

The subgenus *Monilearia* (*Lyrula*) Wollaston, 1878 (Gastropoda: Helicoidea: Cochlicellidae) from Lanzarote and Fuerteventura (Canary Islands), with the description of *Monilearia* (*Lyrula*) *tubaeformis* sp. nov.

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Abstract

Monilearia tubaeformis sp. nov. is described from Fuerteventura (Canary Islands) and placed in the taxon *Lyrula* Wollaston, 1878, previously considered as monospecific, for its distinctive type of shell ornamentation. *Helix multipunctata* Mousson, 1872, from the same island, is also placed in *Lyrula* because it has similar shell ornamentation. The anatomy of the genital system of both species shows that *Lyrula* should be treated as a subgenus of *Monilearia* Mousson, 1872. A new diagnosis of *Monilearia* (*Lyrula*) is added.

Key words: Gastropoda, Cochlicellidae, *Monilearia*, *Lyrula*, taxonomy, Lanzarote, Fuerteventura, Canary Islands

Introduction

The Canarian endemic genus *Monilearia* was established by Mousson (1872) grouping initially nine species based only on morphological characters of the shell. Later on, Wollaston (1878) established *Lyrula*, near to *Monilearia*, for *Helix loweana* Wollaston, 1878, a small and elegant species from Lanzarote with peculiar shell ornamentation. *Lyrula* was considered as monospecific until now. Genital system anatomy of the only species is unknown.

There are other Canarian species that possibly belong to *Monilearia* based on general shell morphology (Table 1). A description of the genital system and other anatomical data

TABLE 1. Data of species possibly belonging to *Monilearia*. The subgenus *Monilearia* (*Lyrula*) groups the last three species.

Island	Species name and synonyms	Literature data
Tenerife	<i>Helix phalerata</i> Webb & Berthelot, 1833 [<i>persimilis</i> var. <i>devia</i> Mousson, 1872; <i>nivariensis</i> Shuttleworth, 1852]	Webb & Berthelot (1833); Shuttleworth (1852a, 1975); Mousson (1872); Wollaston (1878); Tryon (1888); Hesse (1911, 1926); Thiele (1931); Odhner (1932); Bank <i>et al.</i> (2002); Neubert & Gosteli (2003)
Tenerife	<i>H. woodwardia</i> Mousson, 1872	Mousson (1872); Pfeiffer (1876); Wollaston (1878); Tryon (1888); Odhner (1932)
almost all the islands	<i>H. persimilis</i> Shuttleworth, 1852	Shuttleworth (1852a, 1975); Mousson (1872); Wollaston (1878); Tryon (1888); Odhner (1932); Neubert & Gosteli (2003)
Gran Canaria	<i>H. praeposita</i> Mousson, 1872	Mousson (1872); Pfeiffer (1876)
Gran Canaria	<i>H. inops</i> Mousson, 1872	Mousson (1872); Pfeiffer (1876); Wollaston (1878); Schileyko & Menkhorst (1997); Ibáñez <i>et al.</i> (2003); Schileyko (2004)
Gran Canaria	<i>Monilearia montigena</i> Bank, Groh & Ripken, 2002 [<i>lemniscata</i> Webb & Berthelot, 1833]	Webb & Berthelot (1833); d'Orbigny (1836); Pfeiffer (1848); Mousson (1872); Wollaston (1878); Odhner (1932); Bank <i>et al.</i> (2002)
Gran Canaria	<i>H. caementitia</i> Shuttleworth, 1852 [<i>persimilis</i> var. <i>umbilicata</i> Wollaston, 1878]	Shuttleworth (1852b, 1975); Pfeiffer (1853); Mousson (1872); Wollaston (1878); Tryon (1888); Bank <i>et al.</i> (2002); Neubert & Gosteli (2003)
Gran Canaria	<i>H. watsoniana</i> Wollaston, 1878	Wollaston (1878)
Gran Canaria	<i>H. tumulorum</i> Webb & Berthelot, 1833 [<i>tumulorum</i> var. <i>arucasensis</i> Gude, 1896; <i>tumulorum</i> var. <i>pulchra</i> Gude, 1896]	Webb & Berthelot (1833); d'Orbigny (1836); Mousson (1872); Wollaston (1878); Tryon (1888); Gude (1896); Odhner (1932); Bank <i>et al.</i> (2002)
Gran Canaria	<i>H. arguineguinensis</i> Seddon & Aparicio, 1998	Seddon & Aparicio (1998)
Gran Canaria	<i>H. pulverulenta</i> R.T. Lowe, 1861	Lowe (1861); Pfeiffer (1868); Mousson (1872); Wollaston (1878)
La Palma and El Hierro	<i>H. oleacea</i> Shuttleworth, 1852 [<i>deusta</i> R.T. Lowe, 1861]	Shuttleworth (1852a, 1975); Lowe (1861); Mousson (1872); Wollaston (1878); Tryon (1888); Odhner (1937); Bank <i>et al.</i> (2002); Neubert & Gosteli (2003)
Lanzarote and Fuerteventura	<i>H. monilifera</i> Webb & Berthelot, 1833	Webb & Berthelot (1833); d'Orbigny (1836); Pfeiffer (1859); Mousson (1872); Wollaston (1878); Tryon (1888); Odhner (1932); Reischütz (2003)

