

**The slugs of the genus *Geomalacus* Allman, 1843, from the Iberian peninsula (Gastropoda: Pulmonata: Arionidae)<sup>1</sup>**

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New data on the morphology and geographical distribution of the species of the genus *Geomalacus* (*G. maculosus*, *G. oliveirae*, *G. anguiformis* and *G. malagensis*) on the Iberian peninsula are hereby contributed.

Key words: Gastropoda, Pulmonata, Arionidae, *Geomalacus*, taxonomy, distribution, Iberian peninsula.

INTRODUCTION

The genus *Geomalacus* Allman, 1843, comprises four species of arionine slugs, three of which are endemic on the Iberian peninsula. The fourth, *G. maculosus* Allman, 1843, occurs in the same region and also in the south-western corner of Ireland.

All the *Geomalacus* species have a long, dorso-laterally compressed body. Their backs show a greyish background hue, and the usual colour is grey, orange, yellow or reddish. Two or four longitudinal dark bands are present along the back and mantle; only *G. maculosus* is additionally provided with yellowish or white spots. In contrast to the allied genus *Arion*, the genital orifice in *Geomalacus* lies further forward (just behind the right ommatophore), the caudal mucous gland is smaller and the skin tubercles are thinner. A rudimentary shell, consisting of a compact calcareous plate, lodges under the mantle. The spermatheca duct and the epiphallus insert on the atrium with an atrial tubular extension, the diverticulum or atriopenis.

With three of the species restricted to a traditionally little-known area from a malacological point of view, the genus *Geomalacus* has suffered from a paucity of information (namely on species status, geographical distribution and iconography). The genus has been revised recently (Rodríguez et al., 1993) within its Portuguese range, but no Iberian survey had been published up to now. The present contribution is based on sampling work in 1991 and 1992; the material studied belongs to the collection of the Department of Animal Biology of the University of Santiago de Compostela.

KEY TO THE SPECIES

- 1a Slug with yellowish, greenish, or white spots on dorsum. With a long atrial diverticulum and a very short spermatheca duct ..... *G. maculosus*
- b Dorsum without spots. Atrial diverticulum relatively short ..... 2
- 2a Slug with two dark bands along dorsum, which is yellowish-brown or greyish. With a cylindrical, greatly enlarged, short epiphallus. Spermatheca duct of medium length ..... *G. malagensis*

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- b With four dark bands along dorsum, and occasionally also along mantle . . . . . 3  
 3a Medium-sized slug (70 mm long). Epiphallus thin and very long, 10-15 times as long as free oviduct. Spermatheca duct very long . . . . . *G. anguiformis*  
 b Small slug (45 mm long). With a thick epiphallus measuring 3 times the length of free oviduct. Spermatheca duct relatively short . . . . . *G. oliveirae*

## TAXONOMY

*Geomalacus maculosus* Allman, 1843, figs. 1-5, 19

*Geomalacus maculosus* Allman, 1843, Athenaeum: 851.

*Letourneuxia lusitanica* Da Silva e Castro, 1873, Jornal. Sci. Math. Phys. Nat. Lisboa 4: 243.

*Limax lusitanica* (*Letourneuxia*) Da Silva e Castro, 1873; Morelet, 1877, J. Conchyl., Paris 25: 259.

*Geomalacus grandis* Simroth, 1893, Abh. Senckenb. Naturf. Ges. 18: 291; Nobre, 1941, Fauna Malac. Portugal: 74; Castillejo, 1981, Iberus 1: 53.

Slugs (fig. 1) of medium-large size. The largest adult specimens studied measure 70 mm long when preserved (70% ethanol); mantle length 30 mm. A number of juveniles was also collected that measure 30 mm (mantle length 10 mm) when preserved. The dorsum of live individuals can be either greyish sprinkled with white spots, or greenish sprinkled with yellow spots, but the spots turn dark in preserved specimens. Along each side a dark band is visible, the right one arching above the pneumostome. Sole whitish, with a central furrow. Body mucus yellow. Under the mantle a whitish-translucent plate, representing the rudimentary calcareous shell is present (fig. 4); it shows intricate growth lines.

The genital atrium (fig. 2) is a long and sack-like structure, provided internally with transversal and longitudinal folds. The atrial diverticulum is very long and contains circular, fine folds, which results in a festooned appearance. The free oviduct is short, but in juveniles (fig. 5) relatively longer. The free oviduct is lined with longitudinally-oriented fine folds. The epiphallus is a helicoidal tube that is 30-40 mm long in preserved adult specimens; its internal surface is profusely lined with papillae which make up longitudinal folds. The vas deferens measures half the length of the epiphallus in adults and is proportionally shorter in juveniles. The spermatheca is spherical or ovoid in shape and the internal surface of its thick walls shows a number of folds surrounding the opening of the spermatheca duct (fig. 3). The spermatheca duct is short and before joining the atrial diverticulum, it receives the insertion of a long retractor muscle which reaches to the caudal region.

