An undescribed genus and species of Geomitridae (Gastropoda: Helicacea) from peridotite hills in Málaga Province, Spain

Un nuevo género y especie de Geomitridae (Gastropoda: Helicacea) de Sierras peridotíticas de la provincia de Málaga, España

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ABSTRACT

A hitherto unknown species of the family Geomitridae was discovered in 2014 on the Sierra Bermeja (Prov. Málaga, Spain). Subsequent searches in the same Province have revealed its presence at seven localities on this and other peridotite hills, but none on areas with other rock types. Its shell characters are unremarkable for a geomitrid, resembling those e.g. of *Helicella*. However, anatomical study has revealed that it has sufficiently distinctive genital anatomy for description of a new genus to be necessary. In particular, the presence of two very small vaginal appendages in the position usually occupied by (larger) dart sacs, combined with the right ommatophore retractor muscle following a course free of the distal genitalia gives a combination unique in the Geomitridae. Also, the vas deferens is unusually stout. Hence, this paper names it as *Peridotitea bermejensis* gen. et sp. nov., discusses its affinities, and presents an account of what is known of its distribution, status and ecology.

RESUMEN

Una especie desconocida hasta ahora de la familia Geomitridae fue descubierta en 2014 en Sierra Bermeja (Provincia de Málaga, España). Posteriores muestreos en la misma provincia han revelado su presencia en siete localidades de ésta y otras sierras peridotíticas, no habiéndose hallado en zonas con otro tipo de rocas. Sus caracteres conquiolólogicos la hacen indistinguible de otros geomítridos, siendo similares, por ejemplo, a los de *Helicella*. Sin embargo, estudios anatómicos han revelado que posee una anatomía genital lo suficientemente distinta para que sea necesaria la descripción de un nuevo género. En concreto, la presencia de dos pequeños apéndices vaginales en la posición que usualmente ocupan los sacos del dardo (de mayor tamaño), unido a que el músculo retractor del ommatóforo derecho sigue una trayectoria separada de la genitalia distal, constituye una combinación única dentro de los Geomitridae. Además el vaso deferente es extraordinariamente grueso. Por lo tanto este trabajo lo describe como *Peridotitea bermejensis* gen. et sp. nov., discute sus afinidades y presenta lo que se conoce acerca de su distribución, estatus y ecología.

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INTRODUCTION

In 2014 FEVT and JSTA found a small species of helicellid (Geomitridae) on the peridotite hill of Sierra Bermeja (Prov. Málaga, Spain) and nearby that could not be identified with any known species. Specimens sent to DTH and GAH revealed that the taxon involved not only represents an undescribed species, but also that it has sufficiently distinctive genital anatomy for description of a new genus to be necessary. Searches on peridotite hills in the same Province have now revealed its presence at seven localities. This paper names the new genus and species, discusses its affinities, and presents an account of what is known of its distribution and ecology.

MATERIAL AND METHODS

Grid references of localities were recorded using hand-held Garmin Etrex High Sensitivity devices accurate to <5 m horizontally and vertically. Snails were collected by direct searching, mostly by examining the undersides of small boulders and other peridotite rocks. Living snails were drowned in water overnight, then preserved in 80% i.m.s. (with a few kept in 96% eth.). Shell descriptions and dissections were made using Meiji RZ Series stereo-microscopes, with anatomical drawings prepared with assistance from a Meiji drawing tube and shell measurements were made using an eyepiece graticule accurate to ± 0.05 mm. Shell whorls were counted using the method described by KERNEY & CAMERON (1979: 13). Bodies for anatomical study were pulled from the shells after fixation in the 80% i.m.s. preservative. Genitalia were examined, described and drawn after they were dissected out of bodies. Proximal and distal in anatomical descriptions refer to the position in relation to the ovotestis (gonad).

Abbreviations:
AB, maximum breadth of shell aperture;
AH, maximum height of shell aperture (measured perpendicular to AB);
B, breadth of sh;
bis, bodies in i.m.s.;
CGAH, Collection of G.A. and D.T. Holyoak;
CFEVT, Collection of F.E. Vázquez Toro;
CCJPC, Collection of C.J. Pérez Candón;
CJSTA, Collection of J.S. Torres Alba;
DTH, D.T. Holyoak;
eth, 96% ethanol;
FEVT, F.E. Vázquez Toro;
GAH, G.A. Holyoak;
H, height of sh;
i.m.s., 80% industrial methylated spirit;
imm., immature;
JR, J. Ripoll;
JSTA, J.S. Torres Alba;
leg., collected by;
m, metres above sea level;
MNCN, Museo Nacional de Ciencias Naturales, Madrid;
n, sample size;
PM, Pedro Madroño;
sh, shells;
spm, whole specimens;
U, maximum breadth of umbilicus;
U.T.M., Universal Transverse Mercator map grid system;
#, field number of site.

TAXONOMIC PART & RESULTS

Family GEOMITRIDAE C.R. Boettger, 1909

Peridotitea gen. nov.

Type species *Peridotitea bermejensis* sp. nov.

Etymology: *Peridotitea* is derived from Peridotite, the distinctive hard reddish bedrock forming the hills at the type locality and other places where the new species has been found. The term Peridotite for the rock was based on the name of the gemstone Peridot which is of uncertain origin, although the *Oxford English Dictionary* suggests an alteration of the Anglo-Norman *pedoretés*.

