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REVISION OF THE GENUS *ISLAMIA* RADOMAN, 1973 (GASTROPODA, CAENOGASTROPODA, HYDROBIIDAE), ON THE IBERIAN PENINSULA AND DESCRIPTION OF TWO NEW GENERA AND THREE NEW SPECIES

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ABSTRACT

The presence of the genus *Islamia* Radoman, 1973, on the Iberian Peninsula is confirmed based on the detailed study of a group of species, of which three were previously included in the genus *Neohoratia* Schütt, 1961. These species are most abundant in the south-southeastern Mediterranean region but also inhabit the northern Mediterranean areas of the peninsula, with scattered populations in central and western Spain. Iberian *Islamia* currently includes *I. globulus* (Bofill, 1909), *I. lagari* (Altimira, 1960), and *I. ateni* (Boeters, 1969), plus two new species, *I. pallida* and *I. henrici*, the latter with two subspecies *I. h. henrici* and *I. h. giennensis*. Two new genera are also described, *Milesiana* and *Josefus*, each of which contains one species: *M. schuelei* (Boeters, 1981), which was previously assigned to *Neohoratia*, and most recently to *Islamia*, and a new species, *Josefus aitanica*, respectively. Histological study of the female genitalia confirmed the presence of two seminal receptacles and the absence of a bursa copulatrix in all species belonging to the three genera. In *Islamia*, the distal receptacle was once considered to be a reduced bursa copulatrix. We also confirm that there is no trace of glandular tissue on the penial lobe in any of the *Islamia* species for which histological evidence is available.

Key words: Caenogastropoda, Hydrobiidae, *Neohoratia*, *Islamia*, *Milesiana*, *Josefus*, taxonomy, Spain, Iberian Peninsula.

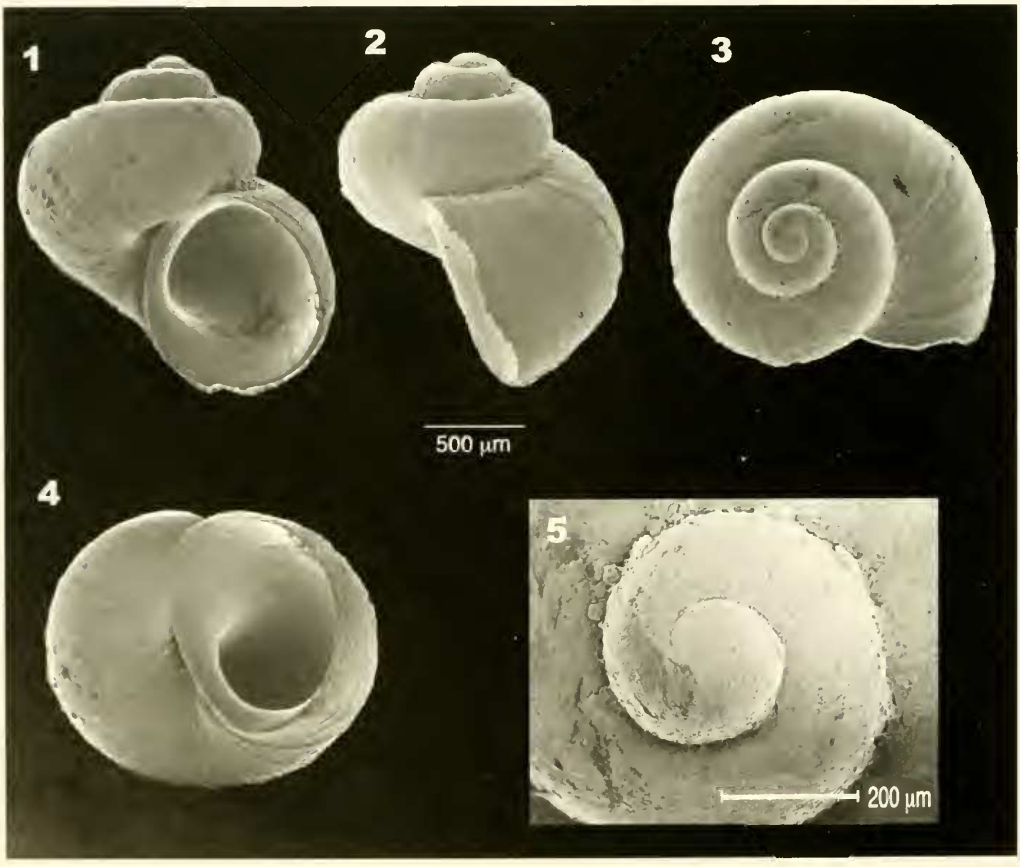
INTRODUCTION

The European fauna of hydrobiids is particularly rich in valvatiform species. However, their morphological study is challenging because of their minute size. Many new genera and species have been described on the basis of shell features, which are known to be highly convergent. Sometimes other anatomical characters, which are frequently non-diagnostic, are used in these descriptions. Data on character variability are absent or very rare. The result has been a much confused taxonomic picture that was recently reviewed and partially clarified by Bodon et al. (2001), who redescribed the type species of most of the European valvatiform genera based on new anatomical studies and data in the literature.

Preliminary studies on Iberian Peninsular valvatiform hydrobiids (Ramos et al., 1992, 1995; Arconada et al., 1996) have shown considerable morphological diversity and high endemicity. Boeters (1988) recognized that species of two genera, *Horatia* Bourguignat, 1887, and *Neohoratia* Schütt, 1961, inhabited this geographical area. An in-depth taxonomic review of the two genera is currently unravelling a very complex situation. Four new genera and several new species have been described in recent papers (Ramos et al., 2000; Arconada & Ramos, 2001, 2002). Some of the species in the new genera were previously included in the above-mentioned genera. We continue these studies by revising the taxonomy of another group of species previously assigned to *Neohoratia* by Boeters (1988).

It has been difficult to distinguish the species of the genera *Neohoratia* Schütt 1961, and *Islamia* Radoman, 1973, given their morphological similarities (Bodon & Giovanelli, 1994; Bodon et al., 1995; Manganelli et al., 1998). The type species of *Neohoratia* is *Valvata* (?) *subpiscinalis* Kuscer 1932 (Figs. 1–5, paratypes from the Biological Institute,

Scientific Research Centre of Ljubljana, N° 1862, leg. Dr. J. Bole). This genus has undergone several changes in its taxonomic status. It has been regarded as a subgenus of *Hauffenia* Pollonera, 1898, and of *Horatia* Bourguignat, 1887 (Schütt, 1961; Boeters, 1974; Bodon & Giovanelli, 1994), and as a distinct genus (Bole & Velkovrh, 1986; Boeters, 1988; Bole, 1993). *Neohoratia* is characterised by having a rather short, flat, blunt or slightly pointed penis with 1–3 small, knob-like lateral lobes on its left side near the apex. The female genitalia include a pin-like bursa copulatrix and one proximal, small seminal receptacle (Bole, 1993; Bodon et al., 2001). Boeters (1988) and Boeters & Rolán (1988) overlooked these diagnostic characters while including several species from the Iberian Peninsula in this genus (*Amnicola globulus* Bofill, 1909; *Microna ateni* Boeters, 1969; *Valvata coronadoi* Bourguignat, 1870; *Hauffenia* (*Neohoratia*) *coronadoi schuelei* Boeters, 1981; *Valvata* (*Tropidina*) *fezi* Altimira, 1960; *Hauffenia* (*Neohoratia*) *gasulli* Boeters 1981; and *Neohoratia azarum* Boeters & Rolán, 1988). However, according to Boeters (1988), these Iberian species, apart from having a narrowing ('Einschnürung') of the outer side of the female oviduct glands (capsule + albumen glands), lacked a bursa copulatrix and had a renal oviduct with two seminal receptacles. This combination of characters, in addition to a male genitalia with a penis usually having one glandular lobe on its left side, has been described as typical of the genus *Islamia* (Bodon et al., 1995; Bodon et al., 2001). *Islamia* is attributed to a wide geographical distribution in the Mediterranean area [species are claimed to be from: Turkey (Schütt, 1964; Radoman, 1973b); the Balkanic



FIGS. 1–5. Shell of *Valvata subpiscinalis* (IBCICL paratype n° 1862).

Peninsula (Radoman, 1973a, b, 1978, 1983); Italy (Giusti & Pezzoli, 1981; Bodon et al., 1995, 1996, 2001; Bodon & Cianfanelli, 2002); Israel (Schütt, 1991; Bodon et al., 1995); Greece (Radoman, 1973b, 1978); and France (cited as *Hauffenia* Pollonera, 1898) (Bernasconi, 1984)].

It was thus feasible that the species listed above from the Iberian Peninsula could be attributed to the genus *Islamia* (type species *Hydrobia valvataeformis* Möllendorff, 1873) or even to new genera. In fact, two of them, *Hauffenia* (*Neohoratia*) *gasulli* [*N.* (?) *gasulli*, *sensu* Boeters, 1988] and *Valvata* (*Tropidina*) *fezi* [*N.* (?) *fezi*, *sensu* Boeters, 1988] were recently allocated to two new genera, *Tarraconia* Ramos & Arconada, 2000 (in Ramos et al., 2000), and *Spathogyna* Arconada & Ramos, 2002, respectively.

Here we describe three new species and redescribe the morphological characters (including previously unknown characters) of the above-mentioned species using a multidisciplinary approach based on type specimens and a vast amount of recently collected material. Additionally, histological studies of these species provide evidence that the two sac-like structures on the renal oviduct are seminal receptacles and demonstrate the nonglandular nature of the penial lobe.

We conclude that two of the "*Neohoratia*" species (*sensu* Boeters, 1988) from the Iberian Peninsula (*Amnicola globulus* and *Microna ateni*) actually belong to the genus *Islamia*, as hypothesized by Bodon et al. (2001). Two other species, one of them with two subspecies, are described as new and placed into *Islamia*. Another species, *Hauffenia* (*Neohoratia*) *coronadoi schuelei*, reported as *N. schuelei* (in Boeters, 1988) and as *Islamia schuelei* (in Bodon et al., 2001), is redescribed and placed into a new genus *Milesiana*, and a third new species is described and placed in a new genus, *Josefus*. *Neohoratia azarum* has not been included here because still unpublished data (Arconada, 2000) clearly demonstrate that its anatomy is differs considerably from the genera and species described here.

This paper increases the number of species and expands the distribution area of *Islamia* (Schütt, 1961; Radoman, 1973a, b; Giusti et al., 1981; Bernasconi, 1984; Bodon et al., 1995) in Europe and reinforces the hypothesis that the Iberian Peninsula is one of the richest hydrobioid (*sensu* Davis, 1979) diversity areas in the Mediterranean Basin (Arconada & Ramos, 2003).

MATERIAL AND METHODS

Field collections, anatomical studies, histological protocols, and morphometric measurements are described in Ramos et al. (2000) and Arconada & Ramos (2001). The number of specimens studied for histology and morphometry, localities and sampling dates for each species are indicated in the corresponding section in the text. The morphological descriptions are based on terminology from Hershler & Ponder (1998). Scanning Electron Microscope (SEM) photographs were made with a Philips XL20 following the methodology described in Ramos et al. (2000). Type material of *Islamia globulus* was photographed with a Environmental Scanning Electron Microscope (ESEM) Philips Quanta 200 SEM at low vacuum mode, after being cleaned with ultrasound (Figs. 18, 20, 23, 25, 27, 30, 31, 33, 34) or the periostracum removed by immersion in 5% sodium hypochlorite (Figs. 19, 28).

Paratypes of *Islamia cianensis* Bodon, Manganelli, Sparacio & Giusti, 1995 (n° 6732), and *I. gaiteri* Bodon, Manganelli, Sparacio & Giusti, 1995 (n° 6733), from the Museo Zoologico "La Specola" collection were used for comparisons.

Localities are listed according to the code: stream or spring, municipality, province, UTM co-ordinates, sampling date, collector's initials, museum catalogue number and preservation conditions (see abbreviations below). Locality names and UTM co-ordinates were obtained from the official Army Geographical Service map (1:50.000 series).

Statistical Analyses

All statistics (mean value, standard deviation and coefficient of variation) were calculated using STATVIEW for Macintosh, and standardized in order to avoid the effect of the measurement scale.

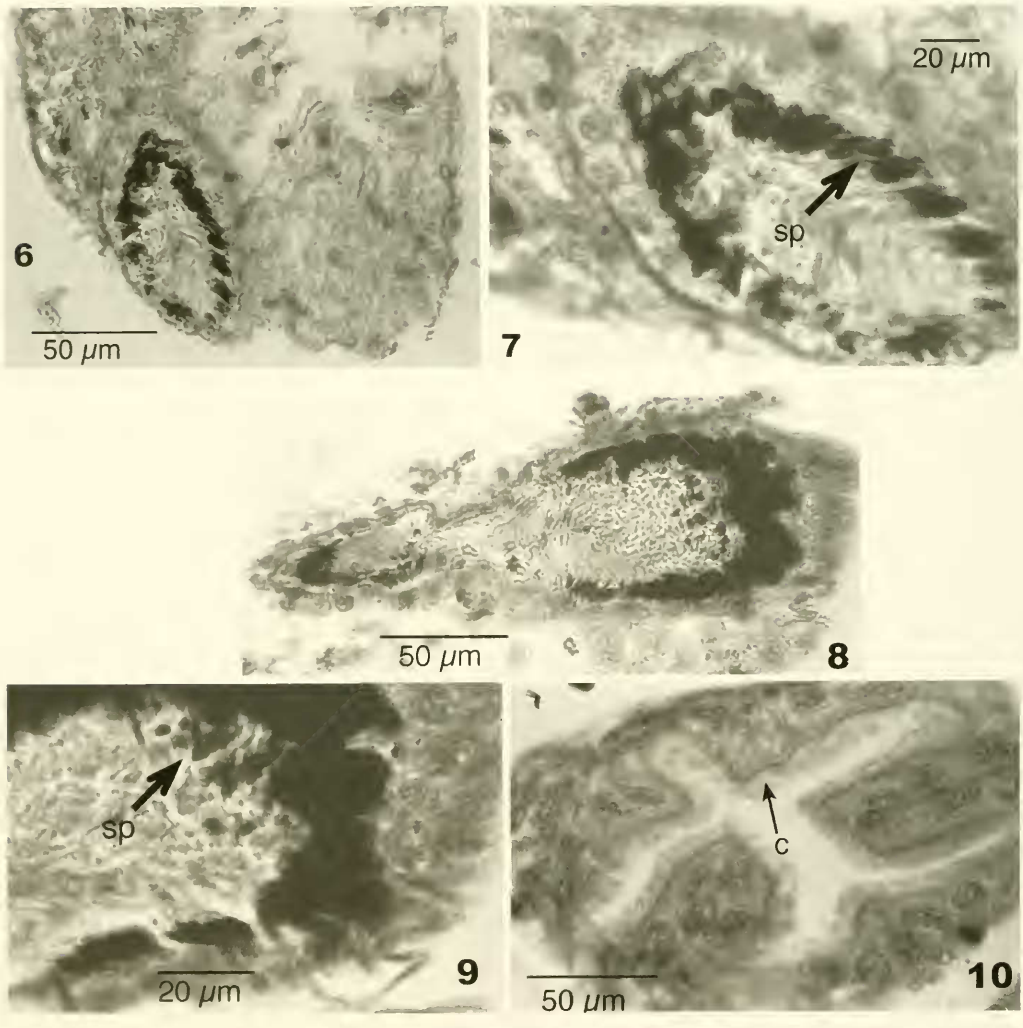
A discriminant funcion analysis (DFA) was performed on nine shell measurements (no ratios) with STATISTICA v.6 for Windows in order to identify the morphological characters that best differentiated species when no or few anatomical data were available. There were no missing data. The effects of violating assumptions are minimized taking into account the robustness of the *F* test (Lindman, 1974). The significance of the overall discriminatory power of the analysis was tested using Wilk's Lambda. Canonical correlation was used to

measure interspecific variation. Classification functions were computed for each group (population) to determine, with the highest probability, which case belonged to which population. Cases were assigned to the group with the highest classification score.

Abbreviations Used in the Text, Tables and Figures

Shell and Operculum Characters: AH: aperture height; AL: aperture length; AW: aperture width; LBW: length of body whorl; NL: length of opercular nucleus; NW: width of opercular nucleus; NSW: number of spire whorls; OL: operculum length; OW: operculum width; OLWL: length of the last whorl of the operculum; OLWW: width of the last whorl of the operculum; SL: shell length; SW: shell width; WAW: width of the antepenultimate whorl; WBW: width of the body whorl; WPW: width of the penultimate whorl; CV: coefficient of variation; SD: standard deviation.

Anatomical Characters: Ag: albumen gland; Bc:



FIGS. 6–10. Histological sections of the anterior female genitalia of *Milesiana schuelei* showing the position of the spermatozoids inside the seminal receptaculum. Note the heads of the spermatozoids attached to the ciliated epithelial cells of the seminal receptacles. FIGS. 6, 7: Proximal seminal receptaculum; FIGS. 8, 9: Distal seminal receptaculum; FIG. 10: Inner epithelium of the widened renal oviduct. Abbreviations: c: cilia; sp: spermatozoids.

bursa copulatrix; Cg: capsule gland; DBC: duct of the bursa copulatrix; Os: osphradium; P: penis; Pl: penial lobe; Po: pallial oviduct; Pp: pseudopenis; Pr: prostate; Ro: renal oviduct; SR1: distal seminal receptacle; SR2: proximal seminal receptacle; Ss: style sac; St: stomach; Vc: ventral channel of capsule gland; L: length; W: width. The concentration of the nervous system was determined by the "RPG" ratio (Davis et al., 1976): length of pleuro-supraesophageal connective divided by the sum of the lengths of right pleural ganglion, pleuro-supraesophageal connective and supraesophageal ganglion. Following several studies, a synthesis of RPG ratios from diverse hydrobioid taxa indicates: dorsal nerve ring concentrated (≤ 0.29); moderately concentrated (0.30–0.49); elongated (0.50–0.67); extremely elongated (≥ 0.68) (Davis et al., 1984, 1986, 1992).

Collections: MNCN: Museo Nacional de Ciencias Naturales, Madrid, Spain; MZB: Museu de Zoologia, Barcelona, Spain; NNM: Nationaal Natuurhistorisch Museum, Leiden, Naturalis, The Netherlands; MHNG: Muséum d'Histoire Naturelle, Genève, Switzerland; SMF: Forschungsinstitut und Natur-Museum Senckenberg, Frankfurt, Germany; MZUF: Museo Zoologico "La Specola", Università di Firenze, Italy; IBCICL: Slovenian Academy of Sciences and Arts, Ljubljana, Slovenia; NHMW: Naturhistorisches Museum, Wien, Austria.

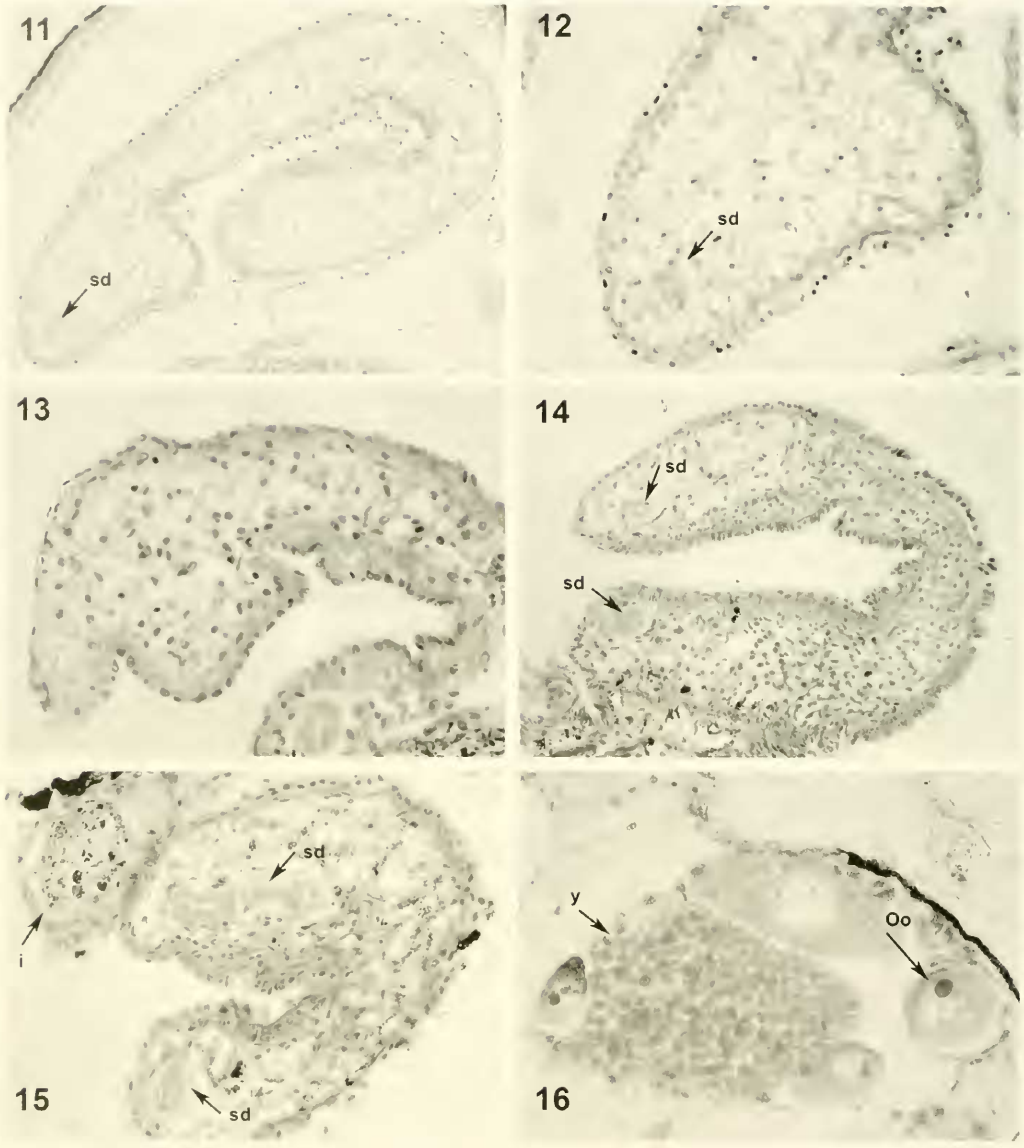
Collectors: R. A.: R. Araujo; B. A.: B. Arconada; J. A.: J. Astigarraga; A. B.: A. Bertrand; D. B.: D. Buckley; A. C.: A. Camacho; J. E.: J. Escobar; S. J.: S. Jiménez; N. M.: N. Martín; D. M.: D. Moreno; C. N.: C. Noreña; J. P.: J. I. Pino; J. M. R.: J. M. Remón; J. R.: J. Roca; E. R.: E. Rolán; G. T.: G. Tapia.