Distribution. — *Geomalacus maculosus* exhibits a typical Lusitanian or Atlantic range, inhabiting the south-west of Ireland and the north-western coastal strip of the Iberian peninsula, with records from the Serra da Estrela (central Portugal), as its known southernmost limits, to the Reserva de Saja (Cantabria, central-northern Spain, this paper), as its most easterly and northerly limits. The map (fig. 19) depicts the presumed range of the species on the Iberian peninsula.

The Iberian records of this species, up to 1990, have been compiled in Castillejo & Rodríguez (1991); more recent citations appear in Rodríguez (1990), Hermida (1991), and Rodríguez et al. (1993). In this study the following localities are added: Reserva del Saja (Cantabria), UTM UN97; Carrejo (Cantabria), UTM UN99; Puerto de los Tornos (Cantabria), UTM VN67; Biobra (Ourense), UTM PH70; Valporqueros (Sierra del Gato, León), UTM TN95; Puerto del Pontón (León), UTM UN37; Gedrez (Ranhadoiro, Asturias), UTM QH06.

Habitat and bionomics. — The specimens of *G. maculosus* examined for this study were found during rainy nights on the bark of oaks and beeches, and on the surface of stony walls, where they were browsing lichens. In Galicia, Asturias and Cantabria this is a non-anthropophilous species with a preference for montane forests and chestnut- and oak-tree groves. During some rainy mornings it is possible to see active individuals, but these are mainly juveniles, for the adults are generally of crepuscular and nocturnal habits, hiding so skilfully by day that they are not easily found.

*Geomalacus oliveirae* Simroth, 1891, figs. 6-8, 20

*Geomalacus oliveirae* Simroth, 1891, Nova Acta Acad. Caesar. Leop. Carol. 56 (2): 159.

*Geomalacus (Arrudia) anguiformis* (Morelet, 1845): Wiktor & Parejo, 1989, Malak. Abh. Dresden 14 (4): 27.

Slug (figs. 6, 7) of small size. Live adult specimens measure up to 50 mm in length, preserved ones about 30 mm. Dorsum brown with four darker longitudinal bands, although the internal ones are often not continuous. Lateral areas light in colour. Sole white, divided into three fields, of which the central one is very narrow. Body mucus yellow. In preserved specimens, the dorsum becomes blackish and the bands turn darker. The sole then changes to a yellowish-grey hue.

Genital atrium (fig. 8) rather long and cylindrical, provided with 7-9 longitudinal folds. Atrial diverticulum (atriopenis) cylindrical and very short. The spermatheca duct, relatively short and thick, joins the atrial diverticulum by means of a bulky dilation and receives the anterior insertion of the retractor muscle in the vicinity of the spermatheca. The spermatheca is spherical or ovoid. The epiphallus is about three times longer than the free oviduct and enlarges progressively towards the atriopenis, finally ending as an annular dilation. A number of longitudinal festooned grooves are present inside the epiphallus.

Distribution (fig. 20). — *G. oliveirae* has been collected in the Serra da Estrela (Central Portugal), Bêjar and Sierra de la Peña de Francia (Spanish province of Salamanca), Sierra de Gredos (Spanish province of Ávila, this paper), Sierra de Guadalupe (Spanish province of Cáceres, this paper) and Montes de Toledo (Spanish province of Toledo), therefore qualifying as an endemic species of the mountain ranges Sistema Central and Sistema Oretano.

The few records of the species up to 1990 are compiled in Castillejo & Rodríguez (1991); more recent citations appear in Rodríguez (1990), Hermida (1991), and Rodríguez et al. (1993). In this study the following localities are added: Hoyos del Collado (Sierra de Gredos, Ávila), UTM UK16; Guadalupe (Cáceres), UTM TJ97.

Habitat. — The specimens were found under stones in a pinewood in Sierra de Gredos (by day) and crawling on a schist slope in Sierra de Guadalupe (by night). Both sierras are covered with *Pinus pinaster* and *Quercus pyrenaica*.

*Geomalacus anguiformis* (Morelet, 1845), figs. 9-11, 21

*Limax anguiformis* Morelet, 1845, Descr. Moll. Portugal: 36.

*Limax squammantinus* Morelet, 1845, Descr. Moll. Portugal: 37.