Diagnosis: Shell dextral, rather small, low-conical in shape, thin, ± translucent, with narrow but open umbilicus; aperture oval, lacking any thickening inside the peristome. Teleoconch above with fine close radial-tangential ribs ± throughout, and sometimes with short hairs present; coloration including spiral dark and light bands and blotching or streaking of light colour.

Right ommatophore retractor muscle free of the distal genitalia, not passing through the angle between distal parts of penis and vagina. Vagina lacking dart sacs, but with two very small appendages in the position usually occupied by (larger) dart sacs in Geomitridae. Vaginal mucus glands four, each of them divided near base into two branches. Free oviduct short. Duct of bursa copulatrix without diverticulum. Vas deferens unusually stout for Geomitridae. Penial flagellum short and stout. Epiphallus moderately long, continuing distally inside sheath of penis to end as long cylindrical verge. Penial retractor muscle attached to distal exposed part of epiphallus. Genital atrium very short.

Peridotitea bermejensis sp. nov.

Type material: Holotype (Figs 1B, 2A-C; B = 10.15 mm), 20 Feb. 2014, from type locality, leg. FEVT & JSTA Ma-0387, 1 sh (dry) & bis, MNCN reg. no. 15.05/84437.

Paratypes: All from at or near type locality: 6 Mar. 2014, between Puerto de Peñas Blancas and Jubrique (30SUF0547), 787 m, leg. FEVT & JSTA Ma-0397, 3 sh, CJSTA #12819; 4 Apr. 2017, Los Pedregales (30SUF0236), leg. DTH, GAH, JSTA, FEVT, JR Ma-0711, 1 spm in eth, 7 sh + bis, 17 sh (found dead), CGAH #E436 & 4 sh, CJSTA #12786.

Other observations from Los Pedregales, at or near type locality: 8 Dec. 2014, 30SUF0236, 230 m, leg. CJPC, PM & FEVT Ma-0488, not kept; 22 Oct. 2015, 30SUF0236, 247 m, leg. JSTA, JR, FEVT, Ma-0580, not kept; 4 Apr. 2017, from Arroyo Abrón, 30SUF0440, 764 m, leg. DTH, GAH, JSTA, FEVT, JR Ma-0712, few sh, not kept.

Other observations & material studied: All from Málaga Prov., Spain: 9 Mar. 2015, uncultivated field next to play ground, Tolox, Sierra de Tolox (30SUF2861), 470 m, leg. JSTA Ma-0504, 3 sh, CJSTA #13307; 5 Nov. 2015, Cerro del Hijar, Tolox, Sierra de Tolox (30SUF2961), 499 m, on peridotites, leg. FEVT & JR Ma-0586, 1 sh, CFEVT, 2 sh + bis, CGAH.

24 Nov. 2015, Fire watch tower Sª Robla, Casarabonela, Sierra de la Robla (30SUF3973), 567 m, leg. FEVT & JR Ma-0596, 1 sh, CJSTA #13675.

26 Apr. 2016, track towards wind turbines, Sierra de Aguas, Casarabonela (30SUF4079), 674 m, leg. JSTA & FEVT Ma-0614, 2 sh, CJSTA #13928; Puerto Banaero, Sierra de Aguas, Álora, 30SUF 41193/80339, 828 m, under peridotite stones, leg. JSTA & FEVT, Ma-0615, 2 sh & bod, 2 spm (all immature) CGAH.

6 Apr. 2017, by A397 *ca* 13.2 km due NNW. of San Pedro de Alcántara (centre), Benahavís, Sierra Palmitera (30SUF1551), shallow gully on rocky (peridotite) slope with loose boulders and patchy scrub, 855 m., leg. GAH & DTH, 1 sh, 1 spm (imm) in eth, CGAH #E445.

13 May 2017, Puerto de las Golondrinas, Tolox, Sierra de las Nieves (30SUF2659), 845 m, leg. FEVT & JR Ma-0732, 1 spm in i.m.s., CFEVT.

Type locality: Los Pedregales, Sierra Bermeja, N. of Estepona, Málaga Prov., Spain (UTM: 30SUF0236; N36.4494º W5.2098º); rocky peridotite slopes with bushes locally, some near small stream, 246 m.

Etymology: The epiphet *bermejensis* refers to the type locality in Sierra Bermeja, Prov. Málaga.

Description: Adult shells from type locality (see Table I for measurements): Shell low-conical with rounded spire. Whorls gradually increasing, periphery slightly angled when immature, rounded on body whorl of adult; sutures ± shallow, sometimes deeper near apex. Body-whorl not or slightly descending at aperture, but aperture widening because lower lip descends. Aperture oval except where interrupted by penultimate whorl; most of peristome simple with little or no thickening and no internal rib, but narrowly reflected over edge of umbilicus. Umbilicus narrow, symmetrical, deep,

Table I. Measurements of *Peridotitea bermejensis* sp. nov. from Málaga Prov., Spain. All linear measurements are in mm, taken with optical micrometer accurate to ± 0.05 mm. Whorls were counted according to method described by Kerney & Cameron (1979: 13). AB, aperture breadth; AH, aperture height; B, maximum shell breadth; H, shell height; U, greatest width of umbilicus; W, count of whorls.