GENITAL HISTOLOGY

Histological studies of 4 µm serial sections were conducted with special focus on female and male genital systems. For each species, the number and sex of specimens investigated are indicated in the corresponding texts.

Considering the female genitalia of *Islamia globulus*, *I. henrici henrici*, *Milesiana schuelei*, and *Josefus aitanica*, histological evidence of "oriented sperm" in the two sac-like structures on the renal oviduct was obtained. The spermatozoa are arranged with their heads anchored to the cell surface among the cilia of the epithelial cells lining the lumen of the seminal receptacle (Figs. 6–9). This is the typical method for sperm storage in a molluscan seminal receptacle (Thompson & Bebbington, 1969; Giusti & Selmi, 1985; Fretter & Graham, 1994: 303–306) and is morphologically responsible for the whitish-pearly refringence characteristic of this structure. On the other hand, the bursa copulatrix (gametolytic gland) does not contain spermatozoa or contains few, non-oriented spermatozoa (its content is centrally located and never refringent) (see also Ramos et al., 2000; Bodon et al., 2001). Therefore, morphological refringence can be used to distinguish bursa copulatrix from seminal receptacles or even to infer the possible role of sperm storage deposit in widened parts of the renal oviduct (Davis et al., 1992; Ramos et al., 2000, and papers cited therein) when histological evidence is not available. The widened portion of the renal oviduct has a thick, more developed inner epithelium in relation to the portion between proximal and distal seminal receptacles, giving rise to a stretched lumen where the spermatozoids move (Fig. 10). Histological differences along the renal oviduct epithelium are similar to those described for *Tarraconia gasulli* (Ramos et al., 2000) and suggest that the widened part of the oviduct may act as an additional sperm storage. However, we are not able to confirm this hypothesis, because we have not had evidence of oriented spermatozoa in any of the species studied.

Careful analysis of serial sections of males belonging to *I. globulus*, *I. pallida*, *M. schuelei*, and *J. aitanica* reveals that the penis and penial lobe are made up of a thick layer of external muscles beneath the outer epithelium (Figs. 11–15). The inner structure consists of numerous vascular spaces of reticulated connective tissue, denser along the periphery of the penis, with muscle fibres running between them. There was no indication of any glandular tissue either on the penial lobe or on any other part of the penis. This structure is similar to that described for other molluscs (Fretter & Graham, 1994: 302). The undulating penial duct can also be observed throughout the different sections of penis until it enters the nuchal area. Females of several species have a nuchal node or a pseudopenis located on the right side of the head, in a position similar to that of the male penis. These females have fully functional genitalia with mature oocytes in the ovary (Fig. 16).



FIGS. 11–16. Histological sections of the penis and its non-glandular lobe. FIGS. 11, 12: *Islamia globulus* from Sopeira population; FIG. 13: *Milesiana schuelei* from Turrillas population; FIGS. 14, 15: *Josefus aitanica* from Torremanzanas population (type locality); FIG. 16: Female gonad of *I. henrici henrici* from Guadalora River population (Hornachuelos), showing oocytes and yolk. Abbreviations: sd: sperm duct; i: rectum; Oo: oocytes; y: yolk.

SYSTEMATIC DESCRIPTION

Islamia Radoman, 1973

Adriolitorea Radoman, 1973a: 234.
Mienisiella Schütt, 1991: 134–136.

Type Species

Islamia valvataeformis (Möllendorff, 1873: 59) = *Horatia servaini* Bourguignat, 1887 (by original designation). *Horatia servaini* is a junior synonym of *Hydrobia valvataeformis* Möl-

lendorff according to Radoman, 1983, and accepted by Bodon et al., 2001.

Diagnosis

Shell small or very small, ovoid or planispiral, rarely ovate-conic; operculum without peg; central tooth with one or two basal cusps on each side; penis with a well-developed non-glandular lobe on its left side; female genitalia with two seminal receptacles, proximal (SR2) larger and longer than distal (SR1); seminal receptacles located on opposite sides (or positions) on unpigmented renal oviduct; they can arise either close to or rather distant from each other; proximal seminal receptacle (SR2) usually with evident duct and distal (SR1), usually without a duct evident; bursa copulatrix absent.

Islamia globulus (Bofill, 1909)

Amnicola globulus Bofill, 1909: 205; 1915: 57, 58, pl. 6, fig. 6; 1917: 35.
Amnicola anatina globulus (Bofill, 1909) – Bofill & Haas, 1920: 50, 57, pl. III, figs. 19, 20.
Amnicola similis (Draparnaud) – Haas, 1929: 408, 409, fig. 163.
Pseudamnicola similis globulus (Bofill, 1909) – Altimira, 1960: 10; 1963: 16.
Neohoratia globulus globulus (Bofill, 1909) – Boeters, 1988: 214, figs. 137–144, 151–155, 163–170, pl. 2, fig. 22; Bech, 1990: 61.
Islamia globulus globulus (Bofill, 1909) – Bodon et al., 2001: 179, figs. 195–200; Bodon & Cianfanelli, 2002: 20.

Type Locality

Font del Sot del Pinell, close to Portellet del Montsech, Lérida, U.T.M.: GC16.

Material Examined

Type material: A lot containing 41 syntypes (dried) of *A. globulus* collected by Artur Bofill at type locality were deposited in the MZB (Bofill, 1917), catalogue number: 80-1589. The specimen illustrated in Figs. 18, 23, 25, 27, 30, 33, is here designated lectotype (ICZN, 1999: Art. 74.7). The remaining syntypes are therefore paralectotypes. Lectotype (MZB 80-1589a) and 29 paralectotypes from this lot are in the MZB collections and 9 in the MNCN collections with n° MNCN 15.05/46546. The second lot with around 1,000 syntypes (dried) is in the MZB collections (MZB 80-1628).

Other populations examined: This species is widely distributed in the provinces of Lérida and Huesca (Fig. 17). Boeters (1988) also

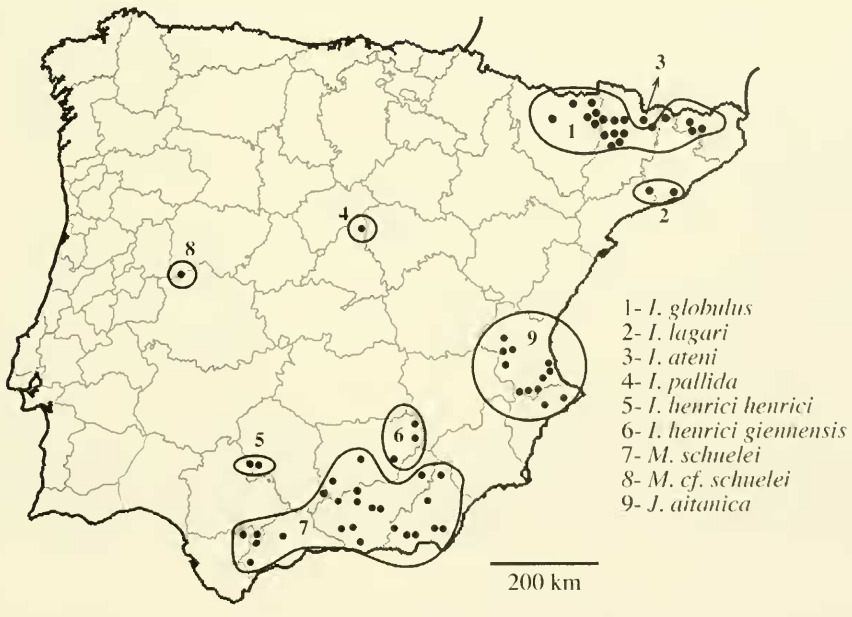


FIG. 17. Map of localities of the genera *Islamia*, *Milesiana* and *Josefus* in the Iberian Peninsula.

cited it from Gerona, although we cannot confirm these data so far. One lot from Font La Figuereta (Lérida) population kept in the MZB (80-1629) was also examined and compared with that from the same locality kept in the MNCN (15.05/46540). Five specimens (ethanol) from Laguarta population were donated to the MZB (nº 2002-0537).

Localities

Spring in Amargosa, Aristot, Lérida, UTM: 31TCG871948, 14 March 1999, B. A., MNCN 15.05/46527 (ethanol and frozen material); Blanca spring, Vilanova de Meya, Lérida, UTM: 31TCG371551, 25 Feb. 1986, J. R., MNCN 15.05/46528 (ethanol, SEM preparation and frozen material); La Argentería spring, Baix Pallars, Lérida, UTM: 31TCG381842, 2 Oct. 1986, J. R., MNCN 15.05/46529 (ethanol and SEM preparation); El Regué spring, Vilanova de Meya, Lérida, UTM: 31TCG304539, 27 Feb. 1986, J. R., MNCN 15.05/46530 (ethanol); La Fayeda spring, Abella de la Conca, Lérida, UTM: 31TCG475668, 10 Oct. 1986, J. R., MNCN 15.05/46531 (ethanol); Fontanet spring, Abella de la Conca, Lérida, UTM: 31TCG4269, 14 March, 1999, B.A., MNCN 15.05/46593 (ethanol and frozen material); Les Greixes spring, Sant Esteve de La Sarga, Lérida, UTM: 31TCG126635, 8 May 1986, J. R., MNCN 15.05/46532 (ethanol); Blanca spring, Gabet de la Conca, Lérida, UTM: 31TCG301658, 13 May 1986, J. R., MNCN 15.05/46533 (ethanol); D'Arcallo spring, Baix Pallars, Lérida, UTM: 31TCG482818, 29 Sept. 1986, J. R., MNCN 15.05/46534 (ethanol); La Sarga spring, Gabet de La Conca, Lérida, UTM: 31TCG375567, 26 Feb. 1986, J. R., MNCN 15.05/46535 (ethanol); Freda spring, Abella de la Conca, Lérida, UTM: 31TCG473677, 10 May 1986, J. R., MNCN 15.05/46536 (ethanol), 14 March 1999, B. A., MNCN 15.05/46616 (ethanol and frozen material); Freda spring de Casa Pallas, Arén, Lérida; UTM: 31TCG065908, 28 March 1987, J. R., MNCN 15.05/46537 (ethanol); Bordons spring, Arén, Huesca, UTM: 31TCG085881, 31 March 1987, J. R., MNCN 15.05/46538 (ethanol); Adraén, Cadí mountains, Lérida, UTM.: 31TCG767817, 15 Feb. 1998, A. B., MNCN 15.05/46539 (ethanol and SEM preparation); 15 March 1999, B. A., MNCN 15.05/46541 (ethanol and frozen material); La Figuereta spring, Alós de Balaguer, Lérida, UTM: 31TCG253439, 11 March 1986, J. R., MNCN 15.05/46540 (ethanol); Les Bulles spring, Isona, Lérida, UTM: 31TCG371667, 8 May 1986, J. R., MNCN 15.05/46594; Laguarta, Huesca, UTM: 30TYM374998, 12 April 1995; B. A., MNCN 15.05/46542 (ethanol and SEM preparation); 26 Oct. 1995, B. A. & E. R., MNCN 15.05/46543 (ethanol, SEM preparation and frozen material); Grima spring, Gistain, Huesca, UTM: 31TBH799184, 13 April 1995, B. A., MNCN 15.05/46544 (ethanol); Sopeira spring, Huesca, UTM: 31TCG1487, 24 July 1991, R. A., D. M., J. M. R., MNCN 15.05/46545 (ethanol and SEM preparation).

Material Examined for Morphometry and Histology

Shell and anatomical measurements (Tables 1, 3–7) correspond to populations from Lérida and Huesca: Operculum and radular measurements (Tables 2, 4) to Huesca (see table captions). Male and females studied and measured were collected in the following months: Feb., March, April, May, July, and Oct. For histology, four females and three males were studied from a spring in Sopeira, Huesca (July 1991), and one female from Laguarta, Huesca (Oct. 1995).

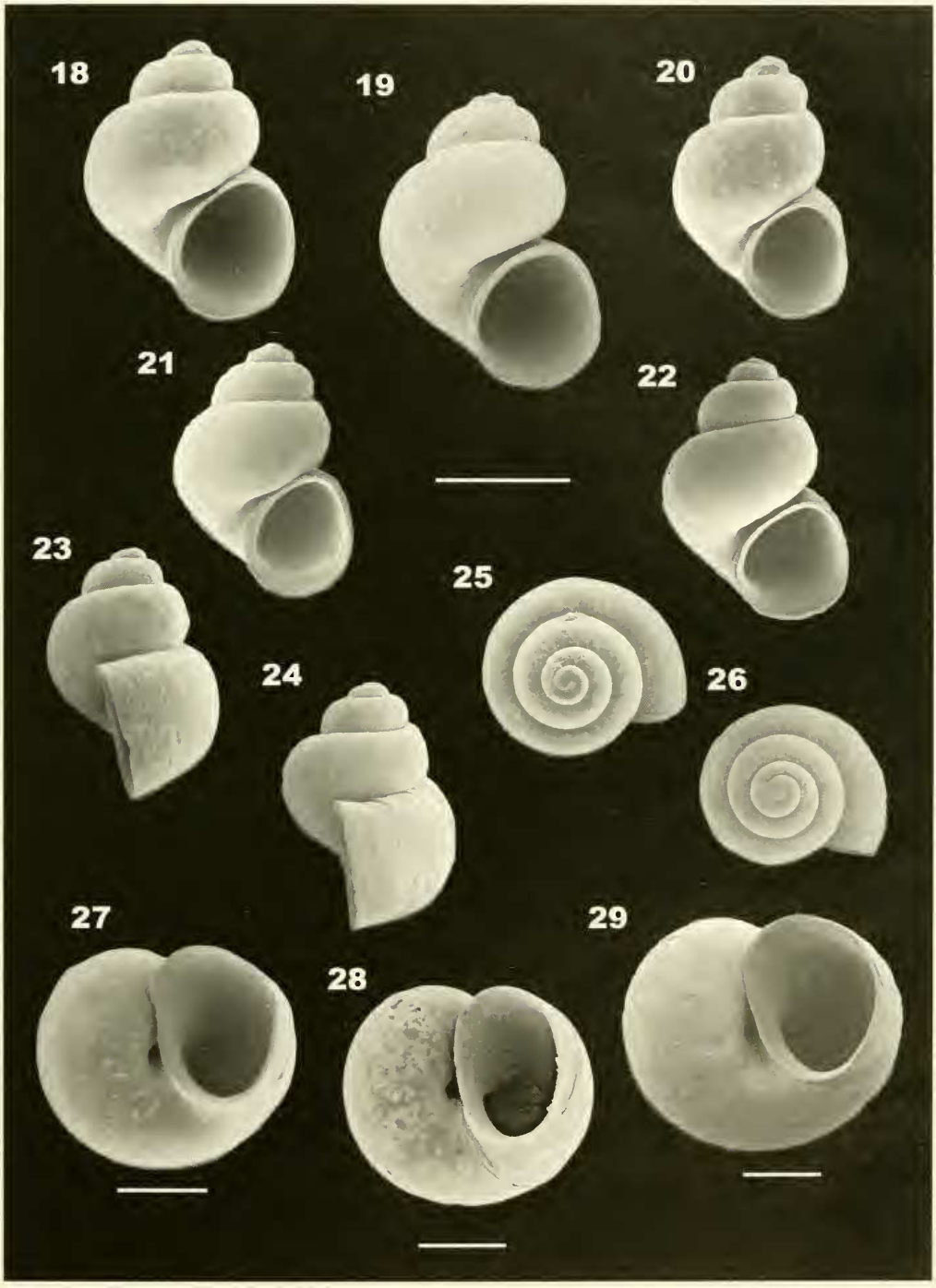
Diagnosis

Shell ovate-conic, body whorl narrow; operculum ovate; central tooth of radula with a single basal cusp on each side; ctenidium well developed; short pleuro-subesophageal connective; esophagus running straight underneath cerebral commissure; bean-shaped prostate gland; big penis, usually black pigmented, with one large, unpigmented non-glandular lobe, commonly protruding from the tip of penis; pyriform and pedunculated proximal seminal receptacle (SR2) and small, elongated, sessile distal seminal receptacle (SR1); receptacles emerge distinctly separated from each other.

Description

(Figs. 18–29, 30–35, 42–49; Tables 1–7; Bodon et al., 2001: figs. 195–200)

Shell: Shell ovate-conic, 4.1 whorls; sutures deep, aperture oval, slightly prosocline; peristome complete, slightly thickened at columelar margin, slightly reflected at lower and columelar margin; body whorl very narrow, over $^{5}/_{7}$ of the total shell length; protoconch consisting of 1.5 whorls; protoconch width and width of the nucleus are 380 µm and 140 µm, respectively (Figs. 30–35); protoconch pitted; umbilicus narrow, 130 µm



FIGS. 18–29. Shells of *Islamia globulus*. FIGS. 18, 23, 25, 27: Lectotype (MZB 80-1589a); FIG. 19: Paralectotype (MZB 80-1589b); FIG. 20: Paralectotype (MNCN 15.05/46546); FIG. 28: Paralectotype (MZB 80-1589c); FIGS. 21, 24, 26, 29: Shells from Laguarta; FIG. 22: Shell from Sopeira population. Scale bar = 1 mm (FIGS. 18–26); 500 µm (FIGS. 27–29).

TABLE 1. Shell measurements (in mm) of type localities of several *Islamia* Iberian species, except for *I. globulus* populations (1–4): 1 - Sopeira spring. Sopeira, Huesca; 2 - Vilanova de Meia, Lérida; 3 - Sant Esteve de La Sarga, Lérida; 4 - Alós de Balaguer, Lérida. *I. lagari* (5), *I. ateni* (6), *I. pallida* (7), *I. h. henrici* (8) and *I. h. giennensis* (9).

	1 Mean ± SD; CV (Max-Min) (n = 30)	2 Mean ± SD; CV (Max-Min) (n = 19)	3 Mean ± SD; CV (Max-Min) (n = 8)	4 Mean ± SD; CV (Max-Min) (n = 7)	5 Mean ± SD; CV (Max-Min) (n = 6)	6 Mean ± SD; CV (Max-Min) (n = 9)	7 Mean ± SD; CV (Max-Min) (n = 8)	8 Mean ± SD; CV (Max-Min) (n = 15)	9 Mean ± SD; CV (Max-Min) (n = 7)
SL	1.93 ± 0.12; 0.06 (2.26-1.68)	1.94 ± 0.10; 0.05 (2.26-1.68)	2.18 ± 0.11; 0.05 (2.32-2.02)	1.85 ± 0.14; 0.08 (2.00-1.56)	1.38 ± 0.06; 0.05 (1.43-1.28)	1.70 ± 0.20; 0.12 (2.20-1.54)	1.10 ± 0.19; 0.17 (1.41-0.81)	0.84 ± 0.07; 0.09 (1.00-0.73)	0.85 ± 0.08; 0.09 (1.00-0.75)
SW	1.39 ± 0.09; 0.06 (1.56-1.26)	1.44 ± 0.09; 0.06 (1.60-1.32)	1.47 ± 0.08; 0.06 (1.64-1.36)	1.39 ± 0.11; 0.08 (1.60-1.26)	1.21 ± 0.09; 0.07 (1.35-1.08)	1.09 ± 0.11; 0.10 (1.37-0.97)	1.26 ± 0.21; 0.16 (1.58-1.04)	1.07 ± 0.12; 0.11 (1.28-0.88)	1.09 ± 0.06; 0.06 (1.15-0.97)
SL/SW	1.38 ± 0.07; 0.05 (1.56-1.26)	1.35 ± 0.07; 0.05 (1.47-1.27)	1.37 ± 0.07; 0.05 (1.47-1.22)	1.34 ± 0.10; 0.07 (1.45-1.18)	1.1 4 ± 0.05; 0.04 (1.19-1.05)	1.56 ± 0.06; 0.04 (1.64-1.45)	0.88 ± 0.09; 0.11 (1.03-0.72)	0.78 ± 0.04; 0.05 (0.84-0.72)	0.78 ± 0.06; 0.08 (0.91-0.71)
AH	0.97 ± 0.06; 0.06 (1.10-0.86)	0.99 ± 0.05; 0.05 (1.08-0.90)	1.04 ± 0.07; 0.07 (1.16-0.96)	0.93 ± 0.04; 0.04 (1.00-0.88)	0.79 ± 0.06; 0.07 (0.85-0.70)	0.87 ± 0.08; 0.09 (1.05-0.80)	0.68 ± 0.10; 0.15 (0.84-0.54)	0.61 ± 0.04; 0.07 (0.70-0.53)	0.59 ± 0.02; 0.04 (0.61-0.55)
LBW	1.51 ± 0.08; 0.05 (1.72-1.38)	1.54 ± 0.07; 0.05 (1.66-1.36)	1.75 ± 0.14; 0.08 (1.94-1.56)	1.45 ± 0.12; 0.08 (1.60-1.20)	1.18 ± 0.06; 0.05 (1.23-1.08)	1.39 ± 0.15; 0.11 (1.77-1.24)	0.90 ± 0.17; 0.19 (1.16-0.62)	0.72 ± 0.05; 0.08 (0.81-0.61)	0.74 ± 0.07; 0.10 (0.87-0.63)
WBW	1.17 ± 0.07; 0.06 (1.04-0.78)	1.22 ± 0.07; 0.06 (1.32-1.08)	1.29 ± 0.06; 0.05 (1.42-1.20)	1.21 ± 0.04; 0.03 (1.28-1.16)	0.95 ± 0.04; 0.05 (1.00-0.88)	0.96 ± 0.10; 0.10 (1.20-0.87)	0.96 ± 0.18; 0.18 (1.26-0.71)	0.73 ± 0.08; 0.11 (0.88-0.58)	0.74 ± 0.05; 0.06 (0.80-0.65)
AL	0.92 ± 0.06; 0.06 (1.04-0.78)	0.96 ± 0.06; 0.06 (1.10-0.86)	1.00 ± 0.06; 0.06 (1.12-0.94)	0.90 ± 0.07; 0.08 (1.00-0.80)	0.59 ± 0.03; 0.05 (0.62-1.55)	0.70 ± 0.07; 0.11 (0.83-0.59)	0.59 ± 0.12; 0.21 (0.78-0.45)	0.56 ± 0.05; 0.09 (0.65-0.46)	0.50 ± 0.03; 0.07 (0.57-0.47)
AW	0.78 ± 0.06; 0.07 (0.96-0.68)	0.84 ± 0.06; 0.07 (0.96-0.72)	0.87 ± 0.05; 0.06 (0.96-0.82)	0.79 ± 0.04; 0.06 (0.84-0.72)	0.72 ± 0.03; 0.04 (0.75-0.68)	0.66 ± 0.07; 0.11 (0.83-0.60)	0.58 ± 0.10; 0.18 (0.71-0.43)	0.51 ± 0.04; 0.09 (0.58-0.41)	0.46 ± 0.02; 0.05 (0.50-0.42)
WPW	0.7 4± 0.04; 0.05 (0.84-0.66)	0.76 ± 0.04; 0.06 (0.84-0.68)	0.81 ± 0.05; 0.06 (0.88-0.74)	0.76 ± 0.04; 0.05 (0.80-0.70)	0.95 ± 0.04; 0.05 (1.00-0.88)	0.62 ± 0.07; 0.11 (0.77-0.57)	0.48 ± 0.09; 0.19 (0.61-0.34)	0.52 ± 0.03; 0.06 (0.55-0.47)	0.34 ± 0.03; 0.10 (0.37-0.30)
WAW	0.39 ± 0.04; 0.10 (0.50-0.32)	0.39 ± 0.04; 0.10 (0.44-0.32)	0.41 ± 0.03; 0.07 (0.46-0.38)	0.39 ± 0.04; 0.10 (0.44-0.32)	0.59 ± 0.03; 0.05 (0.62-1.55)	0.30 ± 0.05; 0.15 (0.40-0.26)	0.21 ± 0.05; 0.23 (0.28-0.13)	0.21 ± 0.02; 0.11 (0.23-0.17)	0.14 ± 0.01; 0.08 (0.15-0.12)
NSW	4.10 ± 0.25; 0.06 (4.75-3.50)	4.42 ± 0.17; 0.05 (4.50-4.00)	4.28 ± 0.21; 0.05 (4.50-4.00)	4.18 ± 0.19; 0.05 (4.50-4.00)	0.72 ± 0.03; 0.04 (0.75-0.68)	4.03 ± 0.08; 0.02 (4.25-4.00)	3.50 ± 0.20; 0.06 (3.75-3.25)	3.43 ± 0.25; 0.07 (3.75-3.00)	3.42 ± 0.12; 0.03 (3.50-3.25)

TABLE 2. Operculum measurements (in mm) of *Islamia* Iberian species. All populations from type locality except specimens of *I. globulus* (1) belonging to Laguarta population (Huesca). *I. ateni* (2), *I. pallida* (3), *I. h. henrici* (4) and *I. h. giennensis* (5).