to be continued.

TABLE 1 (continued).

Island	Species name and synonyms	Literature data
Fuerteventura (see note below)	<i>H. umbicula</i> Shuttleworth, 1852	Shuttleworth (1852b, 1975); Mousson (1872); Pfeiffer (1876); Wollaston (1878); Bank <i>et al.</i> (2002); Neubert & Gosteli (2003)
Fuerteventura	<i>Helix granostrata</i> Mousson, 1857	Mousson (1857, 1872); Wollaston (1878)
Lanzarote	<i>H. loweana</i> Wollaston, 1878 [<i>torrefacta</i> R.T. Lowe, 1861; <i>usurpans</i> Furtado, 1886]	Lowe (1861); Mousson (1872); Wollaston (1878); Furtado (1886); Bank <i>et al.</i> (2002); this study
Fuerteventura	<i>H. multipunctata</i> Mousson, 1872	Mousson (1872); Wollaston (1878); Odhner (1932); this study
Fuerteventura	<i>Monilearia tubaeformis</i> Alonso & Groh, sp. nov.	this study

Note: *H. umbicula* has been considered as originating from Madeira (Neubert & Gosteli 2003) or from outside Macaronesia (Bank *et al.* 2002) but we found shells as the ones figured in Shuttleworth (1975) in the central area of Fuerteventura.

of *M. phalerata* (Webb & Berthelot, 1833) and *M. inops* (Mousson, 1872) as well as that of the radula of *M. tumulorum* (Webb & Berthelot, 1833) has been published elsewhere (Hesse 1911; Odhner 1932; Schileyko & Menkhorst 1997). Hesse (1926) and Thiele (1931) were the first ones indicating that *M. phalerata* is a species close to the genus *Cochlicella* A. Férussac, 1821, in respect to the branched vaginal stimulator appendix of *M. monilifera* (Webb & Berthelot, 1833). Subsequently, Schileyko & Menkhorst (1997), Ibáñez *et al.* (2003) and Schileyko (2004) placed *Cochlicella* and *Monilearia* in the family Cochlicellidae Schileyko, 1972, which is characterized mainly by its well-developed stimulator appendix with 1–3 apical, simple, or ramified tubular mucous glands. The stimulator is similar to the penial appendix of the Orthurethra, except that the A₃ portion is not present because it was already reduced in the stem form of the Helicoidea (Hausdorf 1998).

Lanzarote and Fuerteventura are the easternmost and oldest islands of the Canary Archipelago (Fig. 1), Fuerteventura situated only 110 km off the Northwest African coast. Both islands have an arid climate (annual rainfall is ca. 100 mm) and they are considered to be the western outpost of the Saharan Zone (Ortiz *et al.* 2006). Both islands are separated by a narrow strait less than 40 m in depth. They were interconnected in the past during times of lower sea levels, most recently during the last glaciation period, in which the sea level dropped more than 100 meters (Carracedo *et al.* 2005). Thus, almost half of the Canarian endemisms present in Lanzarote are also present in Fuerteventura and several taxa are endemic to both islands, with *Lyrula* being one of them.

In this paper the two *Lyrula* species above mentioned (*H. loweana* and *H. multipunctata*) are re-described including data of the genital system of *L. multipunctata*. A

new *Lyrula* species from Fuerteventura is also described. The relations between *Lyrula* and *Monilearia* are shown, and a new diagnosis of *Monilearia* (*Lyrula*) is added. We only describe the distal genitalia (excluding the spermoviduct, albumen gland and gonad).