Tabla I. Medidas de Peridotitea bermejensis *sp. nov. de la provincia de Málaga, España. Todas las medidas lineales están en mm, tomadas con un micrómetro óptico con una precisión de ± 0.05 mm. Las vueltas se han contado de acuerdo con el método descrito por Kerney & Cameron (1979: 13). AB, anchura de la abertura; AH, altura de la abertura; B, diámetro máximo de la concha; H, altura de la concha; U, diámetro máximo del ombligo; W, número de vueltas.*

Measurement	B	H	U	(U/B)x100	AB	AH	W
Los Pedregales (holotype, mature)	10.15	6.05	1.25	12.3%	4.48	3.41	5.2
Los Pedregales (paratypes, CGAH: E436, largest of live-collected)	10.16	6.11	1.35	13.3%	4.46	3.83	5.3
	10.31	6.42	1.14	11.1%	4.35	3.83	5.3
Cerro del Hijar (± mature)	8.99	5.42	1.25	13.9%	4.03	3.11	4.9
	7.65	4.38	1.18	15.4%	3.32	2.99	4.6
Puerto Banaero (immature, 2 largest sh)	5.99	3.59	0.76	12.7%	2.71	2.34	4.5
	5.77	3.27	0.76	13.2%	2.57	2.35	4.4

exposing upper whorls of spire internally. Shell thin, ± translucent.

Protoconch ± smooth but slightly corroded; teleoconch above with fine close radial-tangential ribs ± throughout, the ribs somewhat irregular but not broken into papillae; underside with lower ribs; no hairs seen. Shell surface with waxy lustre or slightly glossy, but texture mostly concealed by the surface sculpture. Shell coloration, above predominantly light brown with single chestnut band slightly above periphery of whorl; all teleoconch whorls also with irregular blotches of pale buff and crests of ribs with same colour giving fine streaks or wider irregular bands; underside of shell pale brown with irregular spiral bands of pale buff (mainly from pale areas on crests of ribs, or of papillae at Puerto Banaero).

Variation in shell characters is apparent between localities, especially in shell sculpture, and possibly in size (Table I, Figs 1, 4B, C). *At Cerro del Hijar*, protoconch smooth with small ribs or elongate papillae developed by whorl 1.0; teleoconch above with fine close radial-tangential ribs ± throughout, the ribs rather irregular; underside with lower ribs; smaller of two shells studied with short closely spaced hairs over most (whorls 1.7-4.2) of upperside, the hairs somewhat curved backwards away from aperture, whitish, each up to *ca* 350 μm long, caducous; larger shell has very few hairs remaining; *at Puerto Banaero*, protoconch smooth initially, but with few large low papillae by whorl 0.5; teleoconch above with close radial-tangential ribs broken into elongate papillae to variable extent (some parts of some whorls appearing papillose, others appearing ribbed); underside with lower sculpture ± papillose throughout; small hairs rare, seen only on last part of periphery of body whorl of one shell (perhaps rapidly caducous).

Exterior of body: holotype has exterior of body all white, including top of head and of foreparts, the ommatophores showing as dark areas by translucence; surface of mantle whitish with scattered small, irregular brown markings. Two snails from Cerro del Hijar more heavily pigmented: sole of foot, tail, lower part of sides all whitish; forepart of body dorsally pale grey (one snail) or light grey (one snail); mantle-collar unmarked whitish (one) or with few small pale grey marks (one);

Figure 1. Shells of *Peridotitea bermejensis* gen. & sp. nov. from Prov. Málaga, Spain. A-C: from type locality at Los Pedregales, Sierra Bermeja (A: paratype, CGAH; B: holotype, MNCN; C: paratype, CFEVT); D: from Puerto Banaero in Sierra de Aguas (leg. JSTA, in CGAH); E: from Cerro del Hijar in Sierra de Tolox (leg. JSTA, in CGAH).