	1 Mean ± SD; CV (Max-Min)	2 Mean ± SD; CV (Max-Min)	3 Mean ± SD; CV (Max-Min)	4 Mean ± SD; CV (Max-Min)	5
OL	0.88 ± 0.04; 0.05 (0.96-0.82) (n = 9)	0.58 ± 0.02; 0.03 (0.61-0.56) (n = 4)	0.45 ± 0.03; 0.07 (0.47-0.42) (n = 2)	0.52 ± 0.01; 0.02 (0.54-0.50) (n = 5)	0.55 (n = 1)
OW	0.41 ± 0.01; 0.06 (0.73-0.61) (n = 9)	0.41 ± 0.02; 0.06 (0.44-0.39) (n = 4)	0.38 ± 0.01; 0.02 (0.39-0.38) (n = 2)	0.43 ± 0.02; 0.06 (0.48-0.41) (n = 5)	0.45 (n = 1)
OLWL	0.41 ± 0.01; 0.03 (0.43-0.40) (n = 4)	0.32 ± 0.01; 0.03 (0.32-0.31) (n = 2)	0.16 (n = 1)	0.17 ± 0.02; 0.13 (0.20-0.15) (n = 5)	0.15 (n = 1)
OLWW	0.28 ± 0.04; 0.03 (0.33-0.24) (n = 4)	0.20 ± 0.04; 0.19 (0.22-0.17) (n = 2)	0.10 (n = 1)	0.13 ± 0.01; 0.08 (0.14-0.11) (n = 5)	0.13 (n = 1)
NL	0.33 ± 0.06; 0.20 (0.40-0.24) (n = 4)	0.17 ± 0.02; 0.12 (0.19-0.16) (n = 2)	?	0.27 ± 0.02; 0.10 (0.29-0.23) (n = 5)	0.27 (n = 1)
NW	0.38 ± 0.02; 0.07 (0.42-0.36) (n = 4)	0.20 ± 0.02; 0.12 (0.22-0.18) (n = 2)	0.25 (n = 1)	0.29 ± 0.02; 0.08 (0.32-0.27) (n = 5)	0.30 (n = 1)
OL/OW	1.31 ± 0.06; 0.04 (1.40-1.22) (n = 4)	1.43 ± 0.09; 0.06 (1.51-1.32) (n = 4)	1.17± 0.05; 0.05 (1.21-1.13) (n = 2)	1.20 ± 0.08; 0.06 (1.28-1.08) (n = 5)	1.22 (n = 1)

in diameter (Figs. 27–29). In apical view, shell growth is quite regular and, consequently, the general shell shape is also regular.

Operculum: Pale yellowish, ovate, submarginal nucleus (Figs. 36–38), with a muscle attachment area rounded or oval.

Body: Head scarcely pigmented, with scattered pigment cells around the eye-spots (Fig. 46). External body pigmentation very dark, except last body whorl.

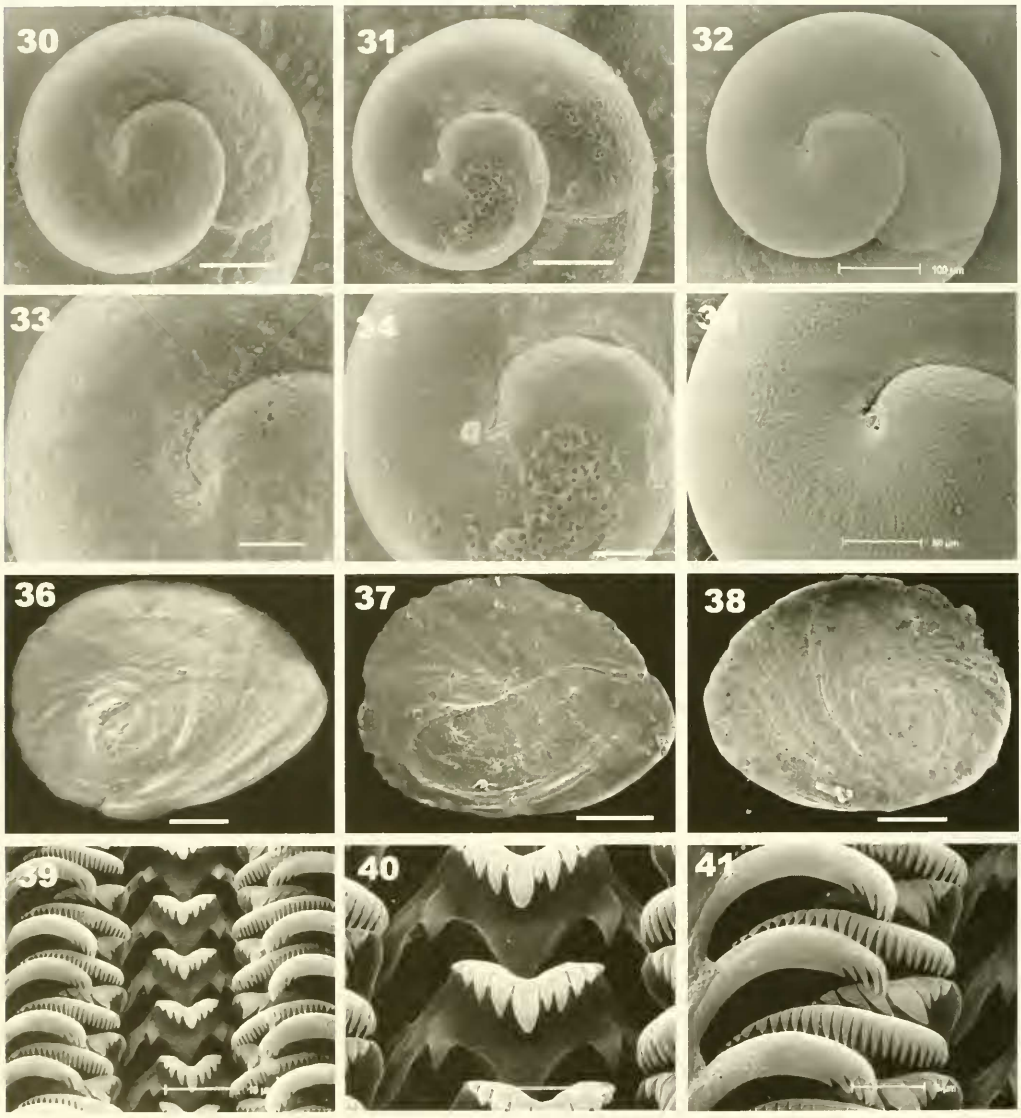
Nervous System: With long pleuro-supraesophageal and short pleuro-subesophageal connectives; RPG ratio is 0.43 (moderately concentrated). Esophagus running straight underneath cerebral commissure (Fig. 42).

Ctenidium: With 12–13 well-developed lamellae (Fig. 43). Occupying nearly entire length of pallial cavity. Osphradium length two to three times longer than its width (Table 3).

TABLE 3. Osphradium measurements (in mm) of several *Islamia* Iberian species. All populations from type localities except for *I. globulus* (1–2): 1 - Gabet de la Conca (La Sarga spring), Lérida; 2 - Sopeira spring, Huesca. *I. ateni* (3), *I. pallida* (4), *I. h. henrici* (5) and *I. h. giennensis* (6).

	1 Mean ± SD; CV (Max-Min) (n = 2)	2 Mean ± SD; CV (Max-Min) (n = 2)	3 Mean ± SD; CV (Max-Min) (n = 13)	4 Mean ± SD; CV (Max-Min) (n = 3)	5 Mean ± SD; CV (Max-Min) (n = 4)	6 Mean ± SD; CV (Max-Min) (n = 3)
Os L	0.19 ± 0.04; 0.23 (0.22-0.16)	0.33 ± 0.01; 0.03 (0.34-0.32)	0.15 ± 0.01; 0.07 (0.16-0.14)	0.12 ± 0.01; 0.05 (0.13-0.12)	0.13 ± 0.02; 0.12 (0.16-0.12)	0.17 ± 0.04; 0.22 (0.21-0.14)
Os W	0.07 ± 0.01; 0.11 (0.07-0.06)	0.08 ± 0.01; 0.07 (0.08-0.07)	0.08 ± 0.01; 0.11 (0.09-0.07)	0.06 ± 0.01; 0.20 (0.07-0.05)	0.08 ± 0.01; 0.07 (0.08-0.07)	0.08 ± 0.02; 0.24 (0.11-0.07)

Stomach – Radula: Stomach length greater than width (Table 5); style sac protruding anteriorly into the intestinal loop (Fig. 44); rectum U-shaped, sometimes bending towards anterior portion of body (Fig. 45). Radula (Table 4) small (17%) relative to maximum shell dimension; central tooth (Figs. 39, 40) with a single basal cusp on each side; distance between cusps is approximately 11 µm; central denticle long and wide, followed on each side by four small denticles in decreasing order of size; lateral teeth with 3–4 denticles on each side of a central one (Fig. 41).



FIGS. 30–41. Protoconch, operculum and radula of *Islamia globulus*. FIGS. 30, 33: Lectotype (MZB 80-1589a); FIGS. 31–34: Paralectotype (lost specimen); FIGS. 32, 35, 36, 39–41: Shells, opercula and radula from Laguarta population; FIG. 38: Operculum from Sopeira population; FIGS. 30–35: Protoconch and microsculpture; FIGS. 36, 37: Inner side of the operculum; FIG. 38: Outer side of the operculum; FIG. 39: Transverse rows; FIG. 40: Central teeth; FIG. 41: Lateral, outer and inner marginal teeth. Scale bar = 100 µm (FIGS. 30–32); 50 µm (FIGS. 33–35); 200 µm (FIGS. 36–38); 10 µm (FIG. 39); 5 µm (FIGS. 40, 41).

TABLE 4. Radula formulae and measurements (in mm) of *Islamia* Iberian species. *I. globulus* (1) from Laguarta population. *I. ateni* (2) and *I. h. henrici* (3) populations from type localities.

	1	2	3
Central teeth	4+C+4/1-1	5+C+4(5)/1-1	4+C+4/2-2
Central teeth width	~ 9 µm	~ 7 µm	~ 5.6 µm
Left lateral teeth	4+C+3	6+C+3	5+C+3
Inner marginal teeth	~ 24 cusps	~ 24 cusps	~ 24 cusps
Outer marginal teeth	~ 6 cusps	~ 10 cusps	~ 9 cusps
Radula length	~ 345 µm	~ 364 µm	~ 193 µm
Radula width	~ 58 µm	~ 59 µm	~ 46 µm
Number of rows	~ 50	~ 62	?

Male Genitalia: With bean-shaped prostate gland (Table 6) leaning towards the posterior part of the rectal loop (Fig. 45); approximately $^1/_3$ of prostate gland extending into pallial cavity; first lobes of testis spilling over onto posterior chamber of stomach and sometimes reaching anterior chamber; penis large, usually darkly pigmented, with one large unpigmented glandular lobe located in medial position (Figs. 46, 47); penial duct in central position, at base, then running straight to penis tip.

Female Genitalia: Renal oviduct makes a wide circle that overlies the albumen gland (Fig. 48); almost $^2/_3$ of the oviduct glands (albumen + capsule glands) lie inside pallial cavity; oviduct glands (albumen + capsule glands) usually are not narrow, although some females have a discrete narrowing at their outer edge; albumen gland larger than capsule gland (Fig. 48); proximal seminal receptacle (SR2) generally pyriform, pedunculated (Fig. 49); distal seminal receptacle (SR1) smaller, elongated, sessile; both a good distance from each other on opposite positions on renal oviduct; renal oviduct widening posterior to SR2.

Discussion

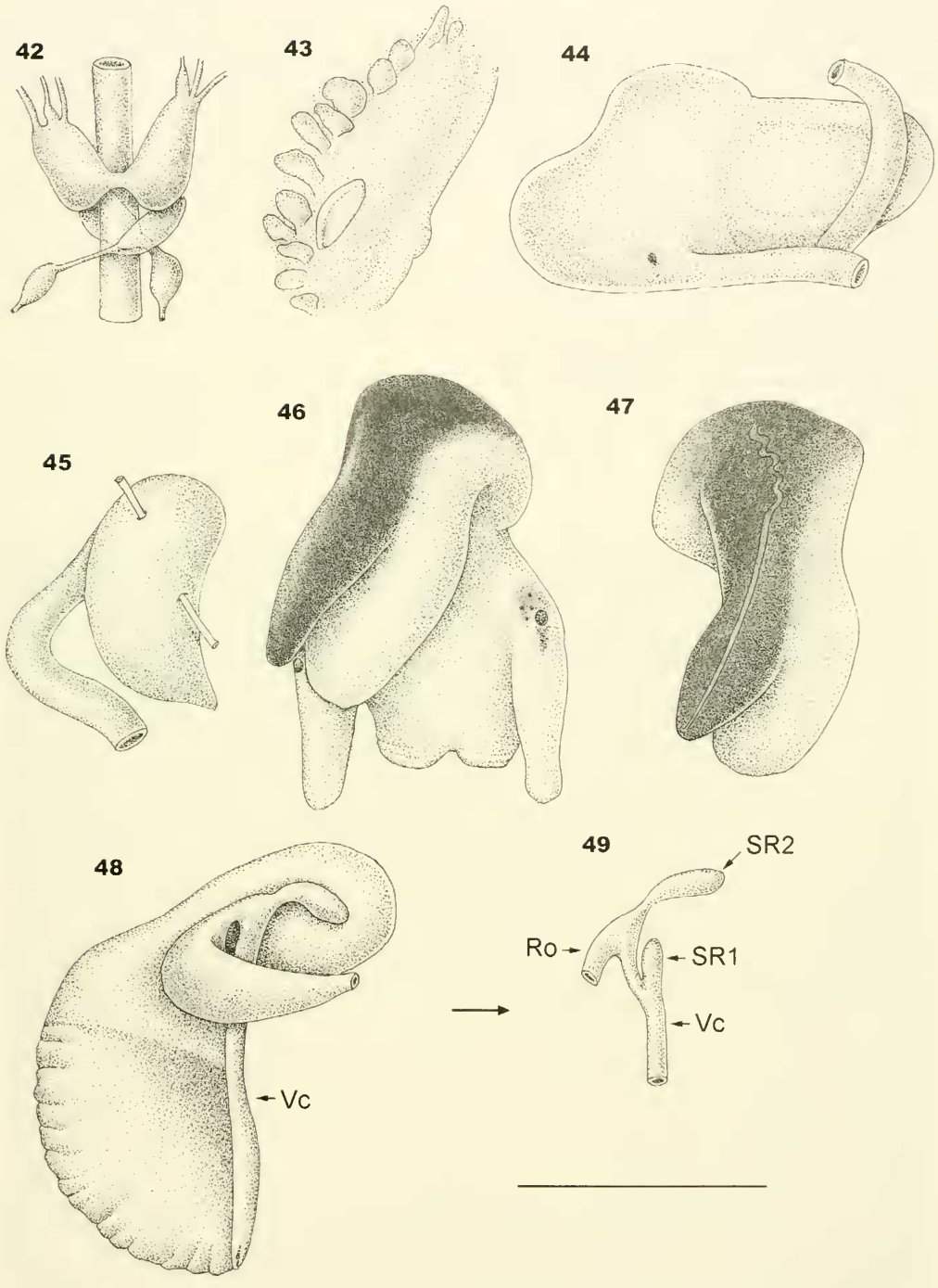
Until now, no lectotype of *Amnicola globulus* has been designated. Since 1920 (Bofill & Haas, 1920), the type material of this species has been referred to in the literature as "unknown". We traced the type material in the MZB collection and found it consists of two lots, one containing 41 specimens (MZB 80-1589) and the other over 1,000 specimens (MZB 80-1628). In the species description (Bofill, 1909) and in later papers, he mentions that "this species was extremely abundant". The first lot contains the original label and is

TABLE 5. Digestive system measurements (in mm) of *Islamia* Iberian species. All populations from type localities, except for *I. globulus* (1) (Sopeira spring, Huesca). *I. ateni* (2), *I. pallida* (3), *I. h. henrici* (4) and *I. h. giennensis* (5).

	1 Mean ± SD; CV (Max-Min) (n = 2)	2 Mean ± SD; CV (Max-Min) (n = 3)	3 Mean ± SD; CV (Max-Min) (n = 3)	4	5 Mean ± SD; CV (Max-Min) (n = 3)
Ss L	0.42 ± 0.01; 0.02 (0.42-0.41)	0.27 ± 0.01; 0.02 (0.28-0.27)	0.19 ± 0.02; 0.11 (0.21-0.17)	0.29 (n = 1)	0.27 ± 0.01; 0.05 (0.29-0.27)
Ss W	0.33 ± 0.04; 0.11 (0.36-0.31)	0.24 ± 0.01; 0.04 (0.25-0.23)	0.18 ± 0.02; 0.12 (0.20-0.16)	0.28 (n = 1)	0.21 ± 0.03; 0.16 (0.25-0.19)
St L	0.46 ± 0.17; 0.37 (0.58-0.34)	0.40 ± 0.07; 0.18 (0.45-0.32)	0.29 ± 0.04; 0.15 (0.34-0.26)	0.26 (n = 1)	0.33 ± 0.02; 0.07 (0.36-0.32)
St W	0.47 ± 0.04; 0.09 (0.50-0.44)	0.41 ± 0.01; 0.02 (0.42-0.40)	0.28 ± 0.04; 0.14 (0.31-0.23)	0.19 (n = 1)	0.28 ± 0.04; 0.16 (0.33-0.24)

TABLE 6. Male genitalia measurements (in mm) of *Islamia* Iberian species: *I. globulus* (1–10) from the following localities: 1 - Sopeira spring, Huesca; 2 - San Esteve de la Sarga (Les Greixes spring), Lérida; 3 - Baix Pallars (La Argenteria spring), Lérida; 4 - Gabet de la Conca (La Sarga spring), Lérida; 5 - Abella de la Conca (La Fayeda spring), Lérida; 6 - Vilanova de Meya (Blanca spring), Lérida; 7 - Alós de Balaguer (La Figuereta spring), Lérida; 8 - Arén (Bordons spring), Lérida; 9 - Huesca, Huesca; 10 - Laguarta, Huesca. The rest of the populations from type localities: *I. ateni* (11), *I. pallida* (12), *I. h. henrici* (13) and *I. h. giennensis* (14).