*Limax viridis* Morelet, 1845, Descr. Moll. Portugal: 38.

*Geomalacus anguiformis* (Morelet, 1845): Pollonera, 1890, Boll. Mus. Zool. Anat. Comp. R. Univ. Torino 87 (V): 36.

*Geomalacus squammantinus* (Morelet, 1845): Pollonera, 1890, Boll. Mus. Zool. Anat. Comp. R. Univ. Torino 87 (V): 37.

Live adult specimens (figs. 9, 10) measure c. 70 mm when fully extended. The upper dorsum is greyish-brown and is provided with four dark longitudinal bands, the external right one passing above the pneumostome without curving. The lateral areas are yellowish and the sole whitish. Body mucus yellowish.

The genital atrium (fig. 11) is relatively long and receives the insertion of the atriopenis laterally. The atriopenis is short and joins a long epiphallus and a very long spermatheca duct terminally. The epiphallus is more than 10 times longer than the free oviduct and the vas deferens measures approximately one half of the length of the epiphallus. The spermatheca is oval and its retractor muscle attaches to the posterior third of the bursal duct, causing a slight bending at the point of contact.

Distribution (fig. 21). — *G. anguiformis* has been collected in the south-western area of the Iberian peninsula, in Serra de Caldeirão and Serra de Monchique (Portuguese Algarve) and in Sierra de Aracena (Spanish province of Huelva, this paper), and therefore it is likely to constitute an endemic of the Sistema Bético.

Castillejo & Rodríguez (1991) compile the citations of the species up to 1990. Recent records appear in Rodríguez (1990) and Rodríguez et al. (1993). In this study the following localities are added: El Repilado (Sierra de Aracena, Huelva), UTM PB99; El Quejigo (Sierra de Aracena, Huelva), UTM PB99.

Habitat. — In both localities of Sierra de Aracena *G. anguiformis* was collected in groves of the evergreen oak *Quercus rotundifolia*.

*Geomalacus malagensis* Wiktor & Norris, 1991, figs. 12-18, 22

*Geomalacus malagensis* Wiktor & Norris, 1991, J. Conch., London 34: 19.

When crawling, *G. malagensis* attains 85 mm in length. In live specimens the background colour is yellowish-brown, some individuals being provided with a greyish hue that is stronger in the hind part. The dorsum (fig. 12), including the mantle, shows two bands, the right one passing above the pneumostome. In greyish individuals the dorsal bands are white and their lower margins are delimited by a dark grey line; occasionally white spots are visible on the upper dorsum, between the longitudinal bands. In yellowish individuals the dorsal bands are dark brown. The lateral areas are lighter than the upper dorsum. Body tubercles fine and ill-marked. Head and tentacles the same colour as the rest of body. Inside the stretched transparent ommatophores the retractor muscles can be seen as blackish straps. Foot fringe whitish, without lineoles. Sole whitish (fig. 13), hyaline (partially transparent), divided into three longitudinal zones, the central one being narrower than the other two. Body and sole mucus pale yellow. Shell (fig. 16) oval, thick, whitish, with its nucleus shifted backwards and growth lines clearly visible.

Genital atrium (fig. 14, 15, 17, 18) pear-shaped, with a smooth thin wall deprived of any trace of external glandular lining, in contrast to the usual condition in the genera *Geomalacus* and *Arion*. Inside the genital atrium there are no folds. Free oviduct tubular, without dilations. Epiphallus very thick, cylindrical, widening posteriorly. The vas deferens enters the epiphallus subterminally. Very short atriopenis. Spermatheca pear-shaped, with a short duct. Genital retractor muscle divided anteriorly into two branches, attaching to the anterior parts of spermatheca and epiphallus. Inside the epiphallus there exists a number of strong, lateral, longitudinal folds and one thinner central U-shaped fold, in the middle of which the vas deferens opens.