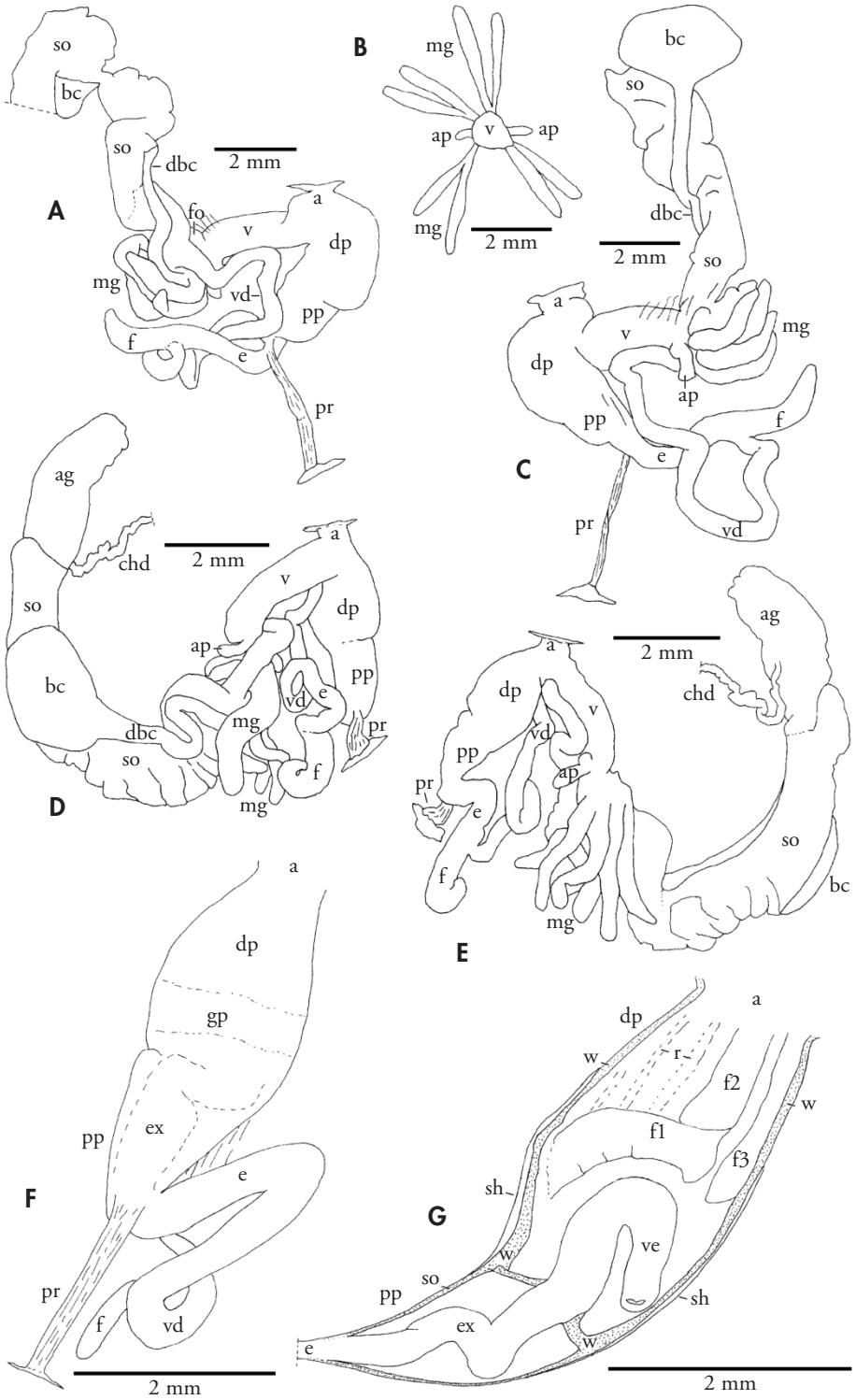
Figura 1. Conchas de Peridotitea bermejensis *gen. & sp. nov. de la provincia de Málaga, España. A-C: de la localidad típica en Los Pedregales, Sierra Bermeja (A: paratipo, CGAH; B: holotipo, MNCN; C: paratipo, CFEVT); D: Puerto Banaero, Sierra de Aguas (leg. JSTA, en CGAH); E: Cerro del Hijar, Sierra de Tolox (leg. JSTA, en CGAH).*

mantle pale cream with blackish-grey spots and irregular thin longitudinal streaks concentrated on upperside; body inside spire of shell dull light grey to brownish. The largest of the immature snails from Puerto Banaero again had a darker body coloration: exposed parts pale grey, darker grey on top of head and dorsum of foreparts; mantle fringe pale grey; mantle inside body-whorl whitish with strong pattern of black lines and streaks forming irregular network (visible as dark pattern through translucent shell of this and the other immatures); digestive gland dull brownish with sparse black bars and blotches.

Anatomy of distal genitalia (Fig. 2): holotype has large genitalia and was evidently mature (Fig. 2A-C). Vas deferens thick throughout (mainly *ca* two-thirds diameter of exposed epiphallus), long, coiled; passing from distal end of spermoviduct distally alongside vagina, deep into penial/vaginal angle before joining proximal end of epiphallus level with base of flagellum. Epiphallus nearly as long as penis, cylindrical, thick-walled. Flagellum nearly as long as (exposed) epiphallus, 1.5× its width basally, tapering to blunt point. Penis large, thick-walled, the distal two-thirds cylindrical, proximal third narrower and tapering proximally (but this may be distal part of epiphallus). Penis retractor muscle a stout strap, attached to proximal end of penis inside a loose sheath of connective tissue, other end attached further proximally to diaphragm. Genital atrium very short.

External genital pore just below base of right ommatophore. Vagina cylindrical, strong-walled, narrower than proximal part of penis (*ca* twice width of exposed epiphallus); giving rise near proximal end on opposite sides to pair of short vaginal appendages, each a projection with length 2-3× width, having a rounded shorter bulge joined to its base. Four mucus glands arise slightly proximal to the vaginal appendages, each gland dividing near base into pair of cylindrical branches that taper in proximal (terminal) one-third to one-quarter of their length to end in blunt to subacute points (the mucus glands overall being