	1 Mean ± SD; CV (Max-Min)	2	3	4 Mean ± SD; CV (Max-Min)	5	6	7	8	9	10	11	12 Mean ± SD; CV (Max-Min)	13 Mean ± SD; CV (Max-Min)	14 Mean±SD; CV (Max-Min)
r L	0.44 (n = 1)			0.39 (n = 1)			0.46 (n = 1)				0.32 (n = 1)	0.29 (n = 1)	0.50 (n = 1)	0.51 ± 0.12; 0.23 (0.59-0.42) (n = 2)
Pr W	0.27 (n = 1)			0.18 (n = 1)			0.27 (n = 1)				0.27 (n = 1)	0.19 (n = 1)	0.21 (n = 1)	0.23 ± 0.03; 0.13 (0.25-0.21) (n = 2)
P L	0.70 ± 0.17; 0.25 (0.82-0.58) (n = 2)	0.65 (n = 1)	0.87 (n = 1)	0.62± 0.16; 0.26 (0.74-0.51) (n = 2)	0.76 (n = 1)	0.67 (n = 1)	0.77 (n = 1)	0.55 (n = 1)	0.75 (n = 1)	0.78 (n = 1)	0.96 (n = 1)	0.47 ± 0.06; 0.14 (0.52-0.42) (n = 2)	0.66 ± 0.23; 0.24 (0.82-0.50) (n = 2)	0.76 ± 0.19; 0.24 (1.13-0.57) (n = 7)
P W	0.16 ± 0.04; 0.27 (0.19-0.13) (n = 2)		0.24 (n = 1)	0.28 ± 0.06; 0.20 (0.32-0.24) (n = 2)	0.24 (n = 1)	0.15 (n = 1)	0.27 (n = 1)	0.21 (n = 1)	0.15 (n = 1)		0.18 (n = 1)	0.18 ± 0.01; 0.04 (0.09-0.05) (n = 2)	0.16 ± 0.01; 0.09 (0.17-0.15) (n = 2)	0.18 ± 0.04; 0.22 (0.24-0.13) (n = 7)
PL. L	0.32 ± 0.04; 0.12 (0.34-0.29) (n = 2)		0.26 (n = 1)	0.29 ± 0.12; 0.42 (0.37-0.20) (n = 2)	0.38 (n = 1)	0.20 (n = 1)	0.37 (n = 1)	0.37 (n = 1)	0.25 (n = 1)	0.36 (n = 1)	0.35 (n = 1)	0.07 ± 0.03; 0.37 (0.09-0.05) (n = 2)	0.11 ± 0.03; 0.25 (0.13-0.09) (n = 2)	0.15 ± 0.05; 0.03 (0.24-0.08) (n = 7)
Pl. W	0.12 ± 0.05; 0.43 (0.15-0.08) (n = 2)	0.21 (n = 1)	0.15 (n = 1)	0.14 ± 0.04; 0.31 (0.17-0.11) (n = 2)	0.17 (n = 1)	0.10 (n = 1)	0.19 (n = 1)	0.17 (n = 1)	0.12 (n = 1)	0.12 (n = 1)	0.10 (n = 1)	0.10 ± 0.01; 0.10 (0.1-0.10) (n = 2)	0.07 ± 0.02; 0.32 (0.08-0.05) (n = 2)	0.12 ± 0.03; 0.2 (0.15-0.08) (n = 6)
Head length	0.57 ± 0.06; 0.11 (0.62-0.52) (n = 2)	0.61 (n = 1)	0.87 (n = 1)	0.62 (n = 1)	0.60 (n = 1)	0.70 (n = 1)	0.58 (n = 1)	0.64 (n = 1)	0.62 (n = 1)		0.57 (n = 1)	0.39 (n = 1)	0.51 ± 0.09; 0.17 (0.57-0.45) (n = 2)	0.71 ± 0.21; 0.29 (1.14-0.55) (n = 7)
PL./ Head length	1.25 ± 0.44; 0.35 (1.56-0.94) (n = 2)	1.07 (n = 1)	1.00 (n = 1)	0.83 (n = 1)	1.27 (n = 1)	0.95 (n = 1)	1.27 (n = 1)	0.87 (n = 1)	1.21 (n = 1)		1.67 (n = 1)	1.08 (n = 1)	1.35 ± 0.68; 0.50 (1.83-0.87) (n = 2)	1.16 ± 0.33; 0.28 (1.55-0.59) (n = 7)



FIGS. 42–49. Anatomy of *Islamia globulus*. FIG. 42: Partial nervous system; FIG. 43: Osphradium and ctenidium; FIG. 44: Stomach; FIG. 45: Prostate and rectum loop; FIGS. 46, 47: Head of a male and penis; FIG. 48: Anterior female genitalia; FIG. 49: Detail of the seminal receptacles; Abbreviations in text. Scale bar = 500 µm (FIGS. 42–48).

probably made up of a selection of the largest specimens; Bofill's descriptions and illustrations were likely based on this lot. After having determined that the specimens of both lots were conspecific, we realised it would be impossible to identify the illustrated specimens (Bofill, 1915; Bofill & Haas, 1920). We selected a lectotype from this first lot.

Islamia globulus is clearly distinguished from the other *Islamia* species by a combination of characters. Its ovate-conic shell easily distinguishes it from both valvatiform (*I. piristoma*, *I. trichoniana*, etc.) and trochiform species (*I. anatolica*, *I. bunarbasa*). Other important character states include a radula with only one basal cusp on each side and two separated seminal receptacles (SR2 large and pedunculated and SR1 small, elongated and sessile). Differences and similarities with *I. ateni* and between *I. globulus* and *I. lagari* are discussed below.

Islamia lagari (Altimira, 1960)

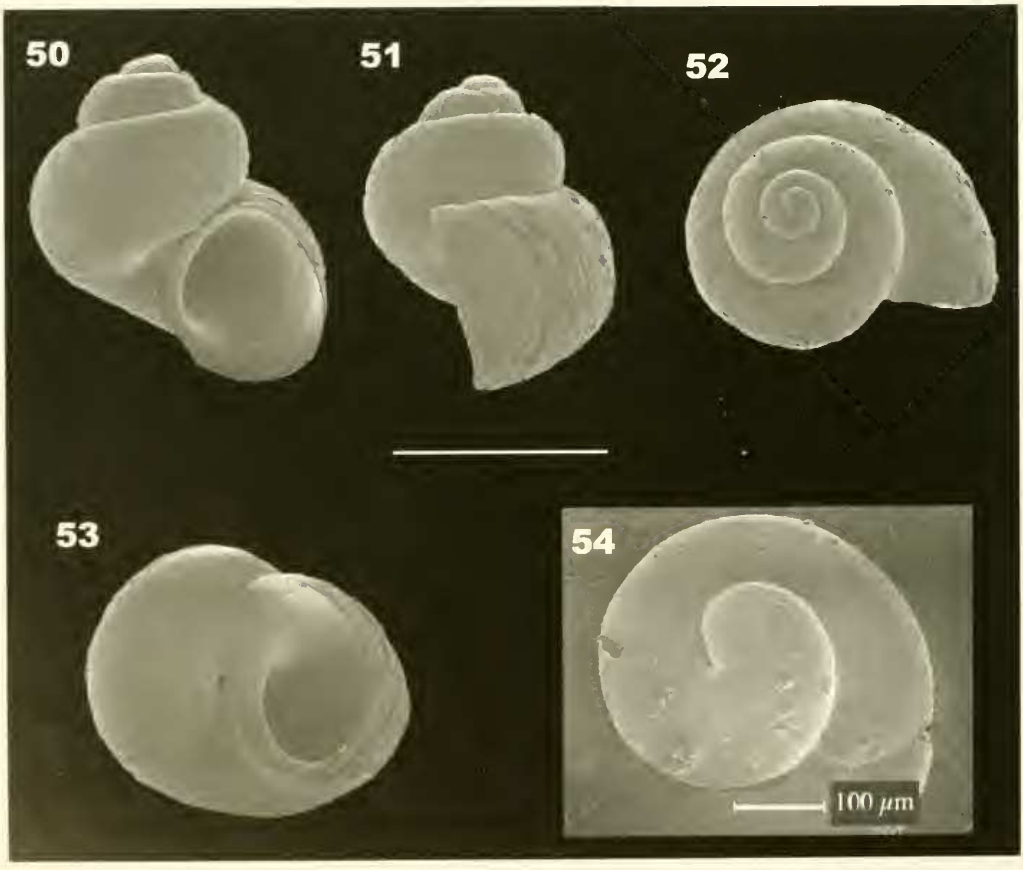
Pseudamnicola lagari Altimira, 1960: 10, fig. 2.
Neohoratia globulus lagari (Altimira, 1960) – Boeters, 1988: 216, figs. 145, 146, 156, 164, pl. 2, fig. 23; Bech, 1990: 61.
Islamia globulus lagari (Altimira, 1960) – Bodon et al., 2001, 43: 179, figs. 201–206; Bodon & Cianfanelli, 2002: 20.

Type Locality

Sot de Can Parés, Gavá, Barcelona, U.T.M.: 31TDF120720 (Fig. 17).

Material Examined

Type material: Lectotype (shell) of *N. globulus lagari* from the NNM (N° 56466/1) (Figs. 50–54). Five dried specimens in the



FIGS. 50–54. Shells of *Islamia lagari* (NNM 56466/1). Scale bar = 1 mm (FIGS. 50–53).

NHMW (Vienna) (Coll. W. Klemm) (NHMW 79000/K 45087) had a label with the same handwriting as that of lectotype. The text in both labels is the same "*Pseudamnicola lagari* Alt. Can Parés. Gavá. Barcelona. 11–59". In addition, the label in NHMW has number "7" also handwritten, thus suggesting that Altimira probably collected seven specimens in Nov. 1959, one of which has not yet been located. Therefore, the specimens at the NHM should be paralectotypes after designation of the lectotype by Boeters.

Material Examined for Morphometry

Shell measurements (Table 1) correspond to the lectotype and paralectotypes.

Diagnosis

Shell ovate-conic with large and inflated body whorl; operculum ovate; central tooth of radula with a single basal cusp on each side; ctenidium well developed; big penis, black pigmented, with one unpigmented non-glandular lobe located in a subterminal position not protruding from penial tip; pin-like proximal seminal receptacle (SR2) with a long stalk and small, elongated, sessile distal seminal receptacle (SR1); receptacles emerge distinctly separated from one another.

Description
(Figs. 50–54; Table 1)

Shell: Ovate-conic with 3.5 whorls; sutures deep, aperture oval to roundish, slightly prosocline, peristome complete, reflected at lower and columellar margin; body whorl large and inflated, over $^{6}/_{7}$ of the total shell length; protoconch consisting of 1.7 whorls; protoconch width and width of nucleus are 370 µm and 130 µm, respectively (Fig. 54); protoconch pitted; umbilicus narrow, about 80 µm in diameter (Fig. 53), partially covered by reflected columellar lip. In apical view, shell growth is rapid, especially body whorl, which has an inflated appearance.
No specimens were available for anatomical study. Anatomical data are shown in Bodon et al. (2001: figs. 201–206).

Discussion

Islamia globulus and *I. lagari* have been considered both good species and subspecies. The last treatment has prevailed since Boeters (1988) considered both to be subspecies of *Neohoratia globulus*. Based on morphological differences, we propose species status for both taxonomic entities. A detailed anatomical description of *I. globulus* is given here. No ethanol-preserved specimens of *I. lagari* were available for study. Therefore, only dried type material and illustrations from literature have been used to compare this species with *I. globulus*. We used the anatomical descriptions provided by Boeters (1988: figs. 156, 164) and Bodon et al. (2001: figs. 201–206). Morphological differences between *Islamia globulus* and *I. lagari* (Boeters, 1988; Bodon et al., 2001) are based on shell shape, penis size and size and shape of the glandular penial lobe and seminal receptacles.

Shells of *I. globulus* are more compressed laterally and, consequently, are taller and narrower than those of *I. lagari*. The body whorl of *I. globulus* is proportionally smaller (shorter and narrower) than in *I. lagari* (Altimira, 1960). The latter species has an inflated body whorl and a relatively lower spire. The penis of *I. globulus* is larger and has a slightly flatter penial lobe. The free part of penis towards the tip is also flatter, narrower and longer than in *I. lagari*. *Islamia lagari* has a smaller distal seminal receptale (SR1) with a short stalk, which is not evident in *I. globulus*. Proximal seminal receptacle (SR2) of *I. lagari* is less developed than in *I. globulus* and has a longer and more slender stalk.

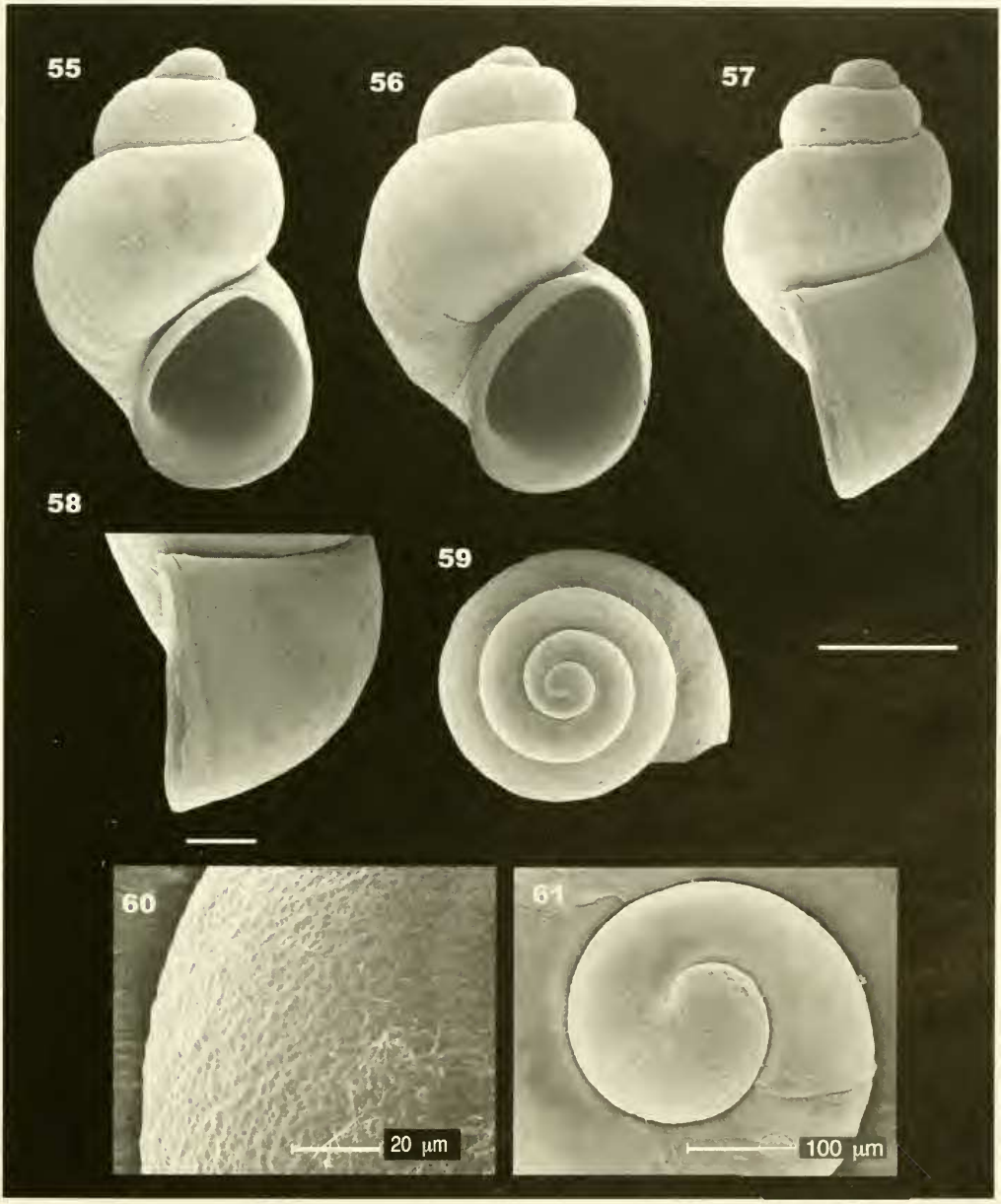
The DFA also confirmed differences between the two species. We analysed nine standard shell measurements from the four *I. globulus* populations and from the *I. lagari* type material. Of the 70 individuals classified, all of the *I. lagari* were correctly classified (100%) and perfectly discriminated from the rest by two highly significant functions (Wilk's lambda = 0.039, F (36.211), $p < 0.0001$). The remaining *I. globulus* individuals were grouped into four overlapping clusters. For the first function, the characters that contributed most of the 83% explained variance were (in order): AL and AH. For the second function the order was: AW, LBW and WBW. Another DFA using all *Islamia* species studied herein yielded similar results. All of the *I. lagari* specimens were correctly classified and definitively discriminated from all the other species (see "Statistical Analysis of *Islamia* species" below and Fig. 138).

Both taxa are allopatric, which does not help clarify their taxonomic status. However, both species are found in two different mountain chains that differ in geological origin and soil

TABLE 7. Female genitalia measurements (in mm) of several *Islamia* Iberian species: *I. globulus* (1–8) from the following populations: 1 - Sopeira spring, Huesca; 2 - Laguarta, Huesca; 3 - Baix Pallars (La Argenteria spring), Lérida; 4 - Gabet de la Conca (La Sarga spring), Lérida; 5 - Abella de la Conca (La Fayeda spring), Lérida; 6 - Vilanova de Meya (Regué spring), Lérida; 7 - Alós de Balaguer (La Figuereta spring), Lérida; 8 - Arén (Bordons spring), Lérida. The rest of the populations from type localities: *I. ateni* (9), *I. pallida* (10), *I. h. henrici* (11) and *I. h. giennensis* (12).

	1 Mean ± SD; CV (Max-Min)	2 Mean ± SD; CV (Max-Min)	3	4	5	6	7	8	9 Mean ± SD; CV (Max-Min)	10 Mean ± SD; CV (Max-Min)	11 Mean ± SD; CV (Max-Min)	12 Mean ± SD; CV (Max-Min)
Op L	0.72 (n = 1)	0.81 ± 0.14; 0.17 (0.94-0.67) (n = 3)	0.77 (n = 1)	0.77 (n = 1)	0.90 (n = 1)	0.43 (n = 1)	0.92 (n = 1)	0.56 (n = 1)	0.62 ± 0.02; 0.04 (0.64-0.61) (n = 2)	0.37 ± 0.07; 0.20 (0.42-0.32) (n = 2)	0.56 ± 0.10; 0.18 (0.67-0.47) (n = 3)	0.80 ± 0.10; 0.12 (0.89-0.69) (n = 3)
Op W	0.35 (n = 1)	0.40 ± 0.04; 0.09 (0.43-0.38) (n = 2)	0.28 (n = 1)	0.32 (n = 1)	0.34 (n = 1)	0.23 (n = 1)	0.29 (n = 1)	0.28 (n = 1)	0.25 ± 0.01; 0.03 (0.26-0.24) (n = 2)	0.20 ± 0.02; 0.12 (0.21-0.18) (n = 2)	0.22 ± 0.05; 0.21 (0.28-0.20) (n = 3)	0.21 ± 0.03; 0.17 (0.24-0.17) (n = 3)
Ag. L			0.46 (n = 1)	0.37 (n = 1)	0.42 (n = 1)				0.21 ± 0.03; 0.14 (0.23-0.19) (n = 2)	0.20 (n = 1)	0.22 ± 0.06; 0.26 (0.27-0.15) (n = 3)	0.30 ± 0.03; 0.10 (0.33-0.28) (n = 2)
Cg. L			0.31 (n = 1)	0.39 (n = 1)	0.48 (n = 1)				0.41 ± 0.05; 0.13 (0.45-0.37) (n = 2)	0.12 (n = 1)	0.34 ± 0.05; 0.15 (0.40-0.31) (n = 3)	0.45 ± 0.12; 0.27 (0.53-0.36) (n = 2)
SR1 L	0.18 ± 0.04; 0.23 (0.21-0.15) (n = 2)	0.09± 0.09; 1.07 (0.15-0.02) (n = 2)		0.05 (n = 1)	0.12 (n = 1)		0.06 (n = 1)		0.05 ± 0.01; 0.38 (0.07-0.04) (n = 2)	0.03 (n = 1)	0.06 ± 0.00; 0.10 (0.06-0.05) (n = 3)	0.05 ± 0.01; 0.31 (0.07-0.04) (n = 3)
SR2 L	0.23 ± 0.04; 0.19 (0.26-0.20) (n = 2)	0.18 ± 0.01; 0.05 (0.18-0.17) (n = 2)		0.18 (n = 1)	0.17 (n = 1)		0.18 (n = 1)		0.09 ± 0.00; 0.00 (0.95-0.95) (n = 2)	0.03 (n = 1)	0.09 ± 0.01; 0.11 (0.10-0.08) (n = 3)	0.11 ± 0.05; 0.45 (0.18-0.07) (n = 4)

composition. *Islamia globulus* has a wide geographical distribution in the provinces of Lérida and Huesca (cites in Gerona could not be confirmed). This area is situated in the "Depresión del Ebro". It is of Oligocene origin and is composed of marls and sands on calcareous substrate. At a great distance away, more than 150 km (Fig. 17), *I. lagari* is restricted to a small area in Sierra de Can Parés in the Garraf Massif (Barcelona), on Lower Triassic soils, where limestone, marls and sandstones predominate.



FIGS. 55–61. Topotypes of *Islamia ateni* (MNCN 15.05/46547). FIGS. 55, 56: Frontal view; FIGS. 57, 58: Lateral view; FIG. 59: Spire whorls; FIGS. 60, 61: Protoconch microsculpture. Scale bar = 500 µm (FIGS. 55–57, 59); 200 µm (FIG. 58).

Islamia ateni (Boeters, 1969)

Microna ateni Boeters, 1969: 70, figs. 6–8.
Neohoratia ateni (Boeters, 1969) – Boeters, 1988: 216, figs. 147, 148, 157, 158, 163, 288, pl. 2, fig. 24; Bech, 1990: 62, fig. 11.
Islamia ateni (Boeters, 1969) – Bodon et al., 2001, 43: 178, figs. 189–194; Bodon & Cianfanelli, 2002: 20.

Type Locality

Balneario de San Vicente, Lérida, U.T.M.: CG89 (Fig. 17).

Type Specimens

Holotype in NNM and paratypes NNM/37, SMF 194371/2 and BOE 205 and 206.

Material Examined

The description of this species was made possible by studying topotypical material, kindly provided and deposited in MNCN by H. D. Boeters. There were 13 specimens in alcohol [leg. Boeters coll. 514, 11/9/1972 (Figs. 55–61) MNCN 15.05/46547 (ethanol and SEM preparation)].

Morphometry

All measurements correspond to specimens from the type locality.

Diagnosis

Shell ovate-conic; operculum ovate; central tooth of radula with a single basal cusp on each side; ctenidium well developed; esophagus running straight underneath cerebral commissure; small pear-shaped prostate gland; penis long, unpigmented, with a large, flat, extended. unpigmented non-glandular lobe located near, but not protruding, from its tapered distal end; elongated. pedunculated proximal seminal receptacle (SR2) bending towards distal portion of renal oviduct and small, globular, sessile distal seminal receptacle (SR1); seminal receptacles quite separated from one another.