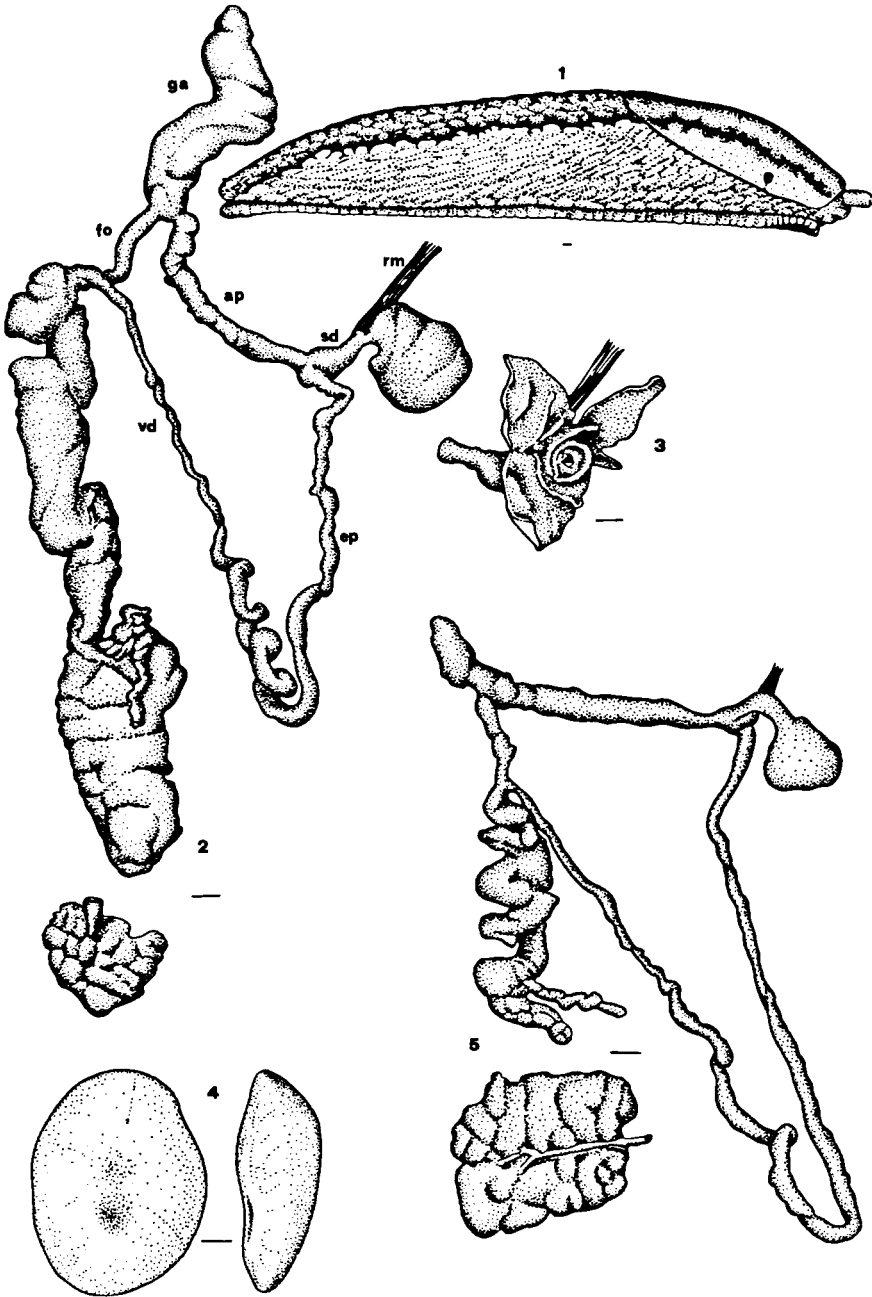
Distribution (fig. 22). — *G. malagensis* has been collected in Gibraltar and several localities in the Spanish provinces of Málaga, Cádiz and Granada. It can be considered as an endemic species of the Sistema Penibético.

The records of the species are published in Hesse (1884, 1926), Pollonera (1890), Norris (1977), and Wiktor & Norris (1991). In this study the following localities are added: Gibraltar, UTM TF80; El Torcal de Antequera (Málaga), UTM UF69; Sierra de las Nieves (Málaga), UTM UF25; Puerto del Madroño (Málaga), UTM UF15; Capileira (Sierra Nevada, Granada), UTM VF69.