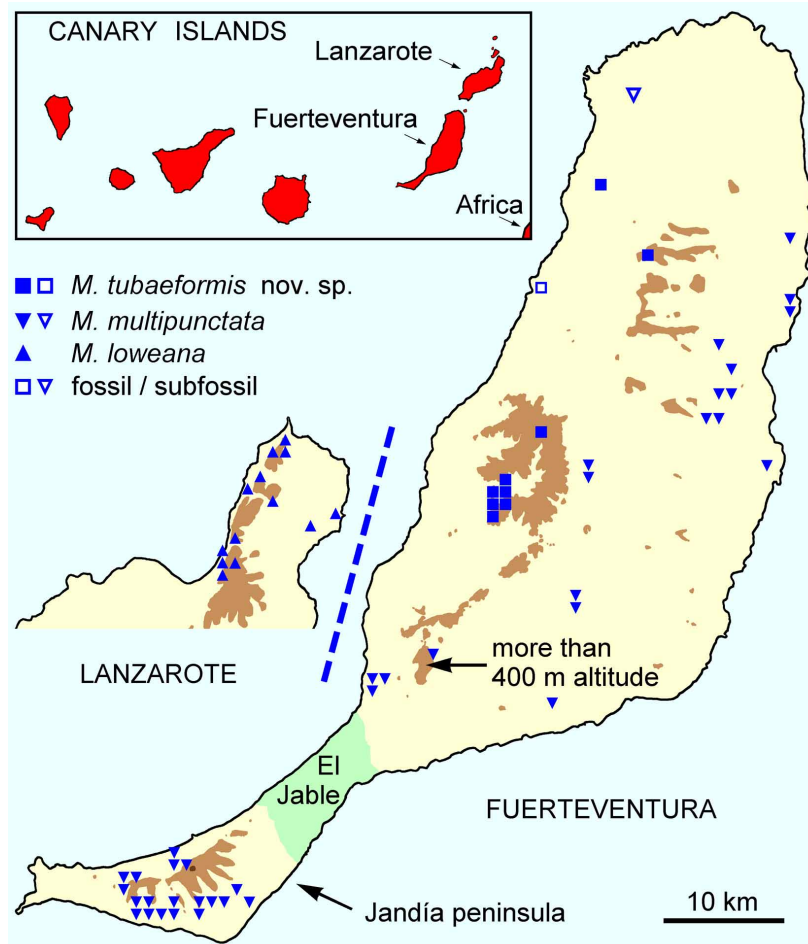


FIGURE 1. Geographical distribution of *Monilearia tubaeformis* sp. nov., *M. multipunctata*, and *M. loweana*. Symbols represent 1 x 1 km UTM squares.

Methods

The photographic methodology is the same as that of Ibáñez *et al.* (2006). Standardized measurements were taken as shown in Figure 2. The shell measurements of the new species (Table 2) were obtained following Alonso *et al.* (2006a; 2006b) and Castillo *et al.* (2006), with the software analySIS® (Soft Imaging System GmbH 2002). Calculation of number of shell whorls follows Kerney & Cameron (1979: 13). The material used for the dissections is in the AIT ethanol collection. "Proximal" and "distal" refer to the position in relation to the gonad.

- AIT Alonso & Ibáñez collection, Department of Animal Biology, University of La Laguna, Tenerife, Canary Islands, Spain
- CGH K. Groh private collection, Hackenheim, Germany
- CKW Klaus Kittel private collection, Wiesthal, Germany
- TFMC Museo de Ciencias Naturales de Tenerife, Canary Islands, Spain
- UTM Universal Transverse Mercator, cartographic projection system
- ZMZ Zoologisches Museum der Universität Zürich, Switzerland