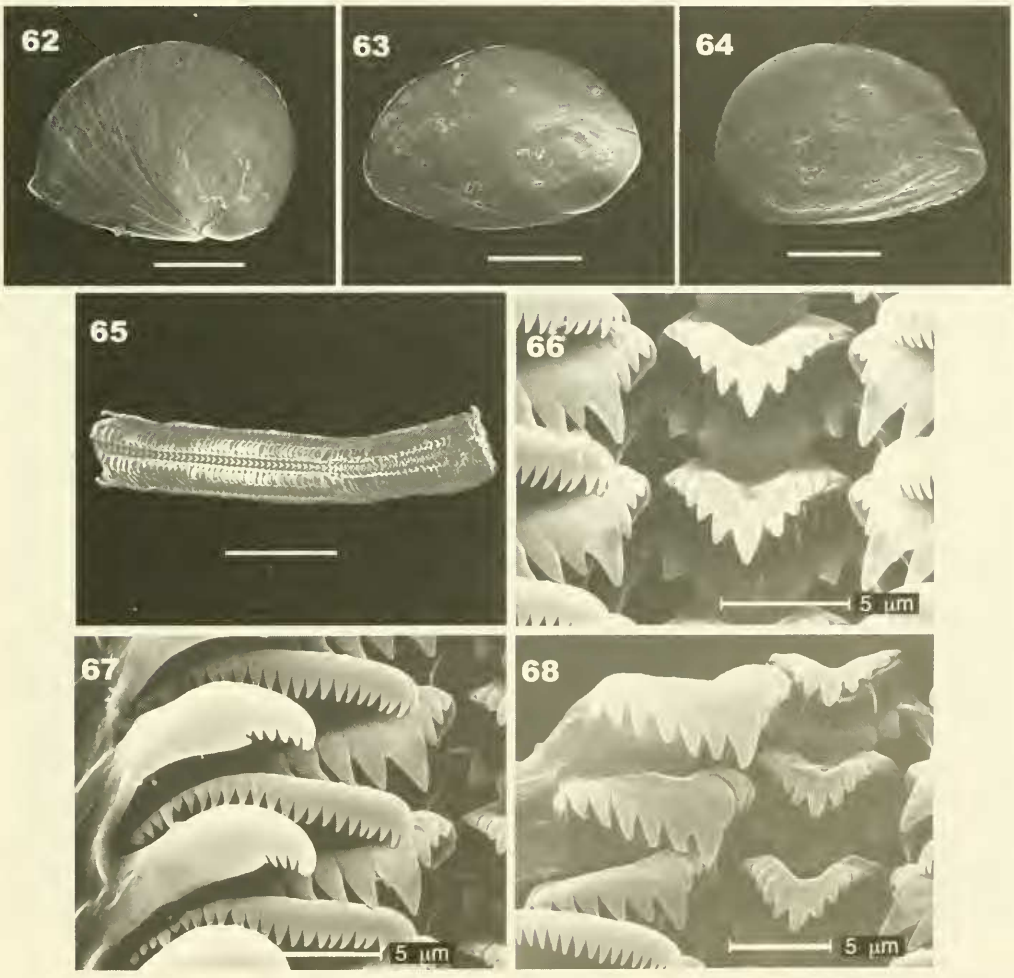
Description
(Bodon et al., 2001: figs. 189–194)

Shell: Ovate-conic, longer than wide, with 4 whorls (Figs. 55–57, 59, Table 1); sutures deep; body whorl occupies more than $^{5}/_{7}$ of total shell length; protoconch pitted (Figs. 60, 61), consisting of 1.5 whorls; protoconch width and width of the nucleus are 280 µm and 120 µm, respectively; last whorl of teleoconch very narrow from apical perspective (Fig. 59); aperture oval, orthocline or slightly prosocline; peristome thin at outer margin and slightly thickened at columellar margin, slightly reflected at lower and columellar margin; umbilicus very narrow; external lip thin (Figs. 57, 58).
Operculum: Yellowish, ovate (Figs. 62–64), with submarginal nucleus; muscle attachment area oval (Fig. 64).
Body: Head dark pigmented from the middle of the tentacles to the eye lobes (Fig. 69); external body pigmentation very dark, except last body whorl.
Nervous System: With long pleuro-supraesophageal connective; no data on pleurosubesophageal connectives were obtained due to the scarcity of specimens available for study; RPG ratio is 0.5 (elongated). Esophagus runs straight underneath the cerebral commissure of the nervous system.
Ctenidium – Osphradium: With approximately 10 lamellae (Fig. 70), occupying $^{3}/_{8}$ of length of pallial cavity. Osphradium oval and intermediate in size (Table 3).
Stomach – Radula: Stomach almost as wide as it is long (Table 5, Fig. 71); style sac protruding anteriorly into intestinal loop; rectum U-shaped (Fig. 70). Radula medium-sized (21%) relative to maximum shell dimension (Table 4, Fig. 65); central tooth with a single basal cusp on each side (Fig. 66); distance between cusps approximately 6.7 µm; central denticle long, sharp, followed on each side by five small denticles in decreasing order of size; cutting edge markedly concave; lateral teeth with 5–6 denticles on each side of central tooth (Figs. 67, 68).
Male Genitalia: Prostate gland small, pear-shaped (Table 6, Fig. 72); vas deferens entering posterior end of prostate, and pallial vas deferens exiting at its middle region, both are relatively close to each other; penis long, unpigmented (Fig. 73), with a large, flat extended, non-glandular lobe near its tapered distal tip; undulating penial duct running along the right portion of penis and becoming straight before opening at penis tip.
Female Genitalia: Distal seminal receptacle (SR1), globular and sessile, smaller than proximal (SR2), which is elongated and pedunculated, bending towards distal portion

of renal oviduct (Fig. 75, Table 7); both seminal receptacles located at a distance from each other on opposite positions of renal oviduct; oviduct glands (albumen + capsule glands) with very weak or no narrowing, capsule gland smaller than albumen gland; renal oviduct forming a wide circle (Fig. 74) overlying albumen gland.

Discussion

Islamia ateni may be differentiated from the remaining European *Islamia* species by its peculiar ovate-conic or bythinelliform shell shape, a very small prostate gland relative to shell length, and by the rather large gap between the two seminal receptacles. A single basal cusp on each side of the central tooth of the radula is a character state shared with *I. valvataeformis*, *I. servaini*, *I. gaiteri*, *I. pusilla* and *I. globulus*. All other species described have two basal cusps. Its morphologically closest species is *I. globulus*. Main characters differentiating both species are related to shell size and shape (that of *I. ateni* are more slender than that of *I. globulus*), shape of the penial lobe (more flattened and less extended in *I. ateni*, never protruding from penis tip), SR2



FIGS. 62–68. Operculum and radula of *Islamia ateni*. FIGS. 62, 63: Outer side of the operculum; FIG. 64: Inner side of the operculum; FIG. 65: Radula; FIG. 66: Central teeth; FIG. 67: Lateral, outer and inner marginal teeth; FIG. 68: Central and lateral teeth. Scale bar = 200 µm (FIGS. 62–64); 100 µm (FIG. 65).

characteristically bending towards distal portion of renal oviduct, and the distance between seminal receptacles, which is longer in *I. ateni*.

Islamia pallida Arconada & Ramos, **n. sp.**

Type Specimens

Holotype MNCN 15.05/46548 (SEM preparation, Fig. 78) and paratypes (Figs. 82, 85, 88, 90, 91) MNCN 15.05/46548, 5 April 1992, D. M. & N. M. (dried material, ethanol and SEM preparation).

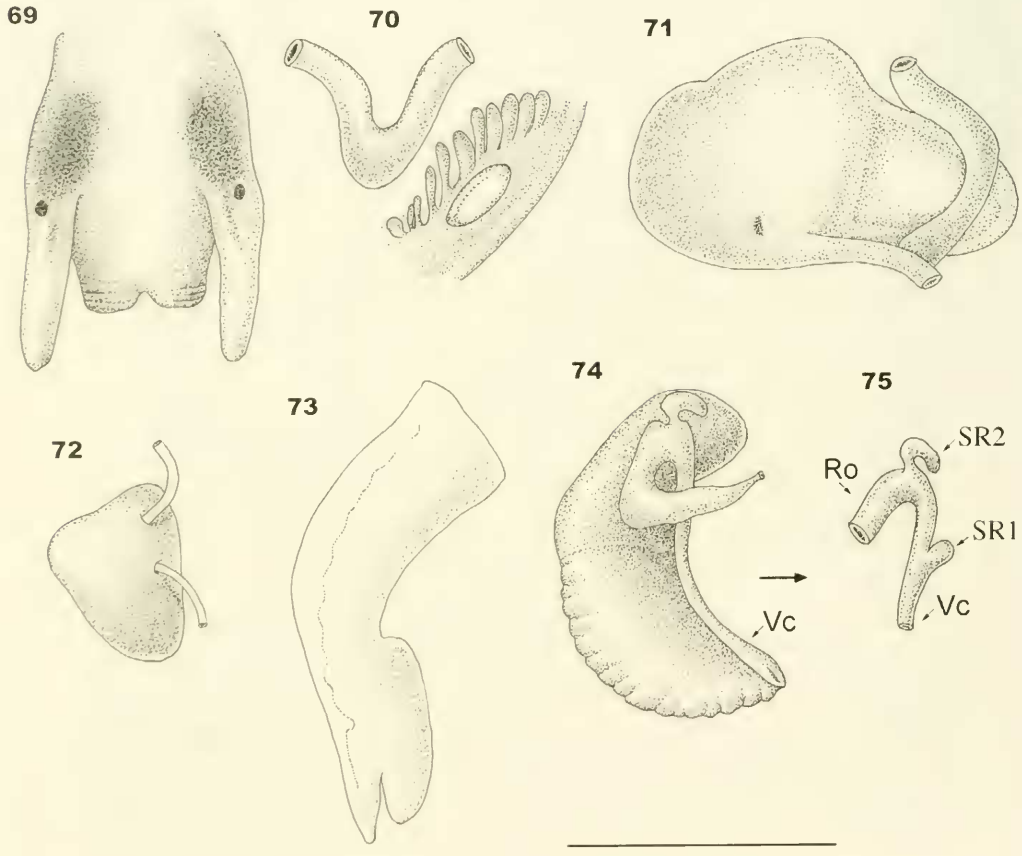
Type Locality

Spring in Patones, Patones de Abajo, Madrid, UTM.: 30TVL603241.

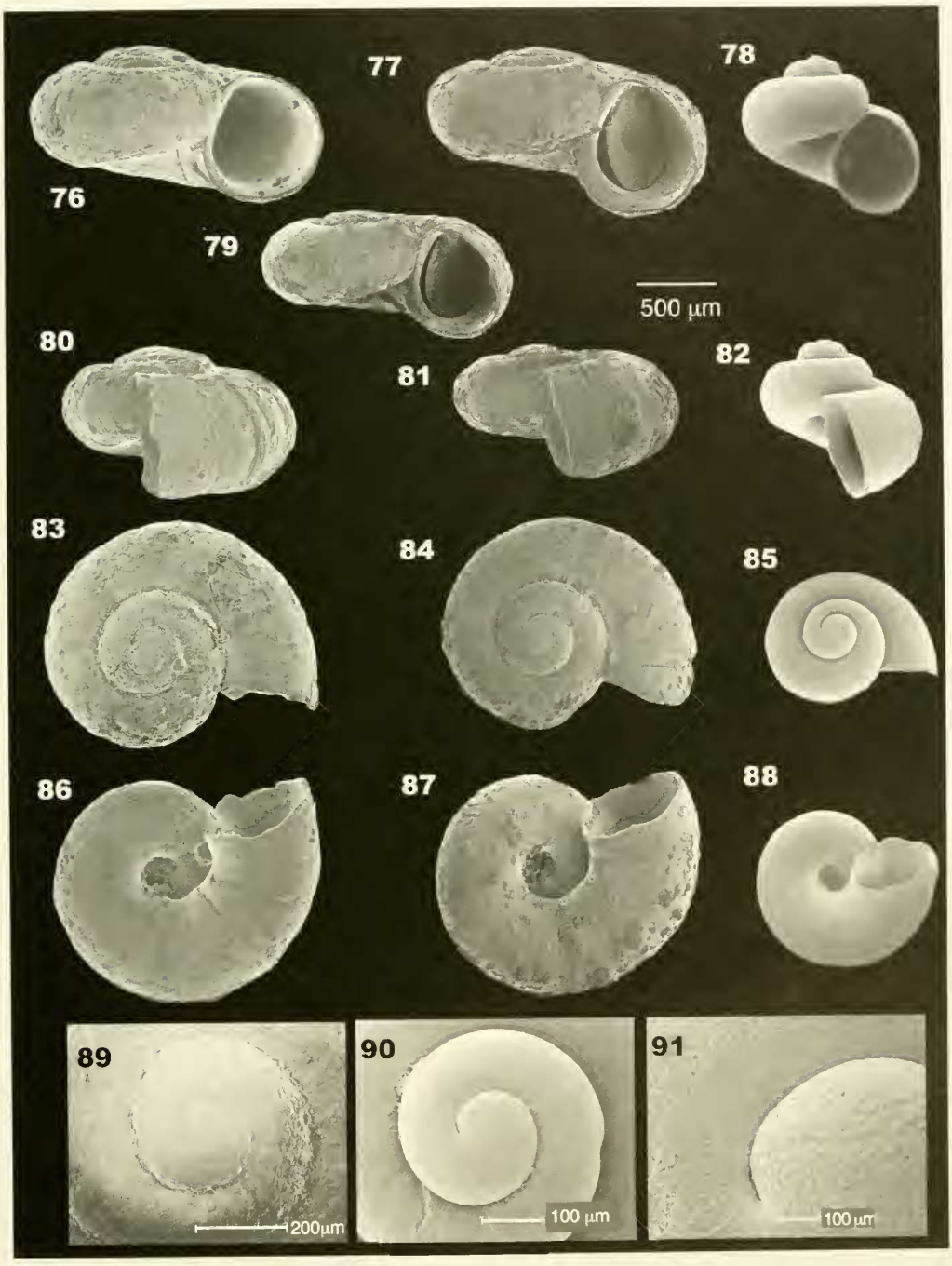
Specimens Examined

The following specimens were also examined for comparative purposes: Lectotype, MHNG (Figs. 76, 80, 83, 86) and paralectotypes, MHNG (Figs. 77, 79, 81, 84, 87, 89) of *Neohoratia* (?) *coronadoi* (Bourguignat, 1870) (originally *Valvata coronadoi*).

Other localities: Province of Madrid (Fig. 17), e.g., Spring in Patones, Patones de Abajo, Madrid (type locality), 29 June 1997, B. A. & D. B., MNCN 15.05/46550 (ethanol material); Jarama River, Patones, Madrid, UTM.: 30TVL5824, 18 Jan. 1989, A. C.; MNCN 15.05/46549 (ethanol); 8 Aug. 1989, A. C.; La Parra channel, Patones, Madrid, UTM.: 30TVL603241, 2 June 1996, B. A. & D. B., MNCN 15.05/46551 (ethanol).



FIGS. 69–75. Anatomy of *Islamia ateni*. FIG. 69: Head pigmentation; FIG. 70: Rectum, osphradium and ctenidium; FIG. 71: Stomach; FIG. 72: Prostate; FIG. 73: Penis; FIG. 74: Anterior female genitalia; FIG. 75: Detail of the seminal receptacles; Abbreviations in text. Scale bar = 500 µm (FIGS. 69–74).



FIGS. 76–91. Shells of *Neohoratia* (?) *coronadoi* and *Islamia pallida*. FIGS. 76, 80, 83, 86: Lectotype of *Neohoratia* (?) *coronadoi* (MHNG); FIGS. 77, 79, 81, 84, 87, 89: Paralectotypes of *Neohoratia* (?) *coronadoi* (MHNG); FIG. 78: Holotype of *I. pallida* (MNCN 15.05/46548); FIGS. 82, 85, 88, 90, 91: Paratypes of *I. pallida*.

Specimens Examined for Morphometry and Histology

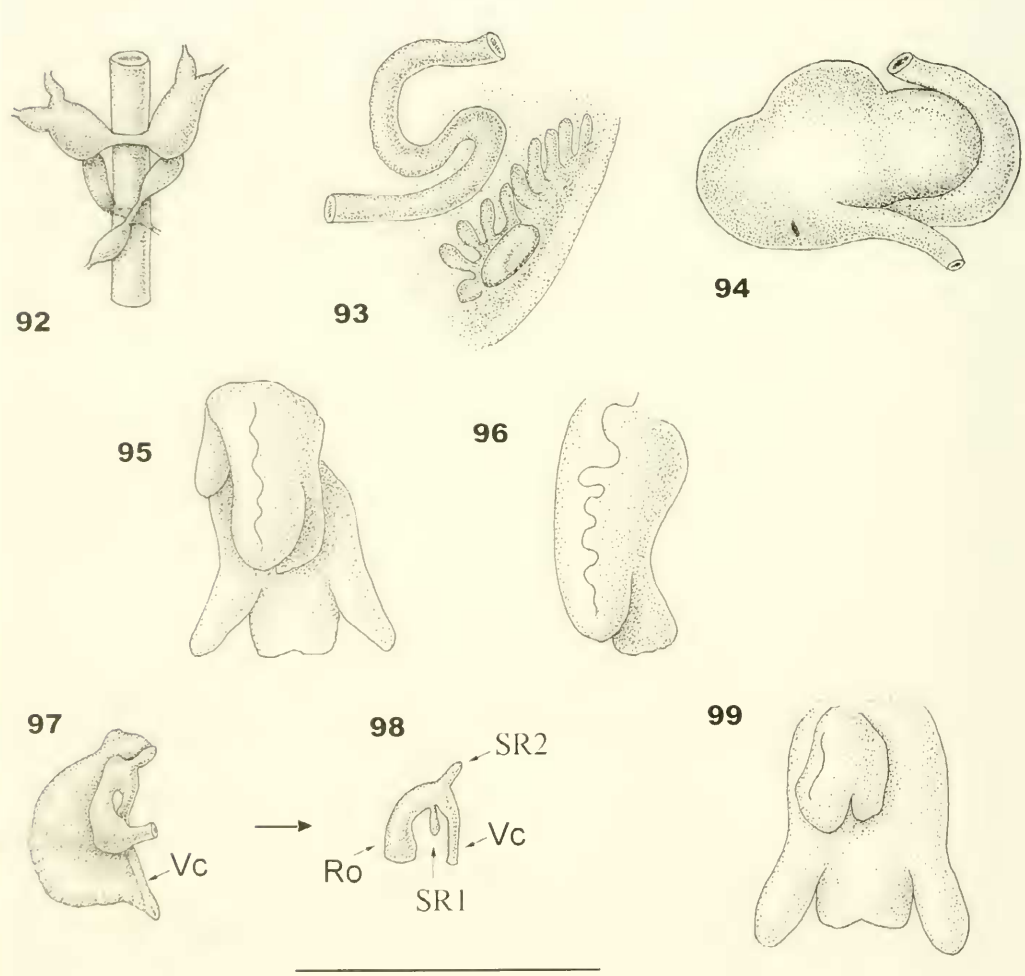
All measurements (Tables 1–3, 5–7) correspond to specimens from type locality (5/4/1992). For histology, one male from type locality (April, 1992) was studied.

Etymology

The name "*pallida*" refers to the fact that body is completely unpigmented.

Diagnosis

Shell depressed-trochiform or valvatiform; operculum circular; head and body unpigmented; ctenidium well developed; short pleuro-subesophageal connective and small subesophageal ganglion; medium size pleuro-supraesophageal connective; esophagus running straight underneath cerebral commissure; penis long, unpigmented, with a rounded and subterminal non-glandular lobe located near its distal end and protruding from penis tip;



FIGS. 92–99. Anatomy of *Islamia pallida*. FIG. 92: Partial nervous system; FIG. 93: Rectum, osphradium and ctenidium; FIG. 94: Stomach; FIGS. 95, 96: Head of a male and penis; FIG. 97: Anterior female genitalia; FIG. 98: Detail of the seminal receptacles; FIG. 99. Head of a female and pseudopenis. Abbreviations as in text. Scale bar = 500 µm (FIGS. 92–97, 99).

penial duct undulates along entire length of central part of the penis; two elongated seminal receptacles located very close to each other on opposite sides of renal oviduct; females with an unpigmented pseudopenis.

Description

Shell: Depressed-trochiform or valvatiform, 3.5 whorls (Figs. 78, 85, Table 1); body whorl occupying more than $^3/_4$ of total shell length; protoconch pitted (Fig. 91), consisting of 1.5 whorls (Fig. 90); protoconch width and width of the nucleus are 350 µm and 120 µm, respectively; aperture prosocline, rounded (Fig. 78); peristome complete, thin (Fig. 82); umbilicus narrow, 0.2 mm in diameter (Fig. 88); shells extremely fragile, some showing marked growth lines in teleoconch microsculpture.

Operculum: Circular, yellowish, with central muscle attachment area on its inner surface (Table 2).

Body: Head and body completely unpigmented (Figs. 95, 99). Eyes absent.

Nervous System (Fig. 92): Medium sized supraesophageal and short pleural-subesophageal connective; subesophageal ganglion very small; RPG ratio is 0.42 (moderately concentrated). Esophagus runs straight underneath cerebral commissure.

Ctenidium – Osphradium: Ctenidium with 9–10 long, narrow lamellae (Fig. 93); osphradium oval, length two times width (Table 3), located in opposite posterior part of ctenidium.

Stomach – Radula: Stomach almost as long as it is wide. Style sac not protruding anteriorly to intestinal loop (Fig. 94). Rectum markedly S-shaped, bending toward anterior portion of body (Fig. 93). Radula: unknown. No data on the radula were available due to its extreme fragility and the scarcity of available specimens.

Male Genitalia: Unpigmented penis almost as long as head (Table 6) with a rounded-trapezoidal, non-glandular, subterminal lobe (Figs. 95, 96) located parallel in ventral position and near its blunt distal tip and protruding beyond tip of penis; penial duct strongly undulating along its length and near central part of penis.

Female Genitalia: Minute with very small oviduct glands (albumen + capsule glands), without narrowing (Fig. 97), located approximately $^1/_3$ inside pallial cavity; renal oviduct making wide circle over albumen gland, which is larger than capsule gland; two elongated seminal receptacles equal in size (Fig. 98, Table 7) very close to one another (almost at the same level) on opposite sides of renal oviduct close to its loop, none of them with a stalk; females have an unpigmented pseudopenis (Fig. 99) measuring approximately 0.20 mm, and occupies almost half length of head.