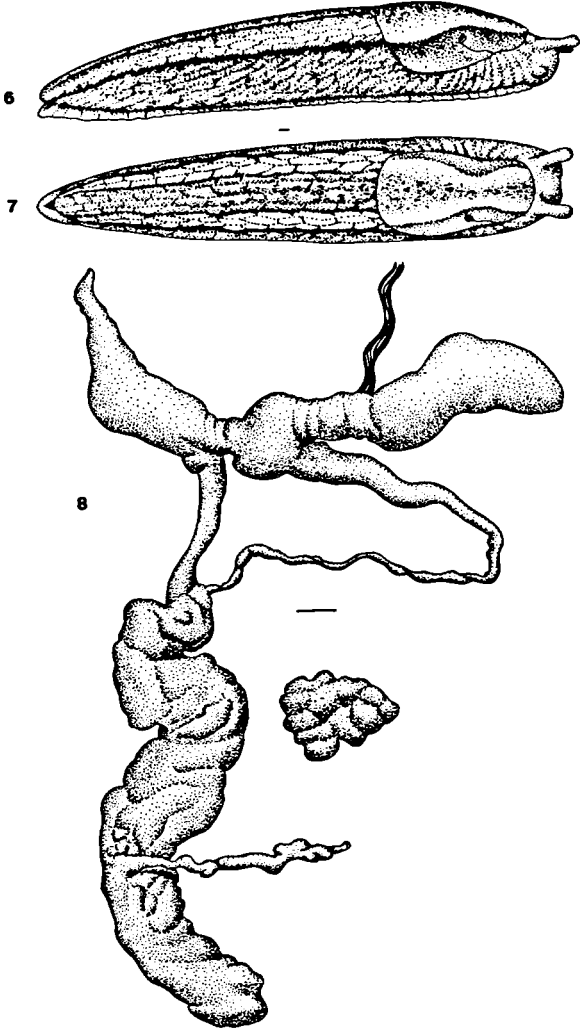
Habitat. — In Gibraltar *G. malagensis* can easily be found in the Alameda gardens. In Andalusia, on the contrary, it is apparently a non-anthropophilous species, being present in the indigenous mountain forests of *Pinus* spp. and *Quercus* spp. In the Torcal de Antequera it thrives in the shrubs and crevices of stony walls.

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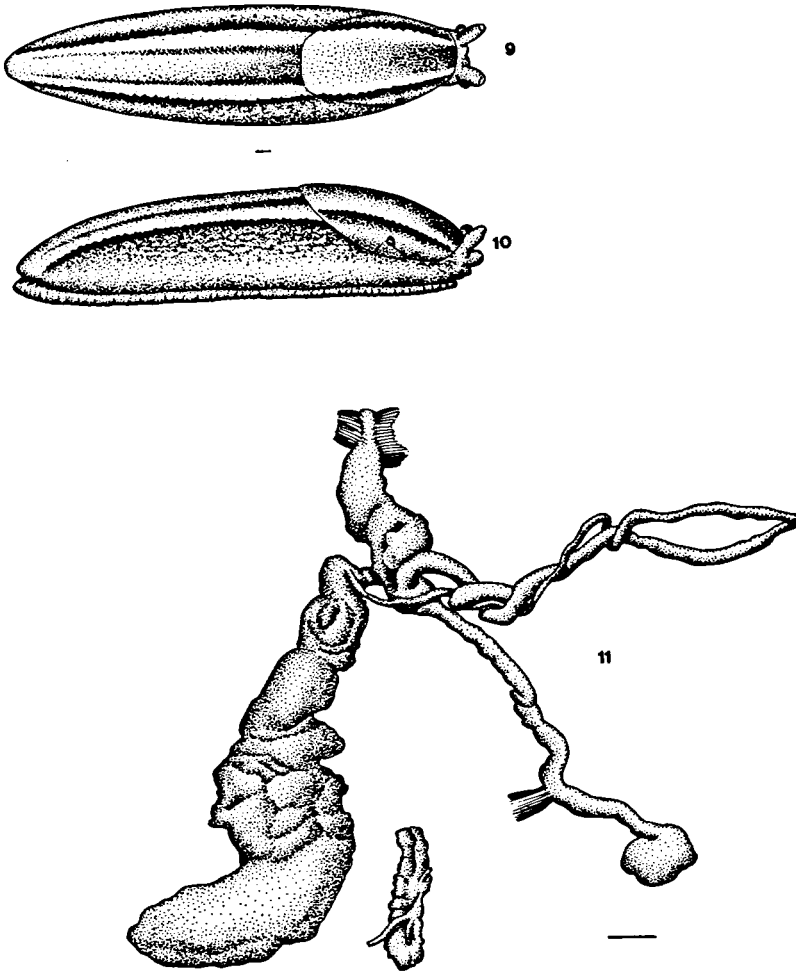
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Figs. 1-5. *Geomalacus maculosus*. 1, external lateral view of an adult specimen from Carrejo (Cantabria); 2, reproductive system of the same specimen (the hermaphrodite duct and genital retractor muscle have been cut); 3, internal folds of spermatheca; 4, dorsal and lateral views of the shell; 5, reproductive system of a juvenile from Reserva de Saja (Cantabria). Scale bars 1 mm; ap: atriopenis, ep: epiphallus, fo: free oviduct, ga: genital atrium, rm: genital retractor muscle, sd: spermatheca duct, vd: vas deferens.

