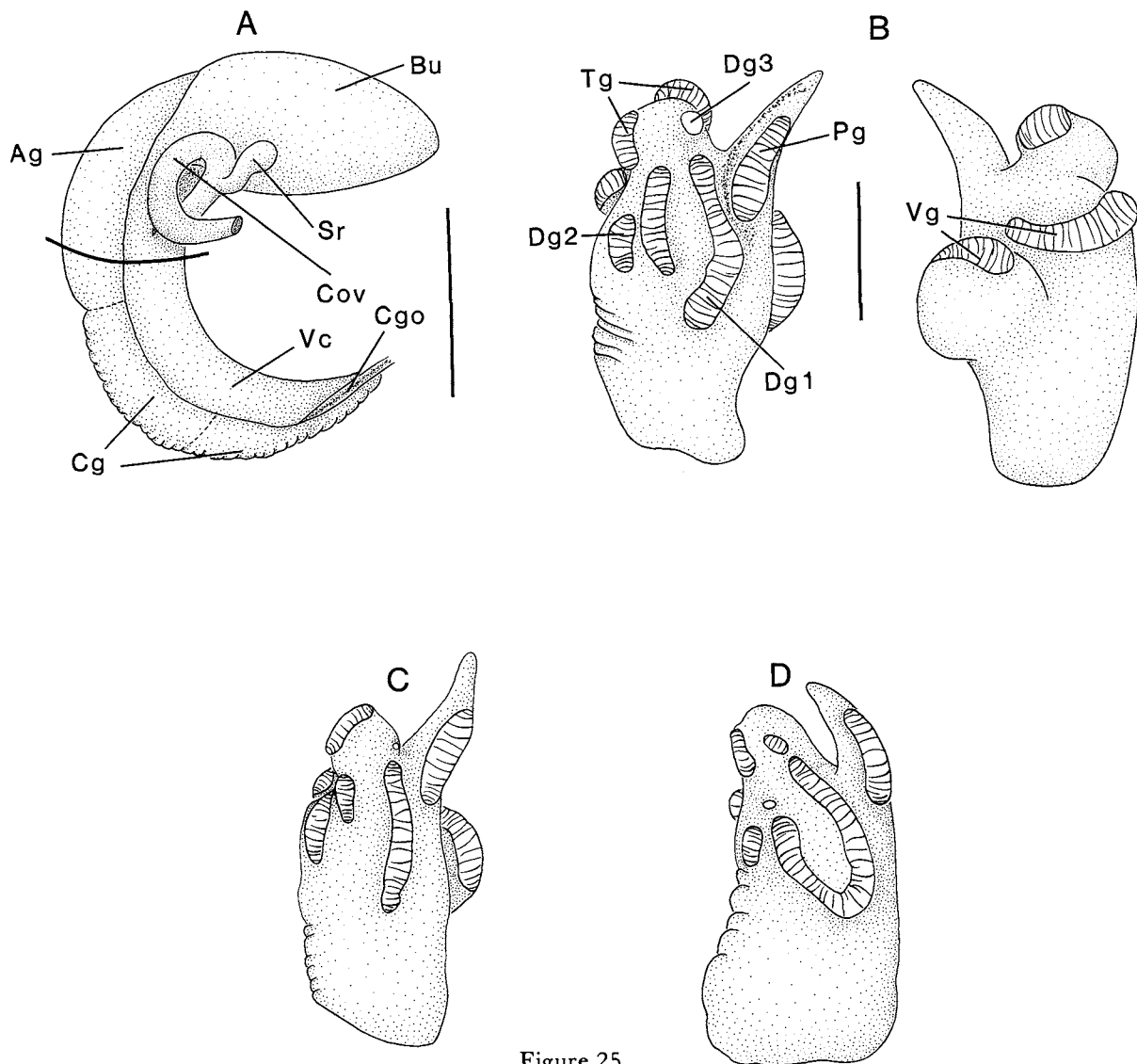


Figure 25

Genital morphology of *P. ventricosa* Hershler, sp. nov., USNM 883790. A. Distal female genitalia (left side). Bar = 0.5 mm. B. Penis (dorsal aspect, left; ventral aspect, right). Bar = 0.5 mm. C, D. Penes (dorsal aspects). Scale as in "B." Ag = albumen gland, Bu = bursa copulatrix, Cg = capsule gland, Cgo = capsule gland opening, Cov = coiled oviduct, Dg1 = gland along right edge, Dg2 = gland along left distal edge, Dg3 = gland along right edge of lobe, Pg = penial gland, Sr = seminal receptacle, Tg = terminal gland, Vc = ventral channel, Vg = ventral gland.