Discussion

The geographical distribution of this species corresponds to that of *Neohoratia* (?) *coronadoi*, described by Bourguignat (1870) as *Valvata coronadoi* "en los alrededores de Madrid, o, al menos, en algunos manantiales o arroyos de la provincia de Castilla La Nueva" [in Madrid's surroundings or, at least, in some springs or streams of the New Castille Province]. There are no anatomical data available for *Neohoratia* (?) *coronadoi*, which has conchological characters that clearly differ from those of *I. pallida*. The shells of *N.* (?) *coronadoi* are large and planispiral, whereas those of *I. pallida* are small and trochiform. Boeters (1988) dubiously assigned the first species, *V. coronadoi*, to the genus *Neohoratia* [as *N.* (?) *coronadoi*], because of its similarities to *Neohoratia schuelei* (*sensu* Boeters, 1988). After several field samplings, we found no specimen of *Valvata coronadoi*, which is possibly now extinct. The presence of a pseudopenis in all females studied of *I. pallida* is a phenomenon that has also been reported and discussed in another Iberian valvatiform species (*Spathogyna fezi* Arconada & Ramos, 2002). The development of male sexual characters in females has sometimes been related to parasitism (Rothschild, 1938), or even to imposex (Smith 1971; Fioroni et al., 1990). In the case of *I. pallida*, we did not find any sign of parasitism in any of the females studied.

Juvenile specimens kept in an aquarium showed a monthly growth rate of 75% shell length and 87% width. They have a ciliated region in the propodium and at the tip of the tentacles (Figs. 100–103).

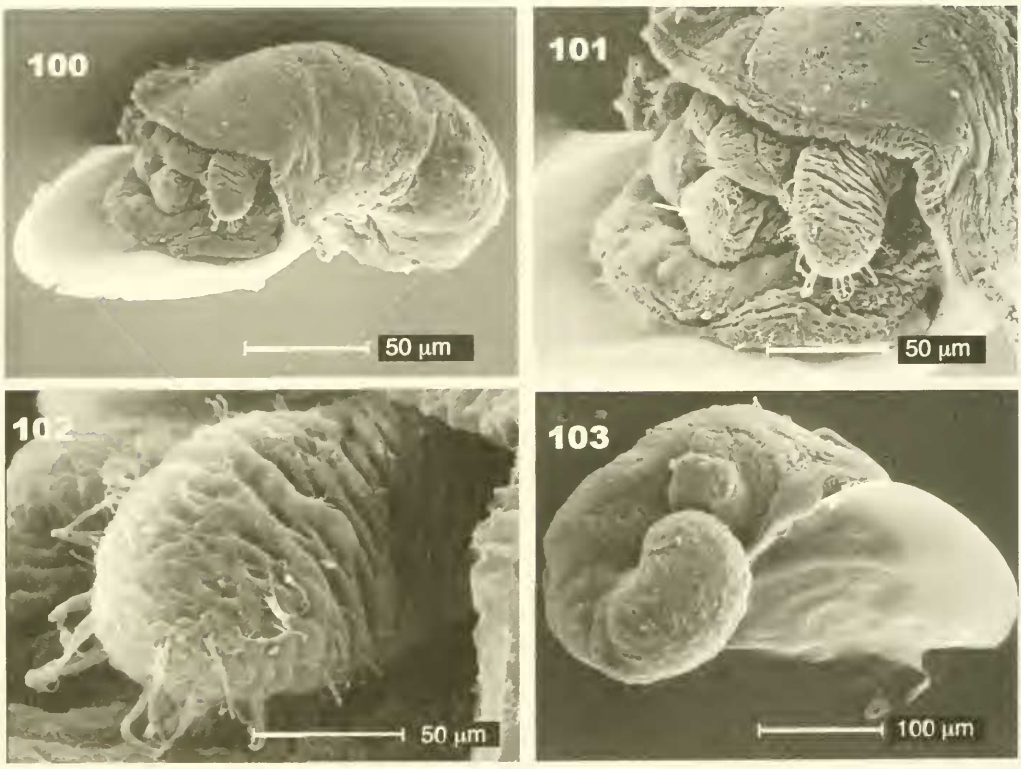
Differences between *I. pallida* and other Iberian *Islamia* species are based on a combination of characters: the absence of head and body pigmentation, a very small subesophageal ganglion, two elongated seminal receptacles, without stalk, very close to one another, located almost at the same level on

opposite sides on the renal oviduct close to its loop and a well-developed female pseudopenis. In relationship to other European *Islamia* species, most of the differences are related with the genitalia. In *I. pallida* the position of seminal receptacles is, in a way, similar to that described for the type species, *Islamia valvataeformis*. However, in *I. pallida* both receptacles are smaller, not pedunculated, similar in size and shape, and are located close to the end of the renal oviduct loop (proximal position), whereas in *I. valvataeformis* (Radoman, 1983: 124, fig. 69A, B; Bodon et al., 2001: 133) both seminal receptacles are "strongly developed" (the proximal one is larger, pyriform, and has an evident stalk), and emerge close to one another from the distal renal oviduct. In *I. pallida*, the penial lobe protrudes beyond the penis tip, similar to that described in species from the Balkan Peninsula. Nevertheless, *I. pallida* has a blunt penis tip. In addition, the penial duct markedly undulates along its length and near the central part of penis. In the Balkan's species, the penial duct runs through the right part of the penis, undulating not so markedly from its base and becoming almost straight at the distal end. As in the Italian *I. gaiteri* and in the French *I. minuta*, *I. globulina*, *I. consolationis* and *I. spirata*, all *I. pallida* specimens studied lack eyes and have a completely unpigmented body. This may be related to living in an interstitial or underground water habitat (Bodon et al., 1995: 47, 51, 52).

Islamia henrici Arconada & Ramos, **n. sp.**

Type Specimens

Holotype MNCN 15.05/46552 (Fig. 15B) (SEM preparation) and paratypes MNCN 15.05/46552, 13 Oct. 1992, E. R. (ethanol and SEM preparation – Figs. 106, 107, 109, 112, 113, 116).



FIGS. 100–103. Juveniles of *Islamia pallida*. FIGS. 100, 103: Complete body and operculum; FIG. 101: Detail of the ciliated propodium; FIG. 102: Detail of the ciliated tentacles.

Type Locality

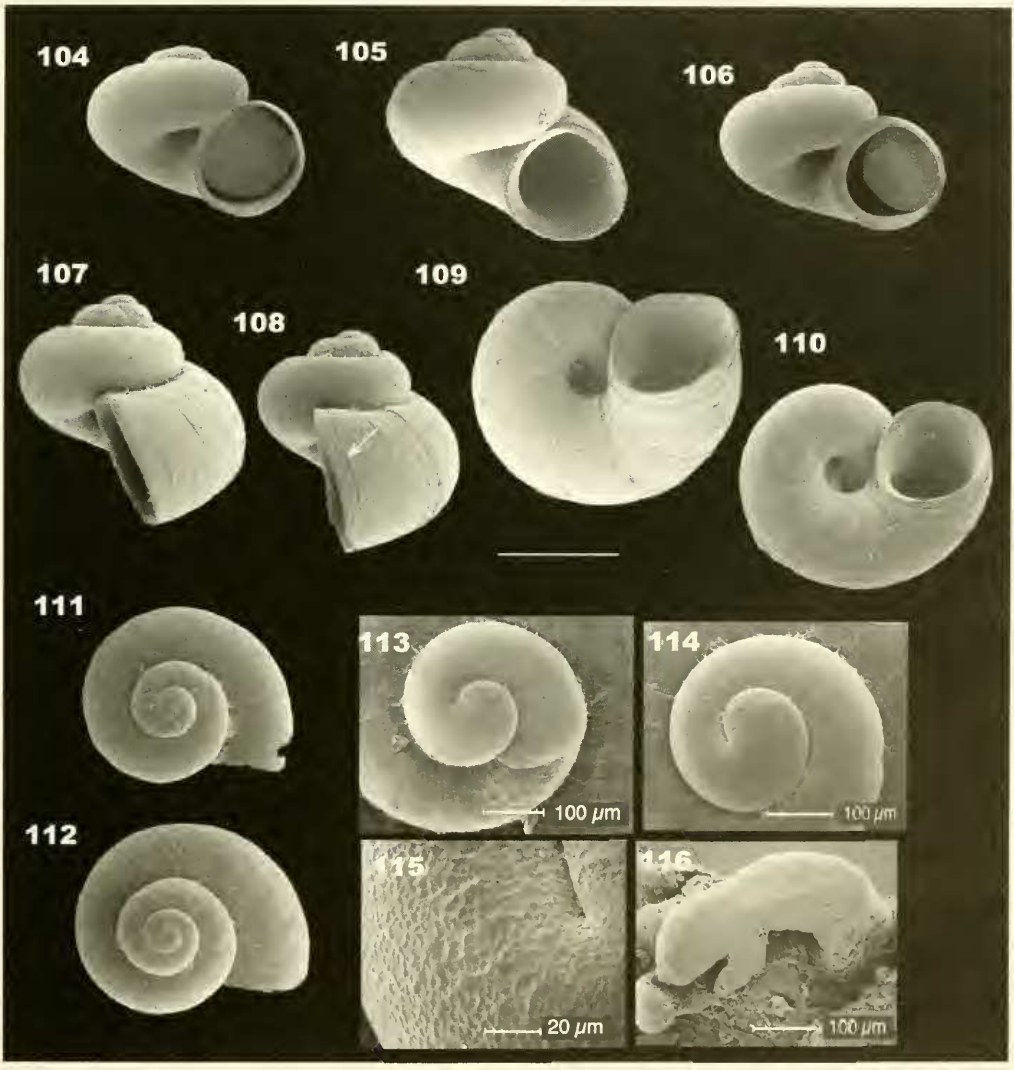
A tributary of the Guadalora River in Parque Natural de Hornachuelos, Córdoba, U.T.M.: 30STG9788.

Etymology

Dedicated to Enrique Arconada, whose given name has been Latinized as Henricus.

Diagnosis

Shell valvatiform or depressed-trochiform; central tooth with two basal cusps on each side; ctenidium scarcely developed or absent; esophagus curving posteriorly to cerebral commissure; long pigmented penis with small non-glandular lobe located near its tip but not protruding from it; proximal seminal receptacle rounded, pedunculated or elongated, with



FIGS. 104–116. Shells and penis of *Islamia henrici*. FIGS. 104, 108, 110, 111, 114, 115: Shells of *I. henrici giennensis* from La Iruela population; FIGS. 105–107, 109, 112, 113, 116: Shells and penis of *I. henrici henrici* from Hornachuelos population; FIG. 104: Holotype of *I. henrici giennensis* (MNCN 15.05/46555); FIG. 105: Holotype of *I. henrici henrici* (MNCN 15.05/46552). Scale bar = 500 µm (FIGS. 104–112).

swollen tip (SR2), bending towards distal portion of renal oviduct and distal seminal receptacle smaller, more or less globular and sessile (SR1).

We consider that this species has two subspecies as follows:

Islamia henrici henrici Arconada & Ramos, **n. subsp.**

Populations Additional to Species Type Material

This subspecies was found in the province of Córdoba (Fig. 17). A tributary of the Guadalora River, Parque Natural de Hornachuelos, Córdoba (type locality), 16 April 1998, B. A., MNCN 15.05/46553 (ethanol and frozen material); La Almarja spring, Parque Natural de Hornachuelos, Córdoba, U.T.M.: 30SUG014869, 16 April 1998, B. A., MNCN 15.05/46577 (ethanol, SEM preparation, and frozen material).

Material Examined for Morphometry and Histology

All measurements of shell, operculum, osphradium, digestive, radular, female and male systems (Tables 1–7) correspond to specimens from the type locality (in Parque Natural de Hornachuelos). Male and females studied and measured were collected in Oct. One female from Guadalora River was studied for histology.

Diagnosis

Long orangish pigmented penis with small non-glandular lobe located in distal position, but not protruding from penis tip; females having a nuchal node.

Description

Shell: Valvatiform or depressed-trochiform, 3.5 whorls (Table 1; Figs. 105, 106, 112); body whorl occupying approximately $^{4}/_{5}$ of total shell length; protoconch pitted consisting of more than 1.5 whorls (Fig. 113); protoconch width and width of nucleus are 290 and 120 µm, respectively; aperture rounded and orthocline or slightly prosocline, sometimes slightly oval descending (Figs. 105–107); peristome complete, thin, slightly reflected at columellar margin; external lip thin, internal lip slightly reflected towards the umbilicus; umbilicus medium-sized, 180 µm in diameter (Fig. 109).

Operculum: Ovate with central nucleus (Figs. 117–118); muscle attachment area rounded.

Body: Head scarcely pigmented with scattered pigment cells at the base of tentacles around the eye-spots (Figs. 124, 129).

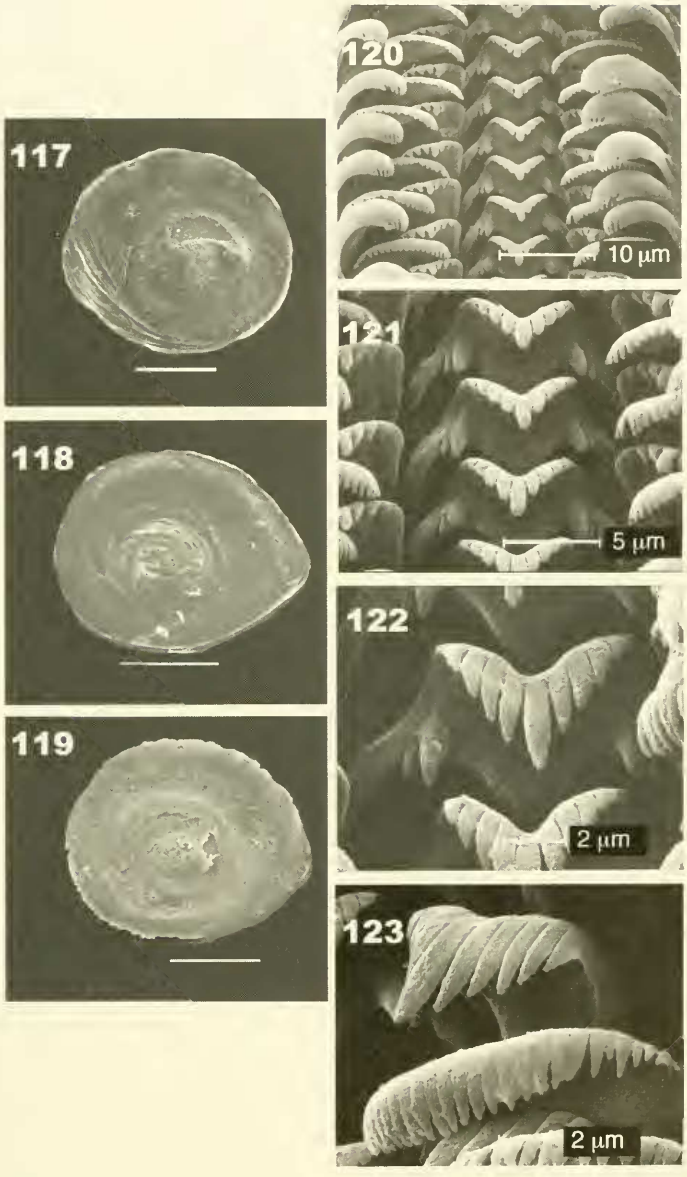
Nervous System (Fig. 125): With a medium-sized pleuro-supraesophageal connective; RPG ratio is 0.3 (moderately concentrated). Esophagus curving posteriorly to cerebral commissure.

Ctenidium – Osphradium: Ctenidium absent or very poorly developed, with 2–6 small lamellae (Fig. 126). Osphradium bean-shaped, length almost two times width (Table 3).

Stomach – Radula: Chambers almost equal in size. Style sac protruding anteriorly into intestinal loop (Table 5, Fig. 127). Rectum forming a marked S-loop and bends towards anterior portion of the body (Figs. 126, 128). Radula medium sized (23%) relative to maximum shell dimension, with two basal cusps on each side of central tooth (Table 5, Figs. 120–122); distance between its internal cusps is approximately 7 µm; its central denticle long, sharp, followed on each side by 4 long denticles in decreasing order of size; cutting edge of central tooth markedly concave; lateral teeth with 5–6 long, sharp denticles on each side of central denticle (Fig. 123).

Male Genitalia: With large bean-shaped prostate gland, narrow anteriorly (Fig. 128); less than 50% of prostate gland extending into pallial cavity; penis very long with small non-glandular lobe located in distal position (Figs. 116, 129), showing a small refringent area; penis orangish pigmented in live specimens; penial duct slightly undulating, close to central part of penis.

Female Genitalia: With renal oviduct that makes a wide circle (Fig. 130); no narrowing of oviduct glands (albumen + capsule glands); capsule gland larger than albumen gland, occupying more than 50% of total pallial cavity length and narrowing at its distal outer margin; proximal seminal receptacle (SR2) oval with a long stalk and slightly bent towards the distal part of renal oviduct (Fig. 131, Table 7); distal seminal receptacle (SR1) smaller than proximal receptacle, globular, sessile; seminal receptacles located relatively far from one another on opposite sides of renal oviduct. Some females have a dark nuchal node on the right side of



FIGS. 117–123. Opercula and radula of *Islamia henrici*. FIGS. 117, 118, 120–123: Opercula and radula of *I. henrici henrici* from Hornachuelos population; FIG. 119: Operculum of *I. henrici giennensis* from La Iruela population; FIG. 117: Outer side of the operculum; FIGS. 118, 119: Inner side of the operculum; FIG. 120: Transverse rows; FIGS. 121, 122: Central teeth; FIG. 123: Lateral and inner marginal teeth. Scale bar = 200 µm (FIGS. 117–119).

head (Fig. 124), which is approximately six times smaller than male penis, occupying 20% of total head length. This nuchal node is usually simple, although it can sometimes be bilobated, similar to the shape of the distal part of male penis.

Islamia henrici giennensis Arconada & Ramos, **n. subsp.**

Type Specimens

Holotype MNCN 15.05/46555 (SEM preparation) (Fig. 104) and paratypes MNCN 15.05/46555 (ethanol and SEM preparation, Figs. 108, 110, 111, 114, 115, 119).

Type Locality

Spring facing the hotel "Sierra Cazorla", La Iruela, Cazorla mountains, Jaén, UTM: 30SWG005969.

Etymology

The subspecific epithet is a Latin adjective related to the province of Jaén (Latin Gienna).

Other Specimens Examined

This species was found in the province of Jaén (Fig. 17). La Toba spring, Jaén, U.T.M.: 30SWH3826, 6 Oct. 1992, E. R., MNCN 15.05/46558 (ethanol); 24 March 1998, B. A., MNCN 15.05/46554 (ethanol); spring facing the hotel "Sierra Cazorla", La Iruela, Cazorla mountains, Jaén, UTM: 30SWG005969, E. R., MNCN 15.05/46556 (ethanol); 30 April 1990, D. M. & N. M., MNCN 15.05/46555 (ethanol); Madera River, La Fresnedilla, Segura mountains, Jaén, UTM.: 30SWH3644, 6 Oct. 1992, E. R., MNCN 15.05/46557 (ethanol and SEM preparation); spring in Cazorla, Jaén, E. R., MNCN 15.05/46559 (ethanol); La Nava de San Pedro, Cazorla, Jaén, UTM: 30SWG094948, 1 May 1990, D. M. & N. M.

Specimens Examined for Morphometry

Shell, operculum, and anatomical measurements – osphradium, digestive, female and male systems (Tables 1–3, 5–7) – correspond to type locality (La Iruela). Male and females studied and measured were collected in April.

Diagnosis

A slight varix near shell aperture in most of the specimens studied from all populations; long black pigmented penis with a small non-glandular lobe located in distal position but not protruding from penis tip, penis tip pointed; females have no nuchal node.

Description

Shell: Valvatiform or depressed-trochiform, with spire consisting of 2.75–3.5 whorls (Table 1; Figs. 104, 111); body whorl occupying approximately $^{4}/_{5}$ of total shell length; protoconch pitted consisting of more than 1.5 whorls (Figs. 114, 115); protoconch width and width of nucleus are 330 and 129 µm, respectively; aperture rounded, orthocline or slightly prosocline, sometimes slightly oval (Figs. 104, 108); peristome complete, thin, slightly reflected at columellar margin; most specimens have a slight varix near shell aperture (Fig. 108); external lip thin; internal lip reflected towards umbilicus; umbilicus medium-sized, 180 µm in diameter (Fig. 110).

Operculum: Ovate yellowish with darker central nucleus (Fig. 119); muscle attachment area rounded.

Body: Head scarcely pigmented with scattered pigment cells at base of tentacles around eye-spots. Mantle with dispersed pigmented areas. Pigmentation quite variable among specimens.

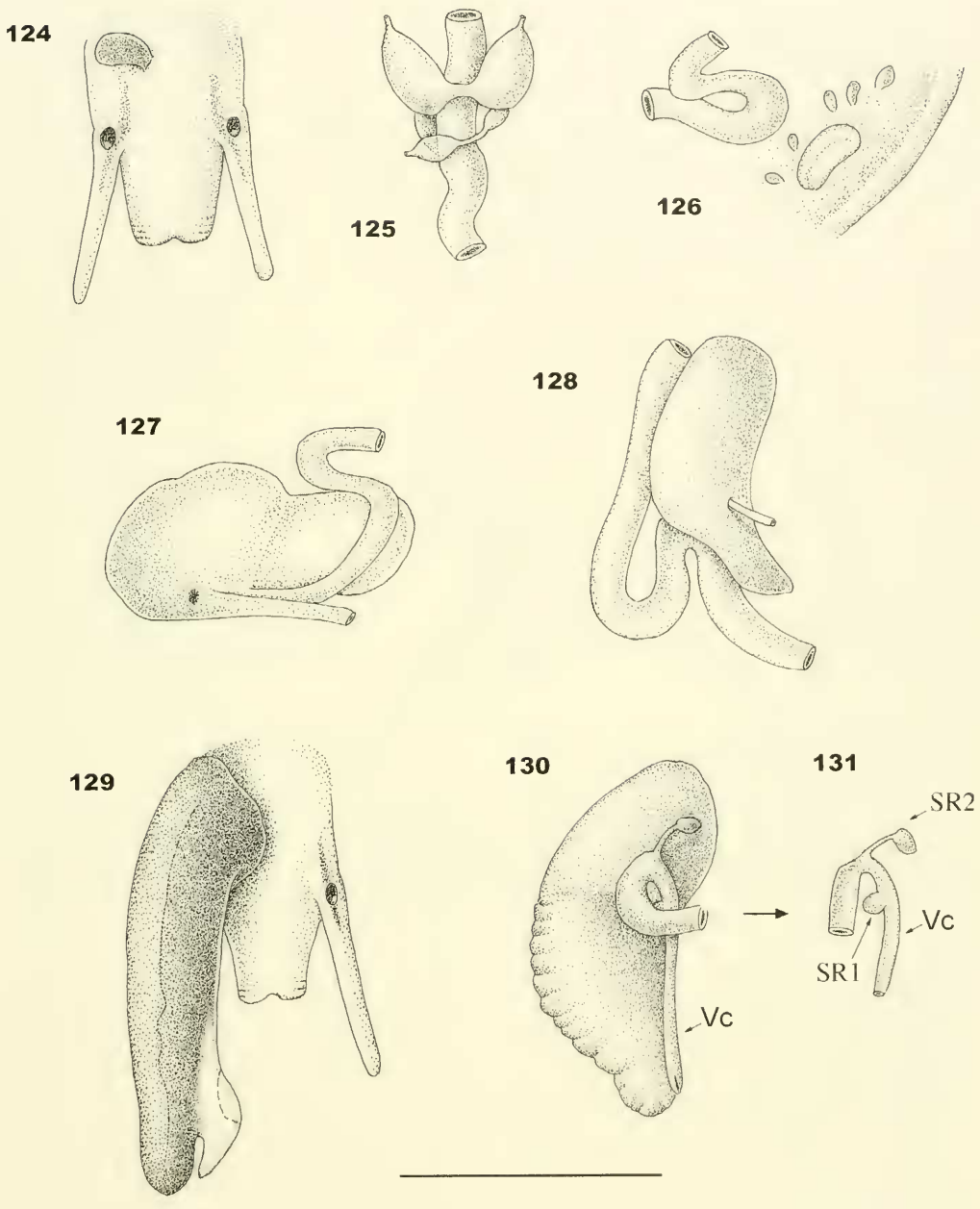
Nervous System (Fig. 132): With a short pleuro-supraesophageal connective; RPG ratio is 0.14 (concentrated). Esophagus frequently making a curve posteriorly to cerebral commissure.