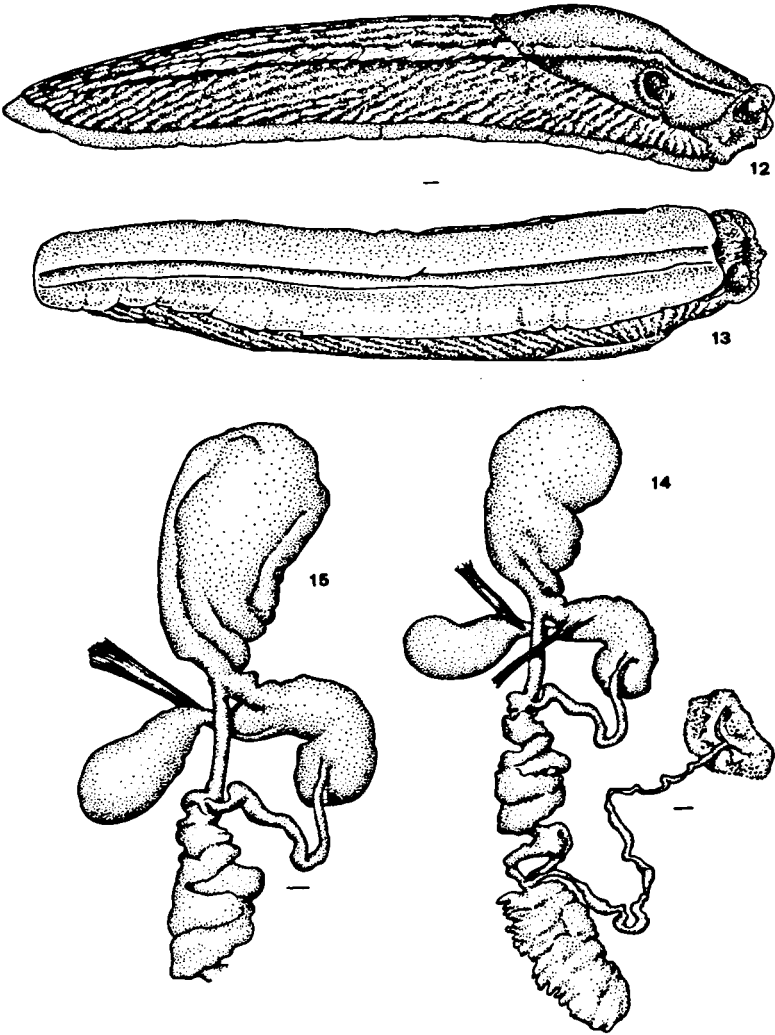


Figs. 6-8. *Geomalacus oliveirae*, Hoyos del Collado (Sierra de Gredos, Ávila). 6-7, external morphology, lateral and dorsal views; 8, reproductive system (the hermaphrodite duct and the genital retractor muscle have been cut). Scale bars 1 mm.

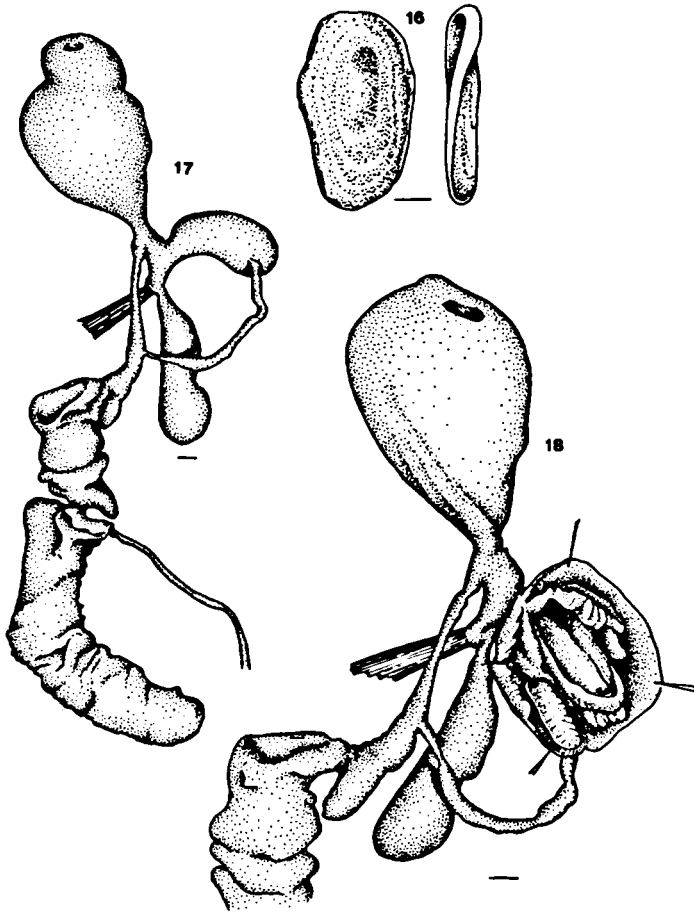


Figs. 9-11. *Geomalacus anguiformis*, El Repilado (Sierra de Aracena, Huelva). 9-10, external morphology, dorsal and lateral views; 11, reproductive system (the hermaphrodite duct and the genital retractor muscle have been cut).  
Scale bars 1 mm.