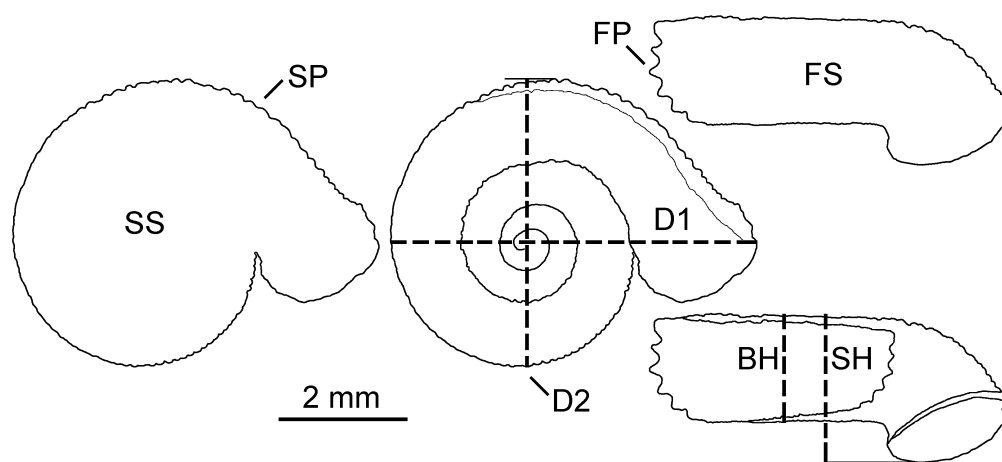


FIGURE 2. *Monilearia tubaeformis* sp. nov. holotype shell showing the placement of the measurements obtained for table 2. BH, body whorl height (without the aperture zone); D1, maximum shell diameter; D2, shell diameter perpendicular to D1; FP, shell frontal perimeter; FS, shell frontal surface (plane view); SH, shell height; SP, shell perimeter (dorsal plane view); SS, shell surface (dorsal plane view).

TABLE 2. *Monilearia (Lyrula) tubaeformis* sp. nov. Shell dimensions (in mm or mm², 12 specimens measured). SD, standard deviation; Min, minimum; Max, maximum; other abbreviations same as in Fig. 2.

Character	Mean	SD	Min	Max	Holotype
D1	5,09	0,27	4,71	5,6	5,60
D2	4,25	0,29	3,77	4,6	4,49
SS	15,11	1,77	12,2	17,43	17,04
SP	15,76	0,91	14,47	17,15	17,15
SH	1,93	0,23	1,64	2,37	2,30
FS	6,87	0,73	6,03	8,77	8,77
FP	13,02	0,66	12,26	14,69	14,69
BH	1,55	0,11	1,33	1,7	1,69

Systematics**Genus *Monilearia* Mousson, 1872**

Type species (by subsequent designation of Pilsbry 1895): *Helix phalerata* Webb & Berthelot, 1833.

Subgenus *Lyrula* Wollaston, 1878

Type species (by monotypy): *Helix [Lyrula] loweana* Wollaston, 1878.

Diagnosis: Small *Monilearia* with a disk-like, almost flat to sunken shell, conspicuously umbilicated, ornamented with sharp, densely-packed, oblique sub-undulating transverse riblets, decussated by multiple minute spiral lines above and below the angled periphery, in one species are several (12–13) pronounced spiral ribs.

This subgenus groups the species *Monilearia loweana*, *M. multipunctata* and *M. tubaeformis* **sp. nov.**

***Monilearia (Lyrula) loweana* (Wollaston, 1878)**

Helix [Actinella] torrefacta R.T. Lowe, 1861, 106–107 [Primary homonym of *Helix torrefacta* C.B. Adams, 1849, from Jamaica (*Sagda torrefacta*)]. Type locality: "Hab. in rupium facie aridissima aprica, sole occidentali calefacta, supra "Salinas" Ariae ad oram septentrionalem Caurum versus Ins. Lanzarotae, in foraminulis superficialibus basalti cis vesicularibus praesertim latitans".

Helix [Lyrula] loweana Wollaston, 1878, 382–383.

Helix usurpans Furtado, 1886, 87.

Lyrula loweana Bank et al., 2002, 118.

Material. Four empty shells of *Helix torrefacta* (ZMZ 506118/4, leg. Wollaston, 1870), 34 empty shells collected between February 1980 and February 1996, in several localities of the North of Lanzarote (Fig. 1).

Distribution and habitat (Fig. 1). The species is endemic to Lanzarote. It can be traced between 50 and 600 m altitude, in lowland vegetation-type. It lives in the steep coastal areas from the extreme north of the island (El Risco) to the Peñas del Chache and also occurs in the young volcanic lava-streams, in Spanish named "Malpaís" (badlands). It can be found between lichens, in cracks and on the rock surface, within the Natural Reserve of the Archipelago "Chinijo" (north of the island and the surroundings islets), in the Natural Monument of La Corona, and also outside the protected areas of the island.