Ctenidium – Osphradium: Ctenidium absent or very poorly developed, with 5–7 small lamellae (Fig. 133). Osphradium oval, length two times the width (Table 3).

Stomach – Radula: Chambers almost equal in size, longer than they are wide. Style sac protruding anteriorly into intestinal loop (Table 5). Rectum forming a marked S-loop, bending toward anterior portion of body. Radula with two basal cusps on each side of central tooth; its central denticle long, sharp, followed on each side by 4 long denticles in decreasing order of size; cutting edge of the central tooth markedly concave; lateral teeth with 4–5 long, sharp denticles on each side of central denticle.

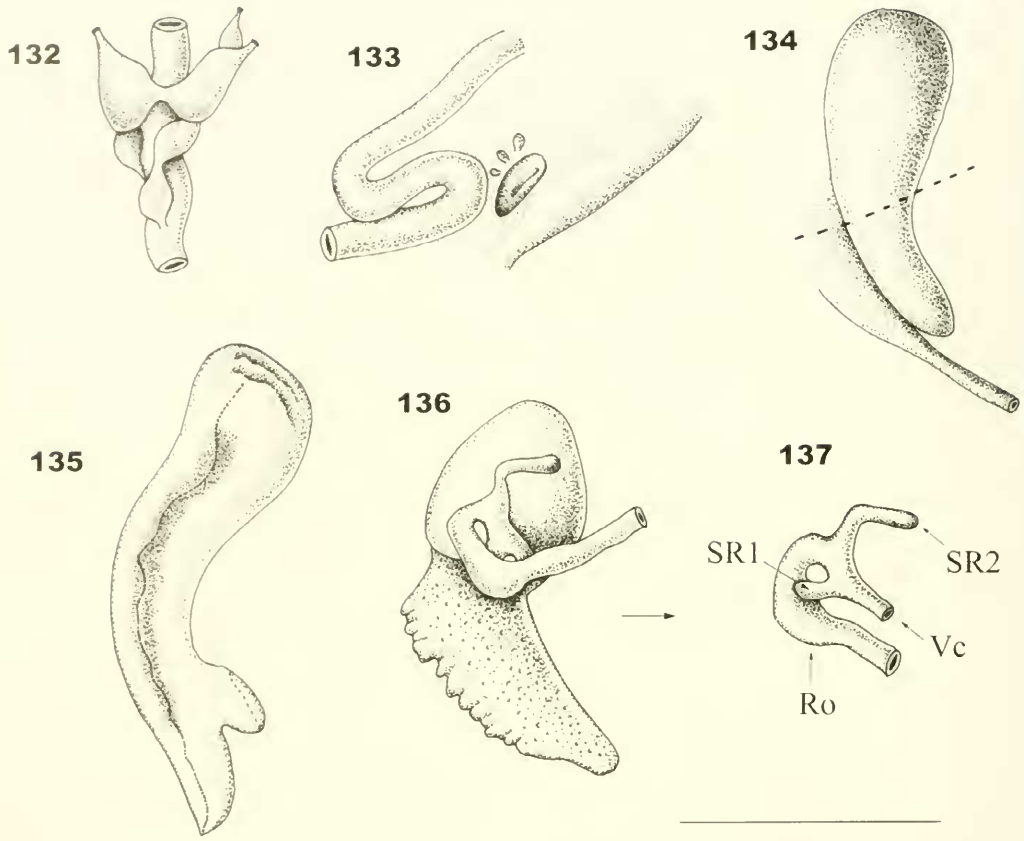
Male Genitalia: With large, long prostate gland, narrowing towards anterior part (Fig. 134); less than 50% of prostate gland extending into pallial cavity; penis very long with a small non-glandular lobe located in a distal position (Fig. 135); penis black pigmented pointed at penis tip; penial duct slightly undulating, running close to central part.

Female Genitalia: With renal oviduct making a wide circle (Fig. 136); oviduct glands (al-



FIGS. 124–131. Anatomy of *I. henrici henrici*. FIG. 124: Head of a female and nuchal node; FIG. 125: Partial nervous system node; FIG. 126: Rectum, osphradium and ctenidium node; FIG. 127: Stomach; FIG. 128: Prostate and rectum; FIG. 129: Head of a male and penis; FIG. 130: Anterior female genitalia; FIG. 131: Detail of the seminal receptacles; Abbreviations in text. Scale bar = 500 µm (FIGS. 124–130).

bumen + capsule glands) sometimes showing a narrowing; capsule gland larger than albumen gland and showing a narrowing at its distal outer margin, occupying more than 50% of total pallial cavity length; proximal seminal receptacle (SR2) elongated, with



FIGS. 132–137. Anatomy of *I. henrici giennensis*. FIG. 132: Partial nervous system; FIG. 133: Rectum, osphradium and ctenidium if present; FIG. 134: Prostate and end of rectum; FIG. 135: Penis; FIG. 136: Anterior female genitalia; FIG. 137: Detail of the seminal receptacles; Abbreviations in text. Scale bar = 500 µm.

swollen tip and bending 90° towards distal part of renal oviduct (Fig. 137); distal seminal receptacle (SR1) much smaller than proximal receptacle (Table 7), elongated or pyriform without evident stalk; seminal receptacles located not far from one another in opposite positions on renal oviduct.

Discussion

All *I. h. henrici* and *I. h. giennensis* populations studied show identical anatomical characters. However, some anatomical differences permit us to distinguish two "groups": one that includes all populations from Córdoba Province, and the other comprising populations from Jaén. The Jaén (*I. h. giennensis*) populations are characterised by a slight varix near the shell aperture in most of the specimens (no varix in *I. h. henrici*), a short supraesophageal connective, RPG ratio = 0.14 (medium-sized in *I. h. henrici*, RPG ratio = 0.30), an oval osphradium (bean-shaped in *I. h. henrici*), a prostate elongated pear-shaped (bean-shaped in *I. h. henrici*), a penial lobe without any refringent area (a small refringent area present in *I. h. henrici*), a black pigmented penis (penis orangish pigmented in *I. h. henrici*), long and slender proximal seminal receptacle (SR2) (elongated with swollen tip in *I. h. henrici*), and the absence of a nuchal node in females. A nuchal node is a constant character in all female specimens from Córdoba (*I. h. henrici*). There is a notable geographic distance between both "groups", which decreases the probabilities of gene flow. The anatomical differences together with the large geographic distances between the "groups", allow us to

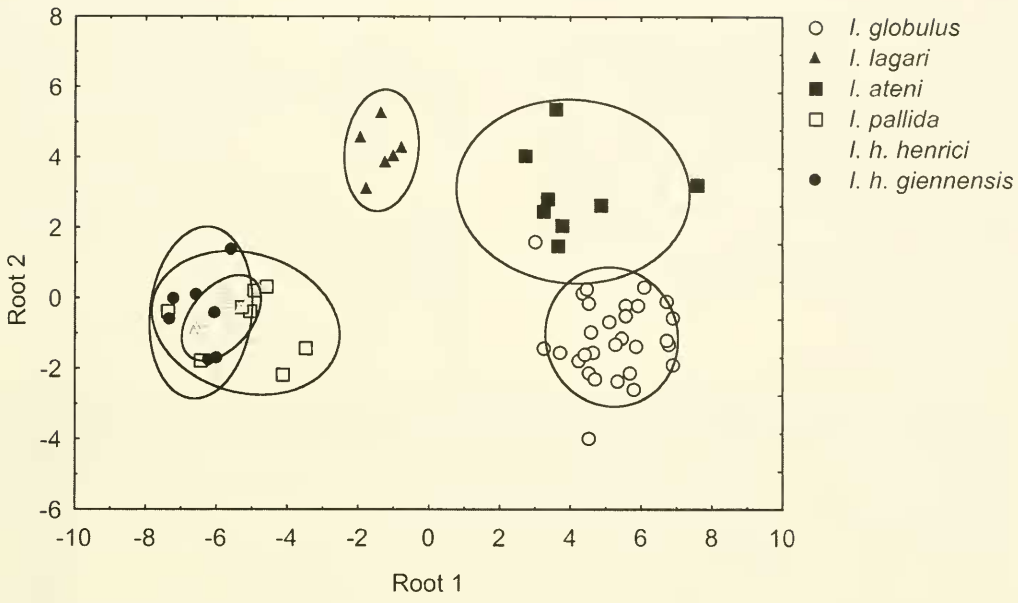


FIG. 138. Plot of discriminant scores on the two canonical axes, obtained from DFA of shell measurements for all Iberian *Islamia* species and subspecies: *I. globulus*, *I. ateni*, *I. lagari*, *I. pallida*, *I.henrici henrici* and *I. h. giennensis*. Confidence interval for ellipses: 0.95.

divide this species into two subspecies, *I. henrici henrici* (Córdoba populations) and *I. henrici giennensis* (Jaen populations). However, more specimens need to be studied to better understand the taxonomical identity of both entities. Unfortunately, due to declining populations, sample sizes were very small.

Islamia henrici can be distinguished from other European *Islamia* species by a group of characters: an under-developed or absent ctenidium (the same character is reported for the Italian *I. gaiteri*, Bodon et al., 1995: 51); a rather long, black or orangish pigmented penis, with a small, pointed lobe, which does not extend the penis tip. This small penial lobe is similar to that described for other species, such as *Islamia gaiteri* (Bodon et al., 1995: 51) and *Islamia* sp. form C, from the population of Monti della Calvana (Giusti et al., 1981: 66). In this latter species, however, the lobe is larger, nearly reaching the tip of the penis. A very small or often indistinguishable area of refringent non-glandular tissue is found at the base of the penial lobe (Fig. 129). The shape of the esophagus posterior to the cerebral commissure is a character that has not previously been described in any *Islamia* species. It slightly curved in *I. henrici*, whereas markedly so in *Josefus aitanica* (see below). Other differences among Iberian *Islamia* are: the reduction or absence of lamellae in the ctenidium, a long stalk on the proximal seminal receptacle, an orangish pigmented penis, and a protuberance on the female heads (the same described for *I. pallida*) of several populations.

Statistical Analysis of *Islamia* species

Conchological differences between *Islamia* species were investigated by a discriminant function analysis using the nine standard shell measurements on Table 1 (all except NSW). For *I. globulus*, the Sopeira population was selected as it had the greatest number of well-classified specimens as well as the highest number of specimens measured (n = 30). Four highly significant discriminant functions were found (Wilk's lambda = 0.0018, F (45, 267) = 18.27, $p < 0.0001$). The variables included in these functions were: SW, WBW, LBW, AL, AW, and WAW. For the first function that accounted for 84.5% of explained variance, the characters that contribute (highest weight) were (in order): SW, WBW and LBW. For the second function, the order was: AL, LBW, SW, WAW and AW. All discriminant functions were highly significant ($p < 0.0001$). Of the 73 individuals classified, all of the *I. ateni*, *I. globulus*,

I. lagari, and *I. h. henrici* were correctly classified (100%); 62.5% of the *I. pallida* individuals and 85.71% of *I. h. giennensis* were also correctly classified. On the scatterplot (Fig. 138), six clusters are observed. Three of them overlap and correspond to the taxa that have the most depressed-trochiform or valvatiform shells and shorter and wider body-whorls (*I. pallida*, *I. h. henrici*, and *I. h. giennensis*).

Milesiana Arconada & Ramos, **n. gen.**

Type Species

Hauffenia (*Neohoratia*) *coronadoi schuelei* Boeters, 1981: 56, figs. 3, 4.

Etymology

This subgenus is dedicated to the musician Miles Davis, for his great contribution to art and pleasure.

Diagnosis

This genus differs from all others by having a proximal receptacle (SR2) sessile and much smaller than distal (SR1), which has a long stalk; the seminal receptacles arise rather close to one another; a big non-glandular lobe is located in medial position of the penis; left pleural and subesophageal ganglia are fused, the pleuro-subesophageal connective is absent in *Milesiana*, whereas it is present in all the other European genera for which information on this character is available (Radoman, 1983), except in the genus *Josefus* described herein. Other features characterizing *Milesiana* are: shell small, ovoid or more usually planispiral; operculum without peg; central tooth with two basal cusps on each side; the two seminal receptacles are located on opposite sides on unpigmented renal oviduct; bursa copulatrix absent.

Milesiana schuelei (Boeters, 1981)

Hauffenia (Neohoratia) coronadoi schuelei Boeters, 1981: 56, figs. 3, 4.
Hauffenia schuelei (Boeters, 1981) – Bernasconi, 1985: 65.
Neohoratia schuelei (Boeters, 1981) – Boeters, 1988: 217, figs. 135–136, 159, 171, 288, pl. 2, fig. 26.
Islamia schuelei (Boeters, 1981) – Bodon et al., 2001: 179; Bodon & Cianfanelli, 2002: 20.
Horatia gatoa Boeters, 1980 – Only paratype in figure 6, which is here re-identified as *M. schuelei*.

Type Locality

"West of two springs between Galera and Orce, Granada" (Boeters, 1981).

Type Specimens

Holotype in SMF 253578/1, paratypes in SMF 253579/1, NNM, Falkner, BOE 222a and 223, *ex* Falkner, 308 and 308b, *ex* Wirth, 548 and 549, *ex* Bou.

In the original description, Boeters (1981) mentioned the type locality but not that of the paratypes. The only available information is: i) that the material was collected by Ulrich Wirth/Bonn (1963), Gerard Falkner/Hörlkofen and Munchen (1967) and Claude Bou/Moulis, Albi (1972), and ii) that species distribution includes: Prov. Granada, Velez-Benaudalla, spring at the road from Motril to Granada (UTM: VF 57), two springs between Galera and Orce (UTM: WG 47). Prov. Teruel, close to Caminreal in ground waters from a tributary of the Jiloca River (UTM: XL 42). Prov. Jaén, between Peal de Becerro and Úbeda, in ground waters of the Guadalquivir River. In his 1988 paper, Boeters confirmed type locality ("west of two springs between Galera and Orce, Prov. Granada", (WG 47) and completed information on paratypes as follows: SMF 253579/1, RMNH, FALK (Galera/Orce), BOE 222a and 223a (Galera/Orce), 308a and 308b (Velez-Benaudalla), 548 (tributary of the Jiloca River) and 549 (tributary of the Fardés River).

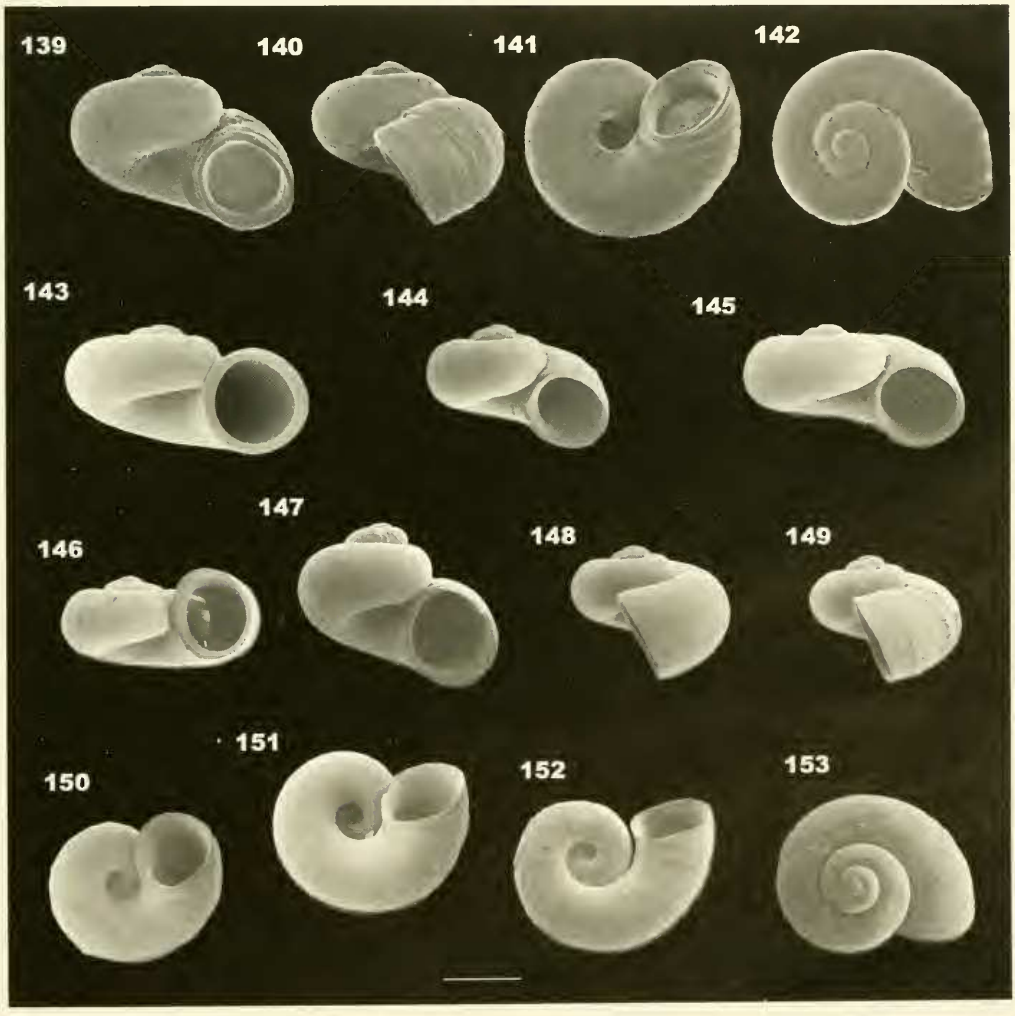
Specimens Examined

Type Material Examined: Holotype in SMF 253578/1 (Figs. 139–142, 154).

Other Populations Examined. This species was found in the provinces of Cádiz, Almería, Granada and Málaga (Fig. 17). A population found far from its distribution range, in the Cáceres province, was provisionally assigned to this species as *M.* cf. *schuelei*. The species has not been found in Teruel Province.

Localities: Algodonales, Cádiz, UTM.: 30STF8584, 19 Oct. 1998, E. R., MNCN 15.05/46495 (ethanol); El Nacimiento spring, Turrillas, Almería, UTM: 30SWF657975, 15 Oct. 1990, D. M., MNCN 15.05/46496 (ethanol, SEM preparation), 10 Oct. 1992, E. R., D. M., MNCN 15.05/46497 (ethanol); Los Minutos spring, Turrillas, Almería, UTM: 30SWF6598, 10 Oct. 1992, D. M., N. M., MNCN 15.05/46591 (SEM preparation); Andarax spring, river and channel, Laujar de Andarax, Almería, UTM: 30SWF0994, 11 Jan. 1992, D. M., N. M.; 11

Oct. 1992, E. R., D. M., MNCN 15.05/46498 (ethanol); Agua spring, Lucainena de Las Torres, Almería, UTM: 30SWF7199, 10 Oct. 1992, E. R., D. M., MNCN 15.05/46499 (ethanol); Vélez Blanco, Almería, UTM: 30SWG7972, E. R., MNCN 15.05/ 46592; Talama spring, Bayarcal, Almería, UTM: 30SWF0098, 26 March 1994, D. M., N. M., MNCN 15.05/46500 (ethanol and SEM preparation), 14 May 1994, D. M., N. M., MNCN 15.05/46501 (ethanol); El Marchal de Antón López, Almería, UTM: 30SWF3383, E. R.; 26 March 1998, B. A., MNCN 15.05/46502 (ethanol, SEM preparation and frozen material); Pool in Berchul, Félix, Almería, UTM: 30SWF298813, E. R., MNCN 15.05/46503 (ethanol and SEM preparation), 26 March 1998, B. A., MNCN 15.05/46504 (ethanol and frozen material); spring near the pool in Berchul, Félix, Almería, UTM: 30SWF298813, 26 March 1998, B. A., MNCN 15.05/46505 (ethanol); spring in Conchar, Granada, UTM.: 30SVF477912, 25 Sept. 1989, E. R., D. M., C. A., MNCN 15.05/46506 (dried); Faldés spring,



FIGS. 139–153. Shells of *Milesiana schuelei*. FIGS. 139–142: Holotype (SMF 253578/1); FIG. 143: Shell from Fuente del Mal Nombre, Padul (Granada); FIGS. 144, 148, 150, 153: Shells from Gaucín (Málaga); FIGS. 145, 151: Shells from Fuente Talama, Bayarcal (Almería); FIGS. 146, 149, 152: Shells from Fuente Los Minutos, Turrillas (Almería); FIG. 147: Shell from Benaoján (Málaga). Scale bar = 500 µm.