(Right page) Figure 2. Genital anatomy of *Peridotitea bermejensis* gen. & sp. nov. from Prov. Málaga, Spain. A-C, G: from type locality (A-C: holotype, with C showing other side of organs drawn in A; B a schematic section of vagina at level of insertion of mucus glands); G: longitudinal section of penis of another specimen (CGAH: E436); D-F: from Cerro del Hijar, Tolox (with E showing other side of organs drawn in D; F showing exterior of penial complex of same specimen; leg. FEVT & JR, in CGAH). Abbreviations, a: genital atrium; ag: albumen gland; ap: vaginal appendage; bc: bursa copulatrix; chd: common hermaphrodite duct; dbc: duct of bursa copulatrix; dp: distal part of penis; e: epiphallus; ex: apparent extension of epiphallus into penis; f: penial flagellum; f1, f2, f3: flaps on inside of wall of distal part of penis; fo: free oviduct; gp: apparently glandular part of exterior of wall of penis; mg: mucus gland(s); pp: proximal part of penis; pr: penis retractor muscle; r: longitudinal ridges on inside of wall of distal penis; sh: thin sheath of penis; so: spermoviduct; v: vagina; vd: vas deferens; ve: verge; w: muscular wall of penis.
(Página derecha) Figura 2. Anatomía genital de Peridotitea bermejensis *gen. & sp. nov. de la provincia de Málaga, España. A-C, G: de la localidad típica (A-C: holotipo, en C se muestra el otro lado de los órganos mostrados en A; B, sección esquemática de la vagina a nivel de la inserción de las glándulas mucosas); G: sección longitudinal del pene de otro espécimen (CGAH: E436); D-F: Cerro del Hijar, Tolox (en E se muestra el otro lado de los órganos mostrados en D; en F se muestra el exterior del complejo penial de otro espécimen; leg. FEVT & JR, en CGAH). Abreviaturas, a: atrio genital; ag: glándula de la albúmina; ap: apéndice vaginal; bc: bolsa copulatrix; chd: conducto hermafrodita común; dbc: conducto de la bolsa copulatrix; dp: parte distal del pene; e: epifalo; ex: aparente extensión del epifalo en el pene; f: flagelo penial; f1, f2, f3: pliegues en el interior de la pared de la parte distal del pene; mg: glándula(s) mucosa(s); pp: parte proximal del pene; pr: músculo retractor del pene; r: crestas longitudinales en el interior de la pared de la parte distal del pene; sh: vaina delgada del pene; so: espermoviducto; v: vagina; vd: vaso deferente; ve: verga; w: pared muscular del pene.*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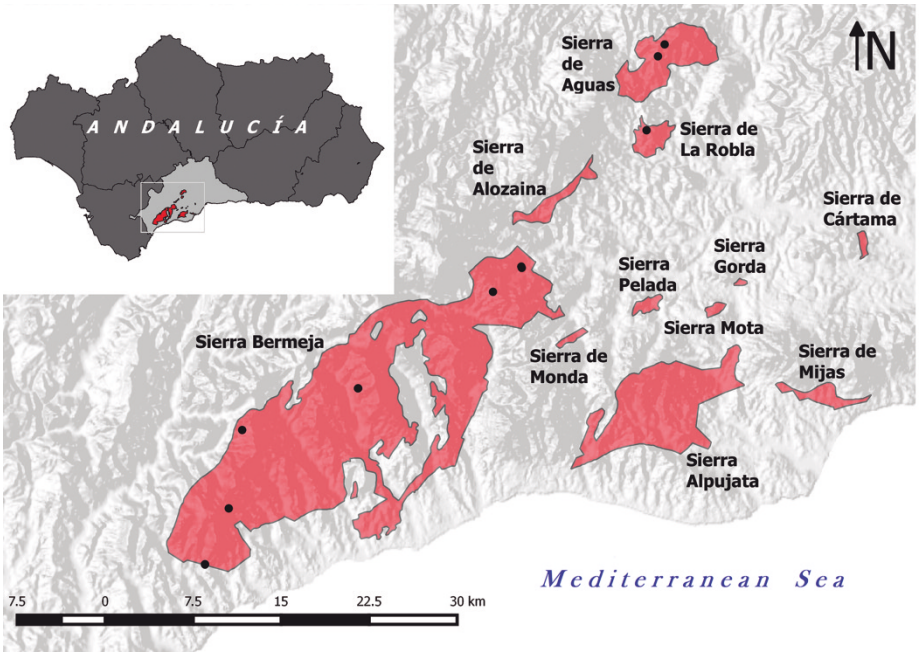


Figure 3. Map showing the main area of distribution of *Peridotitea bermejensis* gen. & sp. nov. in Prov. Málaga, Spain. Areas with reddish background: peridotites; black spots: sampled localities. See text for additional data on localities beyond the area shown.