Description. The elegant discoidal shell (Fig. 3 A) has a nearly flat to slightly elevated spire with a pointed apex; it embraces 4–4½ slowly growing whorls that are moderate

convex, angled at the beginning of the body whorl. The suture is deeply impressed, but simple, the regularly rounded umbilicus is not very wide, but deep and open. The last eighth of the body-whorl is slightly bent downwards obliquely to the square flat ovate aperture. This has a delicate, discontinuous peristome with a non reflected, but slightly thickened lip.

The ornamentation is more pronounced on the dorsal side. There are many radial, laminar riblets crossed by 6–8 fine spiral, also laminar riblets (Fig. 3 B–D), delimiting very numerous, small rectangular areas (reminding of honeycomb cells) which have a fragile, *lacinae*-like bristle in each corner; each bristle is a prolongation of both transverse and radial riblets (Fig. 3 D). Many of the bristles are lost in adult specimens. Each rectangular “cell” can be subdivided by more fine, spiral riblets (Fig. 3 D), leading to the appearance of a fine reticulation. The protoconch is coloured brown with 1–1¼ whorls; at the very beginning it is smooth (approximately ¼–½ whorl), but then it is sculptured by the first radial riblets. The teleoconch is also brown, ornamented with alternating irregular lighter flames (Fig. 3 A), which occupy approximately the same space as the brown colour. In some specimens an obscure brown spiral band can be traced beneath the periphery; the lower part of that band may be interrupted by small white dashes.

Monilearia (Lyrula) multipunctata (Mousson, 1872)

Helix [Discula] multipunctata Mousson, 1872, 54–55, 153, 162, pl. 3 fig. 16–18. Type locality: “Fuerteventura”. It was considered as extinct by the author.

Material. Holotype (empty shell): *Helix multipunctata* (ZMZ 505020, leg. Fritsch, 1863, subfossil). 43 total specimens and 136 empty shells collected between March 1989 and May 2005, in several localities of Fuerteventura (Fig. 1).

Distribution and habitat (Fig. 1). A species endemic to Fuerteventura, where it occurs in dry areas with lowland vegetation, at an altitude of 10–300 m.

Description. The soft body is coloured light brown, the dorsal part being darker.

The shell (Fig. 3E,F) is discoid, with the spire little elevated or even nearly flat but with the protoconch projecting; with 3½–4 moderately convex whorls, distinctly angulated at the periphery; suture deep; umbilicus slightly eccentric, moderate wide, deep and open. The last quarter of the body-whorl is bent downwards obliquely. Aperture well rounded, square ovate, sometimes weakly angulated at the palatal side, the peristome margins normally united and slightly detached from the last whorl; the peristome has a very narrow (0.1–0.2 mm) reflected white lip. In the exceptional cases where the lip is discontinuous, its insertion points at the last whorl are mutually separated less than 0.7 mm.

The ornamentation is stronger on the dorsal side, similar to that of *M. loweana* (Fig. 3F). The protoconch is brown, with 1–1¼ whorls, initially smooth (approximately ¼–½ whorls) while its distal part bears very fine radial ribs. The teleoconch is also brown