well as one to two small glandular dots) centrally positioned between Dg1 and Dg3, apparently sometimes fused with former. Ventral penis with distal transverse gland (rarely interrupted into two units) borne on low swelling and large, near central gland borne on tall swelling. Filament darkly pigmented internally along most of length.

Type locality: Unnamed creek, Seigler Canyon, 7.4 km south of HW 29 along Seigler Canyon Road, Clear Lake basin, Lake County, California, T. 12 N, R. 7 W, NE ¼ sec. 19 (Figure 4F). Holotype, USNM 860647 (Figure

5G); paratypes, USNM 883790, collected by R. Hershler and S. Ellis, 3 May 1994. Snails were commonly found on vegetation in this small (1 m wide, 3 cm deep), spring-fed stream, which had been diverted and additionally impacted by residential activities.

Remarks: This species is similar to the most derived members of the "californiensis series" (see above), which are characterized in part by possession of a full complement of glands on the penis (Pg, Tg, Dg1-3) and an enlarged bursa copulatrix. Of the members of this group, only *P.*

californiensis, from coastal regions along southern California, and *P. wongi*, from Owens River drainage and several other basins to the east of Sierra Nevada, share with our species two well-developed ventral glands (Vg) and a very small seminal receptacle. *Pyrgulopsis ventricosa* shares with *P. californiensis* an ovate-narrow conic shell and short bursal duct, but is distinguished by penial features, including the generally longitudinal (not transverse) orientation of Dg1, shorter Dg2, fewer and smaller additional dorsal glands, and more pronounced proximal ventral gland.

Late Cenozoic hydrobiids from the Cache Formation in the Clear Lake basin have been provisionally allocated to *Hydrobia andersoni* Arnold, 1909 (Taylor, 1966 and references cited therein; Rymer et al., 1988), which in turn was described from fossils of the Tulare Formation in Kettleman Hills, located near the southern end of San Joaquin Valley. Although I have not seen Cache Formation material and thus cannot ascertain possible conspecificity with our snail, this novelty is clearly distinguished from typical *H. andersoni* by its smaller, squatter shell and shallower sutures.

This species is restricted to Seigler Creek drainage in the south end of the Clear Lake basin (Figure 13). Although unpublished historic records suggested that the snail was formerly widespread in this region (at least until the 1970s), I was able to locate only one other living colony a short distance from the type locality in 1994.

Material examined: CALIFORNIA. LAKE COUNTY: Unnamed spring, Seigler Canyon, T. 12 N, R. 7 W, NE ¼ sec. 19, USNM 873134; Seigler Springs, T. 12 N, R. 8 W, NE ¼ sec. 24, USNM 874925.

ACKNOWLEDGMENTS

I thank F. G. Hochberg and P. Scott (Santa Barbara Museum of Natural History) for lending specimens under their care. K. Cummings (Illinois Natural History Survey), J. Landye, and W. Miller (University of Arizona) generously donated specimens and notes.

Scanning electron micrographs were taken by Susann Braden of the NMNH (USNM) Scanning Electron Microscopy Laboratory, and prints of these were made by Victor Krantz, and staff of the NMNH Office of Printing and Photographic Services. Shell drawings and drainage map were prepared by M. Ryan (NMNH, Invertebrate Zoology); S. Escher inked anatomical drawings. Collecting permits were provided by Department of Fish and Game (State of California). Partial support for fieldwork and laboratory studies was provided by contracts issued to the author by Department of Fish and Game (State of California), and California Department of Parks and Recreation. Assistance with fieldwork was provided by S. Ellis (California Department of Fish and Game), J. Kerbavaz (California Department of Parks and Recreation), and D.

Sada. I thank Barry Roth and an anonymous reviewer for comments on the manuscript.

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