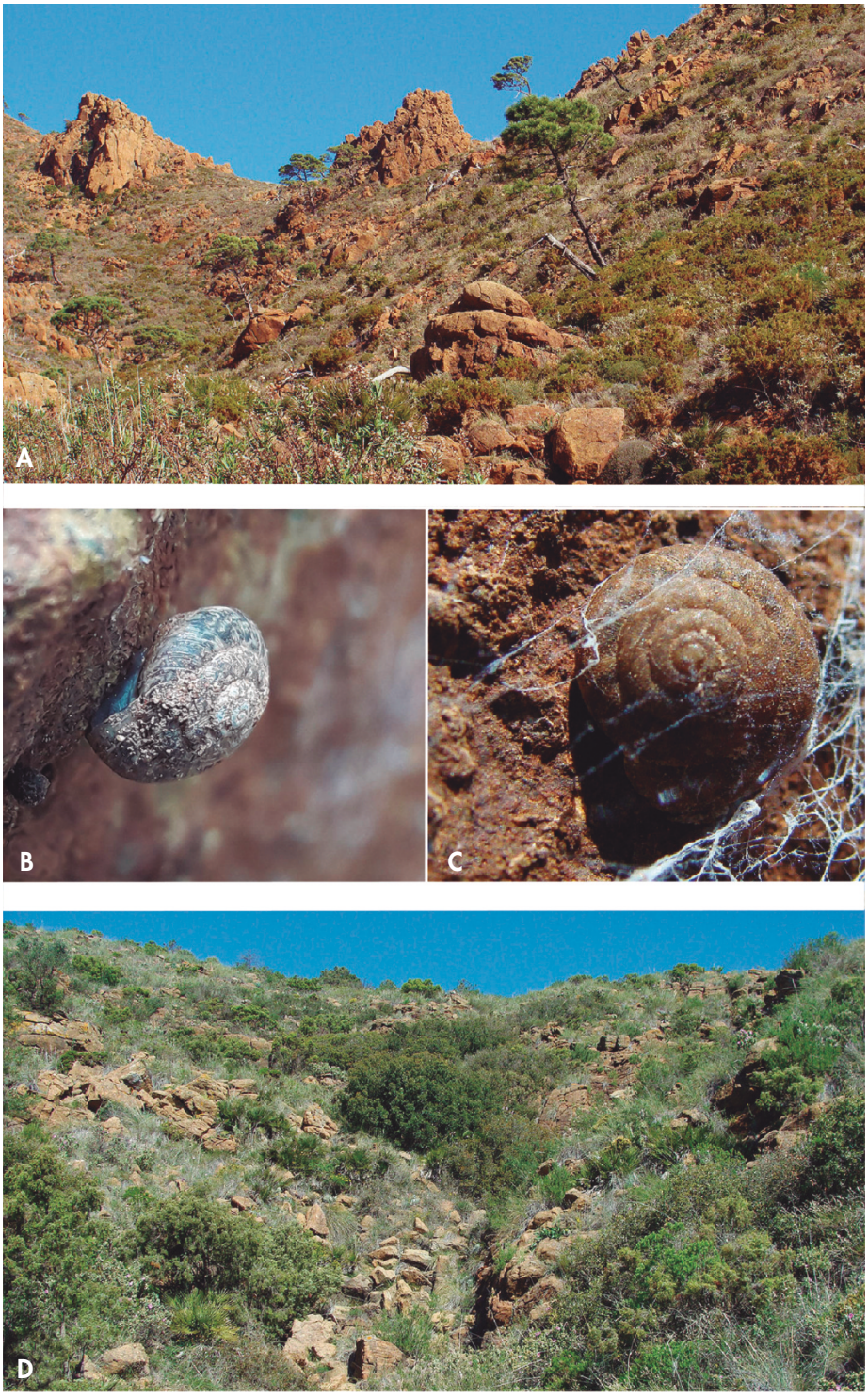
Figura 3. Mapa mostrando la principal área de distribución de Peridotitea bermejensis *gen. & sp. nov. en la provincia de Málaga, España. Áreas con fondo rojizo: peridotitas; puntos negros: localidades muestreadas. Ver texto para datos adicionales sobre las localidades.*

somewhat shorter than penial flagellum and the branches each less than one-half of its basal width). Bursa copulatrix duct branches off end of proximal vagina immediately above bases of mucus glands; duct initially a cylinder nearly as wide as vas deferens, tapering proximally to one-half of this width, its length over twice that of vagina, somewhat convoluted *in situ*, as it passes proximally alongside spermoviduct. Bursa copulatrix reservoir a thin-walled triangular to elongate-D shaped sac, lying on surface of spermoviduct. Free oviduct an extremely short cylinder, its distal end arising almost perpendicular to junction of bursa copulatrix duct with vagina. Right ommatophore-retractor muscle free of penial/vaginal angle (in dorsal view, passing left of and outside penial complex).

The penis was opened longitudinally to reveal internal structures in

(Right page) Figure 4. Habitats and living individuals of *Peridotitea bermejensis* gen. & sp. nov. in Prov. Málaga, Spain. A: type locality at Los Pedregales, Sierra Bermeja, February 2014; B: on underside of peridotite rock, Puerto de las Golondrinas, Tolox, May 2017; C, D: Sierra de Aguas, April 2016.

(Página derecha) Figura 4. Hábitats y ejemplares vivos de Peridotitea bermejensis *gen. & sp. nov. de la provincia de Málaga, España. A: localidad típica de Los Pedregales, Sierra Bermeja, febrero 2014; B: en la parte inferior de una roca de peridotita, Puerto de las Golondrinas, Tolox, mayo 2017; C, D: Sierra de Aguas, abril 2016.*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another mature specimen from the type locality (CGAH: E436, Fig. 2G). This showed that the epiphallus continued distally as a thick-walled tube, passing (with a sharp fold) through the lumen of the proximal penis, continuing into distal penis where it formed a long conical-cylindrical, muscular verge, folded *in situ*, with an apical slit-like opening. Most of the penis was surrounded by a thin loose sheath. Inside the sheath the outer wall of the penis was continuous from the epiphallus to the genital atrium as a muscular penis wall. The proximal penis had the wall thin and smooth internally. The distal penis had a thicker wall throughout, with complex internal structure, comprising a large transverse muscular flap 1 (pilaster) near the middle, along with two adjacent flaps (flap 2 and flap 3) running longitudinally in parallel along one side of the most distal half, with three lower longitudinal parallel ridges along the other half. The junction of the distal penis and proximal penis was marked by a thinning of the outer wall, with the thicker distal wall joined internally to the wall of the proximal end of the verge, separating lumens of proximal penis and distal penis.