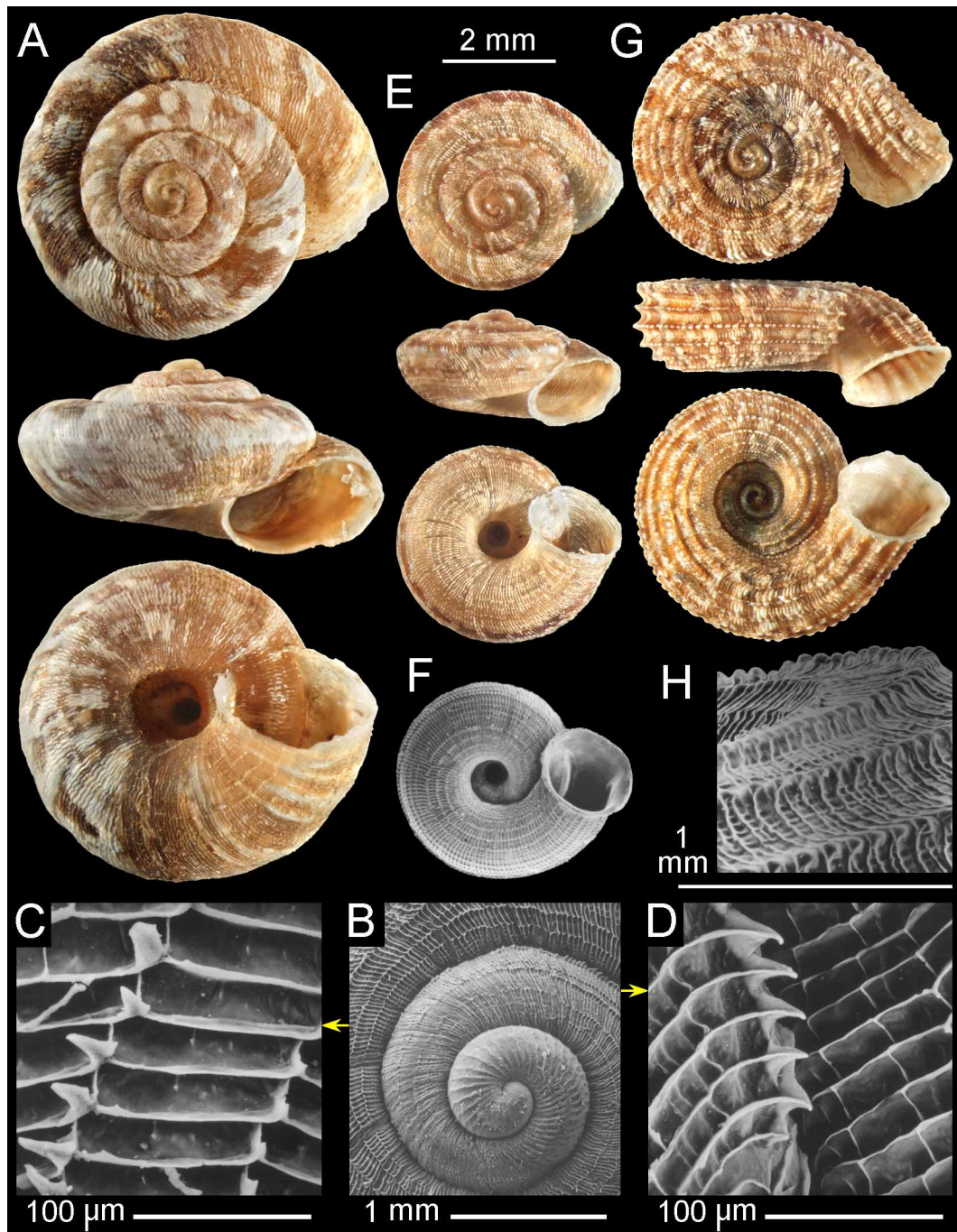


FIGURE 3. Shell and SEM details. A–D. *Monilearia loweana*; A. from Valle Chico; B–D. from Mirador de Malpaso; C. Some bristles of third whorl rectangular “cells”; D. “cell” subdivisions and a line of bristles between second and third whorls; E–F, *Monilearia multipunctata*; E. from Barranco de Gran Valle; F. from Rosa de Zapata; G–H, *Monilearia tubaeformis* sp. nov. G. Holotype, from Lomo del Aceituno; H. Paratype, from Vega de Río Palmas, detail of shell ventral-lateral side. Scale bar (2 mm) applies to A, E, F, G.

alternating with irregular whitish radial streamers, more frequent in the last 1½ whorls of the dorsal side; in the ventral side the streamers are less conspicuous. There are two darker brown spiral bands above and below the periphery, irregularly interrupted by light brown dashes.

Usually it has a dark mantle with whitish stains (in some specimens the whitish surface area is larger than the dark one). The kidney measures less than half the length of the lung; the secondary ureter is extremely short, almost missing. In fully mature specimens, the genital system (Fig. 5B) occupies nearly the whole visceral bulk, the spermoviduct being the most voluminous part. Several specimens of the population located immediately north of “El Jable” (Fig. 1) had a duplicated male duct (Fig. 5C).