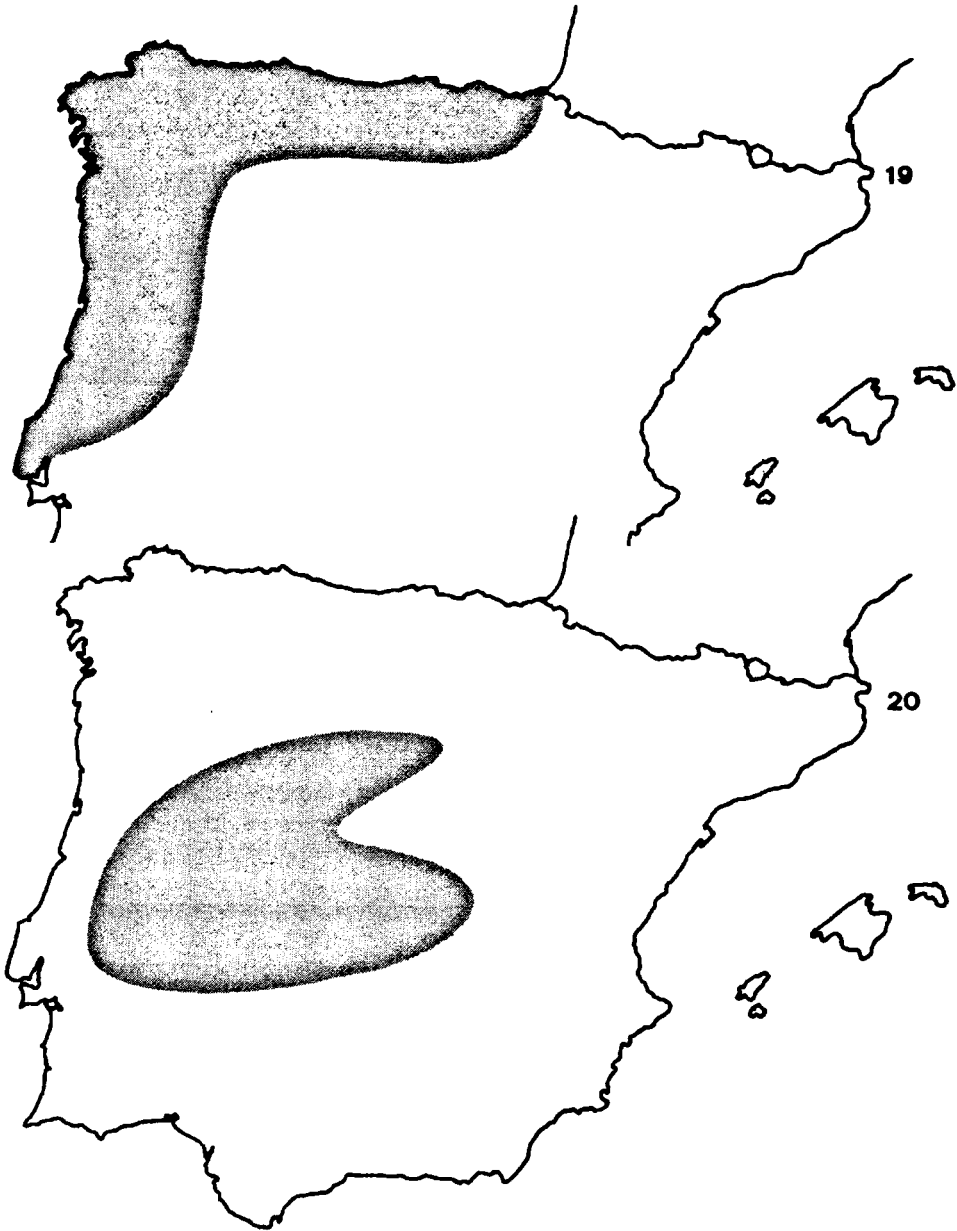




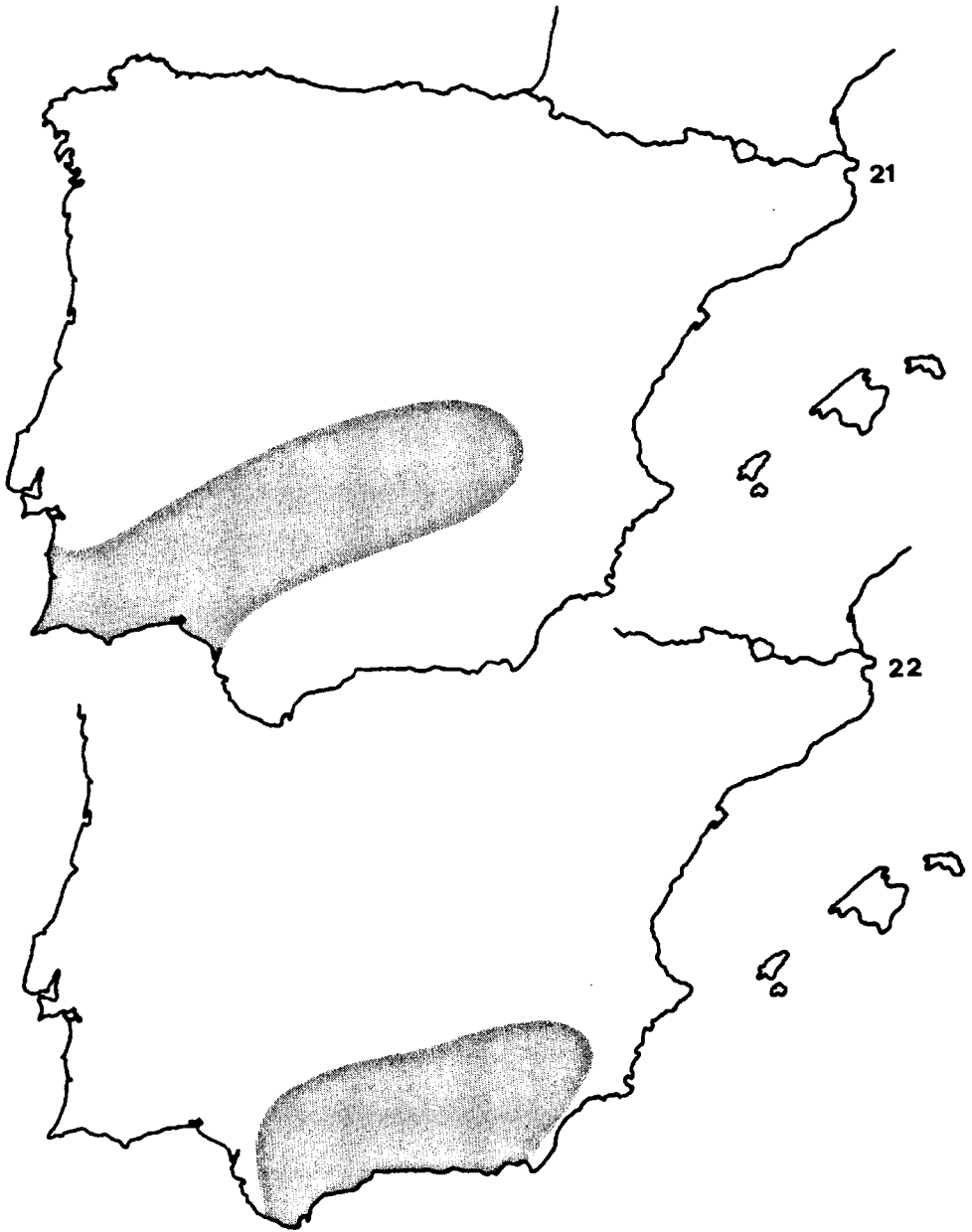
Figs. 12-15. *Geomalacus malagensis*, Gibraltar. 12-13, external morphology, lateral and ventral views; 14, reproductive system (branches of genital retractor muscle have been cut); 15, detail of the copulatory organs. Scale bars 1 mm.



Figs. 16-18. *Geomalacus malagensis*, Gibraltar. 16, dorsal and lateral views of the shell; 17, reproductive system; 18, copulatory organs with epiphallus cut open to show internal folds. Scale bars 1 mm.



Figs. 19-20. Probable geographical distribution (shaded area) of *Geomalacus maculosus* on the Iberian peninsula (fig. 19) and of *G. oliveirae* (fig. 20).



Figs. 21-22. Probable geographical distribution (shaded area) of *Geomalacus anguiformis* (fig. 21) and of *G. malagensis* (fig. 22).