Two almost mature snails from Cerro del Hijar (largest almost fully dissected: Fig. 2D-F, other partly dissected) both similar to holotype in all of main characters seen. Largest body had: vas deferens again a thick tube throughout its length, with evident thin outer sheath; distal penis sheath translucent, revealing internal structure (see drawing); band around distal end of wide proximal penis appeared to be glandular; external genital pore on side beneath base of right ommatophore and low down (one-third of distance upwards from foot-fringe towards base of ommatophore); vagina with its outer edge attached along most of its length to body wall with numerous strands of connective tissue, but free proximally around insertion of mucus glands.

The two largest of the immature specimens from Puerto Banaero had small genitalia, respectively about one-third and one-quarter the size of those of the holotype. However, both clearly had the right occulomotor-retractor muscle free of penial/vaginal angle. The larger individual also showed sufficient development of the penial complex to confirm essential similarity to that of the holotype. The distal female tracts were poorly developed on both specimens, with mucus glands short and mainly undeveloped even on the largest of them.

DISCUSSION

The shell characters of *Peridotitea bermejensis* sp. nov. resemble those of some of the species of *Helicella* A. Férussac, 1821, *Xeroplexa* Monterosato, 1892, or *Xerocrassa* Monterosato, 1892. The shared characters include rather small size, low-conical shape, open umbilicus, sculpture of close radial-tangential ribs, presence of short hairs, and features of coloration, including spiral dark and light bands and blotching or streaking of light colour. Consistent presence in *Peridotitea bermejensis* of only a single dark spiral colour band and absence of any thickening inside the aperture would be rather infrequent characters among "helicellids" but far from unique. The thin shell seems easily explained by the scarcity of calcium in habitat overlying peridotite rocks.

The "helicellid" genera have been subjected to varied taxonomic treatments over the past few decades. The former recognition of a subfamily Helicellinae in Helicidae *sensu lato* was based partly on shell characters and partly on those of the distal genitalia. SCHILEYKO (1991) challenged that arrangement, suggesting instead that the "helicellids" with pale banded shells were merely a polyphyletic assortment of Hygromiidae Tryon, 1866 that had adapted to xerophilous open habitats such as grasslands, since their range of genital characters overlapped broadly with those of

brown-shelled hygrophilous woodland taxa having shell hairs.

Recent phylogenetic analyses based on molecular data (RAZKIN *et al*., 2015) have clarified the position of the "helicellids", confirming some earlier molecular studies involving fewer taxa and fewer molecular markers (e.g. MANGANELLI, SALOMONE & GIUSTI, 2005). They showed that they form a distinct clade from the Hygromiidae which they recognised as Geomitridae. The genera they placed in Geomitridae based on molecular data included *Actinella* R.T. Lowe, 1852, *Caseolus*, R.T. Lowe, 1852, *Discula* R.T. Lowe, 1852, *Cochlicella* A. Férussac, 1821, *Ponentina* P. Hesse, 1921 and *Plentuisa* Puente & Prieto, 1992 in addition to those normally regarded as "helicellids" (*Xerotricha* Monterosato, 1892, *Helicopsis* Fitzinger, 1833, *Helicella*, *Trochoidea* T. Brown, 1827, *Cernuella* Schlüter, 1838, *Xerosecta* Monterosato, 1892, *Xeroplexa* Monterosato, 1892). However, all taxa they analysed with "helicellid" shell features as listed above fell within Geomitridae.

The anatomy of the distal genitalia of *P. bermejensis* does not closely match that of any genus of Helicacea for which the anatomy is known (cf. SCHILEYKO, 2004, 2005, 2006). The presence of two very small vaginal appendages in the position usually occupied by (larger) dart sacs in Geomitridae is noteworthy and reminescent of the existence of mostly larger vaginal appendages in such genera as *Actinella*, *Caseolus*, *Geomitra* Swainson, 1840, *Trochoidea* and *Xerocrassa* Monterosato, 1892 (e.g. SCHILEYKO, 2005), as well as some species but not others in *Ponentina* (HOLYOAK & HOLYOAK, 2012). Dart sacs "reduced" to similar appendages also occur in Hygromiidae, including *Euomphalia* Westerlund, 1889, *Mengoana* Ortiz de Zárate López, 1951, *Prostenomphalia* Baidashnikov, 1985 and *Stenomphalia* Lindholm, 1927 (SCHILEYKO, 2005).

The right ommatophore retractor muscle (ror) is free of the distal genitalia in *P. bermejensis* (confirmed for all three populations studied anatomically), whereas many of the Geomitridae have it passing through the penial-vaginal angle, although *Cernuella*, *Helicella*, *Microxeromagna* Ortiz de Zárate López, 1950, *Xeroplexa* and *Xerosecta* are among numerous exceptions with the ror free; likewise, some Hygromiidae have a free ror. SCHILEYKO (1991) dismissed the importance of this character because it appears independently in various apparently unrelated taxa, as well as being different within groups that otherwise appear related, such as his Trichiinae Ložek, 1956 (= Trochulinae Lindholm, 1927).