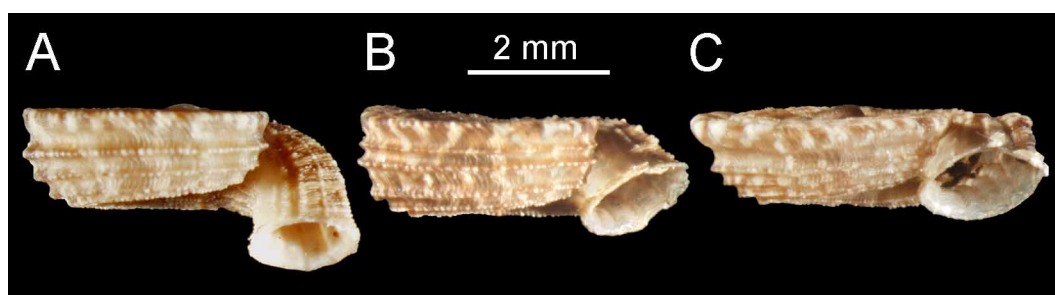


FIGURE 4. *Monilearia tubaeformis* sp. nov. paratypes, showing the shell variability. A–B. from the type locality; C. from Vega de Río Palmas.

Monilearia (Lyrula) tubaeformis Alonso & Groh, sp. nov.

Type locality. Lomo del Aceituno, Fuerteventura (UTM: 28RES8839, 350 m altitude).

Holotype. TFMC (MT 0390); leg. M.R. Alonso and M. Ibáñez, 30 Dec 1993.

Paratypes. 127 paratypes (56 ethanol specimens and 71 shells, collected between 1987 and 2004), CGH (42 paratypes), CKW (38 paratypes) and AIT (47 paratypes).

Etymology. The name *tubaeformis* refers to the shell form, resembling a bugle.

Distribution and habitat (Fig. 1). The species is endemic to Fuerteventura. It occurs at an altitude of 300–600 m, in dry open areas of arid subtropical shrub and small ravines, mostly with *Euphorbia balsamifera* Aiton, 1789, mainly under stones.

Description. Soft body brownish, the dorsum moderately darker than the sides. Shell (Table 2; Fig. 3G) with a flat or even sunken spire, and with a twice significantly angulated periphery. It embraces about 3½ whorls, separated by an only slightly impressed suture. The umbilicus is eccentric, deep and very wide. The last quarter of the body-whorl descends considerably in respect to the prior quarter, the last part becoming completely separated from the coil, being bended down — and outwards and widened a bit (approx. 0.2–0.25 mm), resembling the bell of a tuba and showing some variability in its length and inclination (Fig. 4). The aperture is well rounded, only with a small angulation in its outer

edge. The peristome is free, its edges all around slightly reflected, forming a narrow white lip approximately 0.25 mm wide. The peculiar ornamentation of the teleoconch is of the *Lyrula* type (Fig. 3H) but very much developed, being stronger at the lateral and ventral parts of the shell. At the dorsum it is formed by numerous fine radial riblets which bear in regular intervals raised glossy lobulations which are placed such that they give the appearance of 5–6 spiral costulations that form a reticulation with the radial riblets. The lateral and ventral part exhibits 8–9 significant spiral lobulated ribs, which are not interrupted by the radial riblets; in the contact zone between a spiral rib and each two radial riblets, a nodule is differentiated (Fig. 3H). Additionally, between each two contiguous spiral ribs there are several fine, regular spiral riblets which are crossed by the radial riblets. The protoconch is slightly prominent, brown, with 1–1¼ whorls, initially smooth (approximately ¼–½ whorls) and its distal part bearing fine radial riblets. The teleoconch is coloured light brown, patterned with narrow, darker, irregular radial flames.