The functional significance of a free ror in Geomitridae and Hygromiidae is anyway uncertain. FRIAS MARTINS (2002: 213) commented "it is said that this situation [free ror] has bearing on the copulatory behaviour of xerophilous snails, which can thus copulate without exiting the shell". Not excluding that possibility, it may also be related to the course of the penis and vagina having moving downwards on the right-hand side of the body. The low position of the external genital pore in *P. bermejensis* would be congruent with the latter explanation.

The combination of a free ror and dart sacs reduced to small vaginal appendages appears to be currently known in Geomitridae only in *Moreletina obruta* (Morelet, 1860), which is endemic on Santa Maria in the Azores. However, that species differs from *P. bermejensis* in having only a single vaginal appendage and single mucus gland, possessing a penial caecum, shorter penis with distal swelling, and lacking shell hairs (FRIAS MARTINS, 2002).

Overall, the closest match for the characters of the distal genitalia of *Peridotitea bermejensis* appear to be with some of the species of *Ponentina* showing apparent reduction of the female tract, especially *P. grandiducta* G.A. Holyoak & D.T. Holyoak, 2012, *P. curtivaginata* D.T. Holyoak & G.A. Holyoak, 2012, and *P. papillosa* G.A. Holyoak & D.T. Holyoak, 2012 (HOLYOAK & HOLYOAK, 2012); these also have paired vaginal appendages, up to four mucus glands and very similar structure of the penis complex. However, they do not have two-branched mucus glands (which are nevertheless known in other *Ponentina* species), the vaginal appendages differ in

shape, the ror is not free, and perhaps more radically, the shell characters are very different (fewer whorls; larger aperture; lacking "helicellid" coloration).

Marked reduction of the female genitalia within *Ponentina* mostly comprises loss of darts, reduction in size of the dart sac and loss of the conjoined accessory sac. It occurs mainly in species restricted to calcium-poor sites, characterising six of the eight species of these habitats. It was suggested that extreme shortage of calcium may preclude production of the calcareous darts in the genus, or that very low population densities may lead to predominance of self-fertilization, or mating only with close kin. (Holyoak & Holyoak, 2012: 224-225).

Since *Peridotitea bermejensis* differs greatly from all *Ponentina* in shell characters as well as the free ror it does not belong in that genus. Instead, it might show similar distal genitalia as a result of convergence from a quite different ancestral form with a "helicellid" shell type, maybe *Helicella*, or even *Xerocrassa* which is well represented on calcareous hills in southern Andalucia. It therefore seems best to place the *Peridotitea bermejensis* in a new monotypic genus. In future, comparative molecular data may become available for more taxa of Geomitridae and allied groups of Helicacea which will allow analysis of whether *P. bermejensis* occupies an isolated position or has been derived more recently through reduction of the distal female genitalia.

Finds of *Peridotitea bermejensis* were on five different groups of peridotite hills, most often under stones or boulders. Fig. 3 shows that in the area investigated for land-snails in most detail it ranges widely on three groups of peridotite hills, with no records at all from other lithologies, including much rocky limestone country. Although recorded from seven separate localities, it was judged to be scarce or very scarce overall at six of the seven localities. Indeed, it, occurred at low densities at all of them, being locally more common only at Los Pedregales in Sierra Bermeja.

Peridotite is a coarse-grained ultramafic igneous rock that weathers to serpentinite. It is mainly composed of the mineral olivine, a magnesium orthosilicate. Levels of calcium are variable within the olivine group of minerals but often low, so that soils developed over peridotite or serpentinite commonly support few snails unless there is an input of calcareous wind-blown sand or silt.

The vegetation on the areas with *P. bermejensis* is of distinctive Thermo-Mediterranean types that are associated with serpentinite rock (Fig. 4A, D). At these low elevations it was formerly composed mostly of *Pinus pinaster* Aiton woodland, which is replaced following clearance, overgrazing or fires, or on rocky terrain, by scrub formed of *Chamaerops humilis* L., *Centaurea lainzii* Fern., *Notholaena marantae* (L.) Desv., *Iberis fontqueri* Pau, *Genista hirsuta* Vahl subsp. *lanuginosa* (Spach) Nyman, *Allium rouyi* Gaut., etc. These hills with peridotite or serpentinite rocks support numerous globally endemic vascular plants that are absent from adjacent limestone hills. Other species of terrestrial molluscs present on the peridotite are *Oestophora ebria* (Corbella, 2004), *Iberus* cf. *marmoratus* (A. Férussac, 1821), *Ferussacia folliculum* (Schröter, 1784), *Ponentina martigena* (A. Férussac, 1832), *Geomalacus moreleti* (Hesse, 1884), *Backeljaia gigaxii* (L. Pfeiffer, 1847), *Otala lactea* (O.F. Müller, 1774) and *Milax gagates* (Draparnaud, 1801).

The upper area of Sierra Bermeja, over 1000 metres above sea level, is protected as a "Paraje Natural", whereas the lower part of this Sierra and the other peridotite areas in Málaga Province remain unprotected. *P. bermejensis* has been found only from 246-855 m elevations. The low density observed for its populations, construction of tracks and the frequency of forest fires indicate a need to provide more protected sites for this species.

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