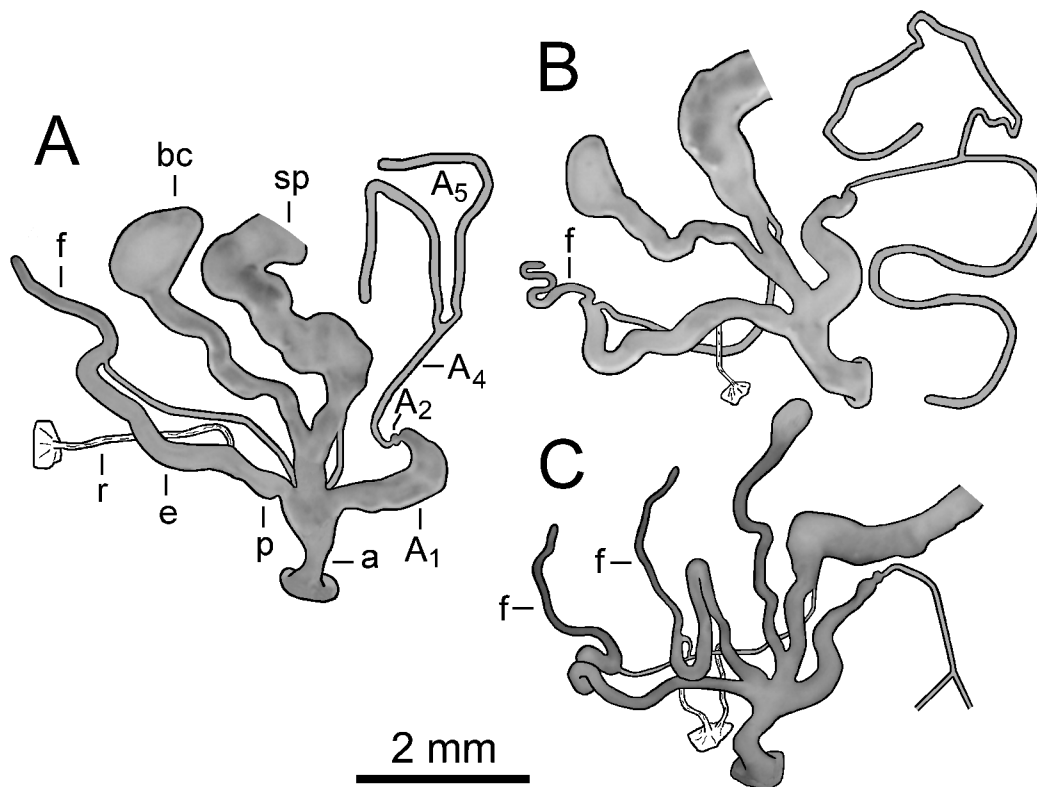


FIGURE 5. Drawings of genital systems. A. *Monilearia tubaeformis* sp. nov., paratype from Vega de Río Palmas; B–C. *Monilearia multipunctata*; from Casas de Ugán; C. genital system with the distal male duct duplicated; A₁–A₅, parts of the vaginal stimulator appendix (terminology after Schileyko, 1984: 39, fig. 18); a, atrium; bc, bursa copulatrix; e, epiphallus; f, flagellum; p, penis; r, retractor muscle; sp, spermoviduct.

The kidney measures less than half of the lung length; secondary ureter extremely short, almost absent.

Genital system (Fig. 5A; 3 specimens dissected): Atrium similar in length to distal male duct (between atrium and penis retractor muscle insertion), which measures about $\frac{1}{3}$ of the length of the proximal portion of the epiphallus and $\frac{1}{2}$ than that of the flagellum. The penis retractor muscle inserts at the epiphallus. The penis is slightly widened. The vagina is very short, its diameter similar to that of the free oviduct. The duct of the bursa copulatrix is long. The branched glandular portion (A_5) of the vaginal stimulator appendix is split into two digit-like, thin ducts that are slightly longer than the A_4 portion.

Remarks. The special shell ornamentation of *M. tubaeformis* and *M. multipunctata* is of the same type as that of *Helix loweana*, being a synapomorphy of these species. Because of this, the three species are placed in the supraspecific taxon *Lyrula*.

The genital system of *M. tubaeformis* and *M. multipunctata* is of the same type as that of *M. phalerata* and *M. inops*, indicating that *Lyrula* is a subgenus of the genus *Monilearia*, whose phylogenetic relationships within the family Cochlicellidae were recently established (Ibáñez et al. 2003).

M. tubaeformis is a species unambiguously different from all of the other Cochlicellidae species because of its very distinctive shell characters. It is less adapted to the driest conditions than *M. multipunctata*, which also colonized the Jandía Peninsula (Fig. 1). *M. tubaeformis* lives at a higher altitude, with more environmental humidity. It has been unable to cross the desert-like barrier of sand dunes occupying the isthmus of the Jandía Peninsula ("El Jable") to colonize the South of the island.

Acknowledgements

We are grateful to Dr. Bernhard Ruthensteiner (Munich), Dr. Ruud A. Bank (Hoofddorp) and an anonymous reviewer for their revision of the manuscript and to P. Agnew (Instituto de Productos Naturales y Agrobiología, Consejo Superior de Investigaciones Científicas) for linguistic revision. This research was supported by the scientific projects BOS2003–00374 and CGL2006–01586/BTE, of the Spanish Ministerio de Ciencia y Tecnología and Ministerio de Educación y Ciencia, respectively.

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