Sierra Harana Granada, UTM.: 30SVG592308, 23 April 1992, D. M., MNCN 15.05/46507 (ethanol), 12 Oct. 1992, E. R., D. M., MNCN 15.05/46508 (ethanol); 25 March 1998, B. A. MNCN 15.05/46509 (ethanol); Los Caños spring, Graena, Granada, UTM.: 30SVG810285, 27 Sept. 1989, E. R., D. M., C. A., MNCN 15.05/46510 (dried, ethanol); Pilar del Mono spring, Durcal, Granada, UTM.: 30SVF493951, 25 Sept. 1989, E. R., D. M., C. A., MNCN 15.05/46511 (dried, ethanol), 17 Oct. 1989, J. T., D. M., 27 March 1998, B. A., MNCN 15.05/46512 (ethanol); La Gitana spring, La Peza, Granada, UTM.: 30SVG703255, 25 March 1998, B. A., MNCN 15.05/46513 (ethanol); spring in Padul, Granada, UTM.: 30SVF4497, 25 Sept. 1989, E. R., D. M., C. A., MNCN 15.05/46514 (ethanol), 17 Oct. 1989, D. M.; 30 Sept. 1989, E. R., MNCN 15.05/46515 (ethanol, SEM preparation); Mal Nombre spring, Padul, Granada, UTM.: 30SUF445963, 27 March 1998, B. A., MNCN 15.05/46516 (ethanol and frozen material); spring in Gaucín, Málaga, UTM.: 30STF9244, 22 Nov. 1988; E. R., MNCN 15.05/46517 (ethanol, SEM preparation), 15 April 1998, B. A., MNCN 15.05/46518 (ethanol and frozen material); Matiaña spring, El Chorro, Málaga, UTM.: 30SUF468824, E. R., MNCN 15.05/46519 (ethanol), 14 April 1998, B. A., MNCN 15.05/46520 (ethanol and frozen material); Wet wall in El Chorro, Málaga, UTM.: 30SUF468824, E. R., MNCN 15.05/46521 (ethanol), 14 April 1998, B. A., MNCN 15.05/46522 (ethanol and frozen material); Cueva del Gato, Benaoján, Málaga, UTM.: 30SVF003673, 24 April 1992, D.M., MNCN 15.05/46523 (ethanol, SEM preparation); 15 April 1998, B. A., MNCN 15.05/46524 (ethanol and frozen material); Avellano River, La Cimada, Málaga, U.T.M.: 30SUF0976, E. R., MNCN 15.05/46525 (ethanol and SEM preparation).

TABLE 8. Shell measurements (in mm) of *Milesiana schuelei* from the following populations: 1 - Turrillas (El Nacimiento), Almería; 2 - Turrillas (Los Minutos spring), Almería; 3 - Padul, Granada; 4 - El Chorro, Málaga; 5 - Benaoján, Málaga.

	1 Mean ± SD; CV (Max-Min) (n = 15)	2 Mean ± SD; CV (Max-Min) (n = 29)	3 Mean ± SD; CV (Max-Min) (n = 10)	4 Mean ± SD; CV (Max-Min) (n = 17)	5 Mean ± SD; CV (Max-Min) (n = 27)
SL	0.75 ± 0.05; 0.07 (0.85-0.68)	0.80 ± 0.06; 0.07 (0.94-0.65)	0.68 ± 0.04; 0.07 (0.74-0.57)	0.68 ± 0.05; 0.08 (0.80-0.57)	0.92 ± 0.10; 0.11 (1.13-0.75)
SW	1.21 ± 0.08; 0.07 (1.35-1.10)	1.27 ± 0.08; 0.06 (1.42-1.01)	1.09 ± 0.07; 0.06 (1.18-0.97)	1.13 ± 0.08; 0.07 (1.27-1.04)	1.32 ± 0.09; 0.07 (1.54-1.17)
SL/SW	0.62 ± 0.06; 0.09 (0.73-0.51)	0.62 ± 0.05; 0.08 (0.73-0.53)	0.62 ± 0.03; 0.06 (0.70-0.57)	0.59 ± 0.04; 0.07 (0.68-0.52)	0.70 ± 0.07; 0.10 (0.87-0.58)
AH	0.65 ± 0.09; 0.14 (0.82-0.55)	0.62 ± 0.04; 0.07 (0.82-0.55)	0.52 ± 0.02; 0.04 (0.57-0.50)	0.53 ± 0.04; 0.07 (0.60-0.47)	0.67 ± 0.04; 0.06 (0.74-0.58)
LBW	0.65 ± 0.04; 0.07 (0.75-0.57)	0.71 ± 0.05; 0.07 (0.81-0.60)	0.43 ± 0.04; 0.10 (0.48-0.35)	0.60 ± 0.05; 0.09 (0.71-0.50)	0.79 ± 0.10; 0.13 (0.98-0.63)
WBW	0.81 ± 0.07; 0.08 (0.92-0.70)	0.82 ± 0.05; 0.06 (0.91-0.68)	0.69 ± 0.04; 0.06 (0.77-0.61)	0.72 ± 0.05; 0.08 (0.85-0.62)	0.88 ± 0.11; 0.12 (1.33-0.75)
AL	0.52 ± 0.03; 0.07 (0.60-0.46)	0.54 ± 0.03; 0.06 (0.91-0.68)	0.49 ± 0.03; 0.07 (0.55-0.42)	0.49 ± 0.04; 0.09 (0.61-0.44)	0.58 ± 0.05; 0.08 (0.67-0.52)
AW	0.50 ± 0.07; 0.15 (0.60-0.25)	0.53 ± 0.02; 0.05 (0.60-0.44)	0.48 ± 0.02; 0.04 (0.52-0.45)	0.49 ± 0.04; 0.09 (0.61-0.44)	0.58 ± 0.04; 0.07 (0.69-0.52)
WPW	0.33 ± 0.03; 0.10 (0.40-0.28)	0.33 ± 0.04; 0.13 (0.40-0.24)	0.27 ± 0.03; 0.12 (0.32-0.21)	0.27 ± 0.04; 0.17 (0.34-0.18)	0.38 ± 0.04; 0.10 (0.47-0.32)
WAW	0.12 ± 0.02; 0.19 (0.10-0.08)	0.14 ± 0.02; 0.18 (0.18-0.08)	0.12 ± 0.01; 0.15 (0.14-0.10)	0.09 ± 0.01; 0.15 (0.12-0.07)	0.15 ± 0.02; 0.15 (0.21-0.11)
NSW	3.22 ± 0.19; 0.06 (3.50-3.00)	3.13 ± 0.14; 0.04 (3.50-3.00)	3.00 ± 0.00; 0.00 (3.00-3.00)	3.02 ± 0.08; 0.02 (3.25-3.00)	3.28 ± 0.21; 0.06 (3.50-3.00)

TABLE 9. Operculum measurements (in mm) of *Milesiana schuelei* from Gaucín population (Málaga).

	Mean±SD; CV (Max-Min)		Mean±SD; CV (Max-Min)
OL	0.59 ± 0.12; 0.21 (0.78-0.46) (n = 5)	NL	0.24 ± 0.04; 0.16 (0.27-0.17) (n = 5)
OW	0.47 ± 0.07; 0.16 (0.60-0.40) (n = 5)	NW	0.31 ± 0.01; 0.05 (0.34-0.29) (n = 5)
OLWL	0.21 ± 0.10; 0.47 (0.36-0.11) (n = 5)	OL/OW	1.23 ± 0.10; 0.08 (1.38-1.11) (n = 5)
OLWW	0.15 ± 0.06; 0.42 (0.26-0.09) (n = 5)		

M. cf. *schuelei*: Robladillo de Gata, Cáceres, UTM: 29TQE0764, E. R., MNCN 15.05/46526 (ethanol, SEM preparation).

Material Examined for Morphometry and Histology

Shell measurements (Table 8) correspond to populations from Almería, Granada and Málaga. Operculum and radular measurements (Tables 9, 11) to Málaga and anatomical measurements (Tables 10, 12–14) to Almería, Granada, Málaga and Cáceres (more details in table captions). Male and females studied and measured were collected in the following months: March, May, Sept., Oct. and Nov. For histology, seven specimens preserved in ethanol were studied: four females from Benaoján, Málaga (April 1992) and two males and one female from Turrillas, Almería (Oct. 1990).

Diagnosis

Shell small, planispiral or valvatiform; operculum circular; ctenidium well developed; pleural-subesophageal connective absent; large pear-shaped prostate gland; penis slightly or completely unpigmented, with large, non-glandular penial lobe located in medial position; proximal seminal receptacle (SR2) small, sessile, rounded; distal seminal receptacle (SR1) always larger than SR2, pyriform, pedunculated; receptacles located very close to one another on opposite positions on renal oviduct.

Description

Shell: Planispiral or valvatiform (Figs. 139, 143–147, Table 8), 3–3.5 whorls (Figs. 142, 153); sutures deep; body whorl expanded near aperture; protoconch consisting of 1.5 whorls; protoconch width and width of nucleus are 315 µm and 110–126 µm, respectively; protoconch pitted (Figs. 154–156); aperture prosocline, rounded (Figs. 143–147); umbilicus wide, approximately 240 µm in diameter (Figs. 141, 150–152); outer peristome simple, thin, straight; inner peristome slightly reflected at columellar margin (Fig. 140, 148, 149).

Operculum: Circular with large, central nucleus (Fig. 157); muscle attachment area rounded (Fig. 158).

Body: Head (Fig. 170) with black pigmentation extending from around the eyes to middle of tentacles.

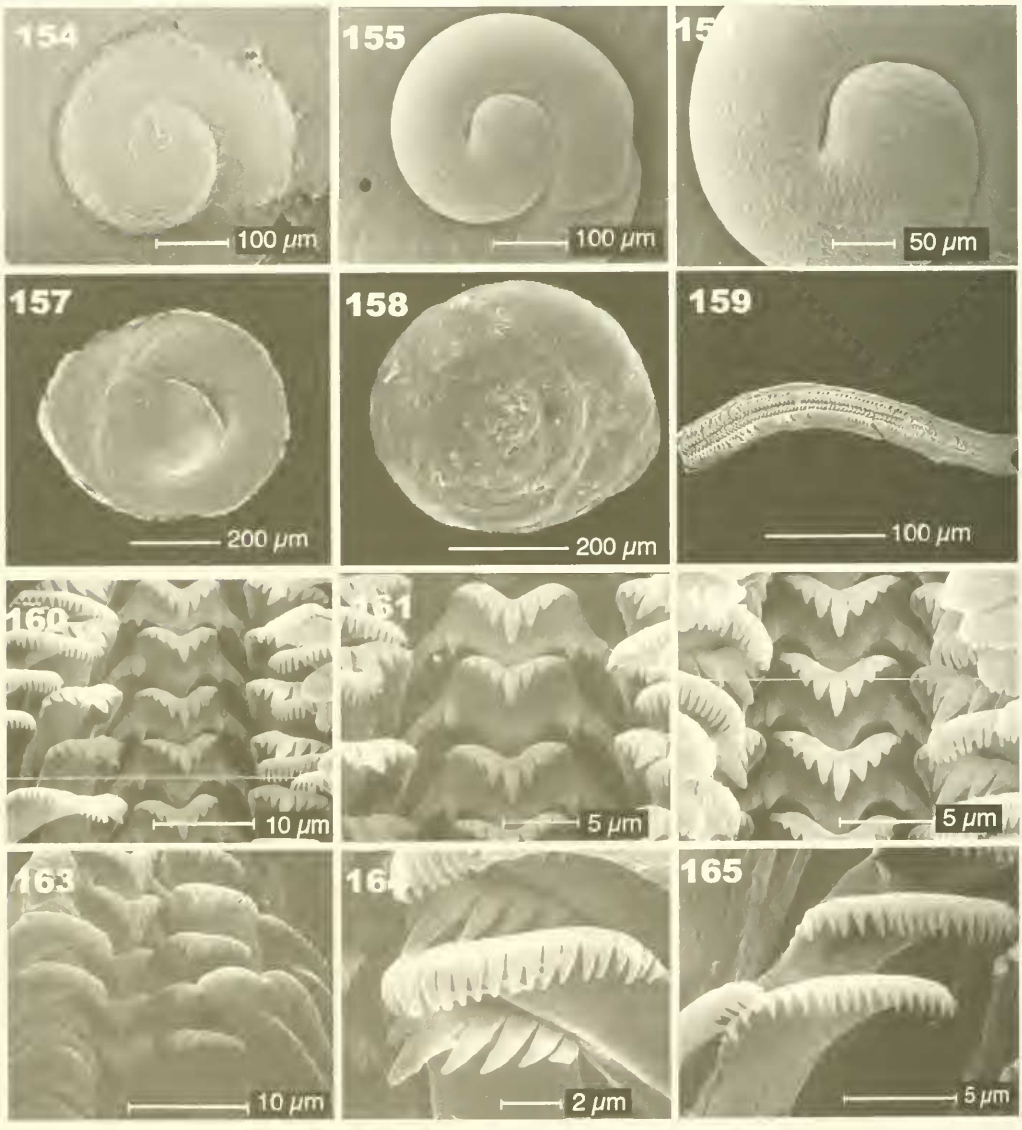
Nervous System: Pleuro-subesophageal connective absent, pleuro-supraesophageal connective middle-sized, RPG ratio 0.24 (concentrated). Esophagus runs straight underneath cerebral commissure (Fig. 166).

TABLE 10. Osphradium measurements (in mm) of *Milesiana schuelei* from the following populations: 1 - Turrillas (El Nacimiento), Almería; 2 - El Laujar de Andarax, Almería; 3 - La Cimada, Málaga; 4 - Padul, Granada; 5 - El Marchal, Almería; 6 - Lucainena de Las Torres, Almería; 7 - Gaucín, Málaga.

	1 Mean ± SD; CV (Max-Min) (n = 8)	2 Mean ± SD; CV (Max-Min) (n = 3)	3 Mean ± SD; CV (Max-Min) (n = 3)	4 Mean ± SD; CV (Max-Min) (n = 2)	5 Mean ± SD; CV (Max-Min) (n = 4)	6 (n = 1)	7 (n = 1)
Os L	0.17 ± 0.02; 0.13 (0.19-0.13)	0.23 ± 0.03; 0.11 (0.25-0.20)	0.24 ± 0.01; 0.05 (0.26-0.23)	0.16 ± 0.02; 0.14 (0.17-0.14)	0.22 ± 0.03; 0.14 (0.27-0.20)	0.21	0.16
Os W	0.08 ± 0.01; 0.09 (0.10-0.07)	0.10 ± 0.02; 0.16 (0.11-0.09)	0.11 ± 0.04; 0.38 (0.14-0.06)	0.08 ± 0.02; 0.28 (0.09-0.06)	0.10 ± 0.03; 0.30 (0.13-0.06)	0.08	0.09

Ctenidium – Osphradium: Ctenidium with 8–13 well-developed lamellae (Fig. 167). Osphradium oval, two to three times longer than it is wide (Table 10).

Stomach – Radula: Anterior and posterior stomach chambers are of approximately same size. Style sac protruding slightly anteriorly into intestinal loop (Fig. 168, Table 12). Rectum strongly U-shaped (Fig. 167). Radula long (40%) relative to maximum shell dimension (Fig. 159); central tooth with two basal cusps on each side (Table 11, Figs. 160–162), distance between internal cusps 7–8 µm approximately; central denticle long, tapered, followed on each side by four long, tapered denticles in decreasing order of size;



FIGS. 154–165. Protoconch, operculum and radula of *Milesiana schuelei*. FIG. 154: Holotype (SMF 253578/1); FIGS. 155, 156, 158, 161, 162: Protoconchs, operculum and radula from Gaucín (Málaga); FIGS. 159, 160, 163: Radula from Marchal de Antón López (Almería); FIG. 158: Inner side of the operculum; FIGS. 159, 160: Transverse rows; FIGS. 161, 162: Central teeth; FIGS. 163, 164: Central, lateral and inner marginal teeth; FIG. 165: Inner and outer marginal teeth.

TABLE 11. Radula formulae and measurements (in mm) of *Milesiana schuelei* from Benaoján (Málaga) population.

Radula characters	Formulae and measurements (in mm)
Central teeth	4-(3.5)+C+4(3)/2-2
Central teeth width	~ 8 µm
Left lateral teeth	4-5+C+3
Inner marginal teeth	~ 22 cusps
Outer marginal teeth	~ 10 cusps
Radula length	~ 351 µm
Radula width	~ 46 µm
Number of rows	~ 85

lateral teeth with 3–4 denticles on each side central one (Figs. 163, 164); denticles of inner marginal teeth larger than those of outer marginal teeth (Fig. 165).

Male Genitalia: With pear-shaped prostate gland (Fig. 169) almost two times longer than it is wide (Table 13), partially covered by rectum in pallial cavity; penis (Figs. 170, 171) generally unpigmented or with a slight dark pigmentation at base, with a blunt distal tip and one unpigmented, big, non-glandular lobe located in medial position; penial duct slightly undulating at the base, then running straight close to outer edge.

Female Genitalia: With renal oviduct making a narrow circle overlying the part between albumen and capsule glands (Fig. 172), oviduct glands (albumen + capsule glands) well developed, sometimes narrowing at outer edge between capsule and albumen glands; capsule gland larger than albumen gland; distal seminal receptacle (SR1) much larger than proximal (SR2); SR1 pyriform, pedunculated, SR2 rounded, sessile (Figs. 172, 173, Table 14), located rather close to one another; the renal oviduct widening distally with respect to SR2.

Discussion

Milesiana schuelei cannot be assigned to the genus *Islamia* because of differences in several diagnostic characters including some of the female genitalia and principally those related to the seminal receptacles. The numerous females studied and collected throughout different months of the year from populations of Almería, Granada, Málaga and Cáceres provinces had a remarkably large and pedunculated distal seminal receptacle (SR1), whereas the proximal one (SR2) was small and sessile. Moreover, illustrations in Boeters (1988: 218) depict a pedunculated distal seminal receptacle and a rounded and sessile proximal receptacle apparently protruding from the widened part of the renal oviduct, in a position corresponding to that of the proximal seminal receptacle. Both character states, a very large and pedunculated distal seminal receptacle (SR1) and a proximal one (SR2) small and sessile, are the opposite of those observed in *Islamia* (SR1 is always smaller or equal in size than SR2, and in addition SR1 is usually sessile while SR2 is always pedunculated).

Bernasconi (1975, 1977, 1984, 1985) described a larger distal seminal receptacle for

TABLE 12. Digestive system measurements (in mm) of *Milesiana schuelei* from the following populations: 1 - Turrillas (El Nacimiento), Almería; 2 - La Cimada, Málaga; 3 - Gaucín, Málaga.; 4 - El Laujar de Andarax, Almería.; 5 - Padul, Granada; 6 - El Marchal, Almería.

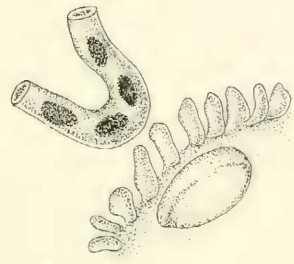
	1 Mean ± SD; CV (Max-Min) (n=3)	2 Mean ± SD; CV (Max-Min) (n=4)	3 Mean ± SD; CV (Max-Min) (n=2)	4 Mean ± SD; CV (Max-Min) (n=3)	5 Mean ± SD; CV (Max-Min) (n=2)	6 n = 1
Ss L	0.26 ± 0.02; 0.08 (0.28-0.23)	0.30 ± 0.02; 0.07 (0.33-0.29)	0.21 ± 0.02; 0.11 (0.22-0.19)	0.26 ± 0.01; 0.05 (0.28-0.25)	0.21 ± 0.06; 0.28 (0.26-0.17)	0.26
Ss W	0.19 ± 0.02; 0.14 (0.22-0.17)	0.24 ± 0.04; 0.15 (0.27-0.19)	0.17 ± 0.03; 0.18 (0.19-0.15)	0.21 ± 0.02; 0.08 (0.22-0.19)	0.17 ± 0.01; 0.08 (0.18-0.16)	0.20
St L	0.35 ± 0.02; 0.07 (0.37-0.32)	0.41 ± 0.03; 0.07 (0.45-0.38)	0.26 ± 0.02; 0.09 (0.28-0.24)	0.36 ± 0.04; 0.11 (0.39-0.32)	0.30 ± 0.04; 0.15 (0.33-0.27)	0.32
St W	0.26 ± 0.01; 0.04 (0.27-0.25)	0.39 ± 0.05; 0.12 (0.44-0.34)	0.29 ± 0.04; 0.13 (0.32-0.27)	0.33 ± 0.01; 0.04 (0.34-0.32)	0.25 ± 0.01; 0.02 (0.26-0.25)	0.33

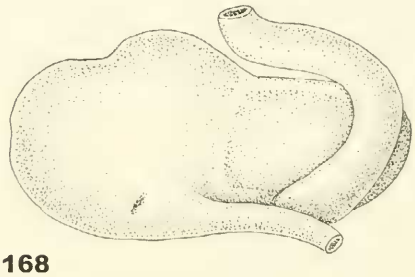
TABLE 13. Male genitalia measurements (in mm) of *Milesiana schuelei* from the following localities: 1 - El Marchal, Almería; 2 - Turrillas (El Nacimiento). Almería; 3 - La Cimada, Málaga; 4 - Gaucín, Málaga; 5 - Benaoján, Málaga; 6 - Fuente Grande, S. Harana, Granada; 7 - Robladillo de Gata, Cáceres; 8 - Los Minutos spring, Turrillas, Almería; 9 - Lucainena de Las Torres, Almería; 10 - Padul, Granada.

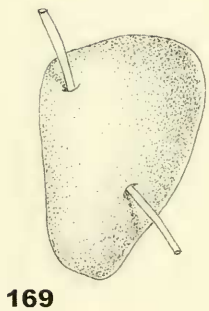
	1 Mean ± SD; CV (Max-Min)	2 Mean ± SD; CV (Max-Min)	3 Mean ± SD; CV (Max-Min)	4 Mean ± SD; CV (Max-Min)	5 Mean ± SD; CV (Max-Min)	6	7	8	9	10
Pr L		0.43 ± 0.01; 0.02 (0.43-0.42) (n = 2)	0.68 ± 0.38; 0.56 (0.95-0.41) (n = 2)	0.29 (n = 1)		0.48 (n = 1)				0.33 (n = 1)
Pr W		0.20 ± 0.03; 0.16 (0.22-0.18) (n = 2)	0.29 ± 0.14; 0.49 (0.39-0.19) (n = 2)	0.16 (n = 1)		0.28 (n = 1)				0.16 (n = 1)
P L	0.45 ± 0.13; 0.29 (0.55-0.29) (n = 4)	0.48 ± 0.14; 0.30 (0.67-0.34) (n = 4)	0.63 ± 0.11; 0.17 (0.76-0.56) (n = 3)	0.52 ± 0.13; 0.25 (0.67-0.41) (n = 3)	0.8 1± 0.35; 0.44 (1.21-0.53) (n = 3)	0.60 (n = 1)	0.43 (n = 1)	0.53 (n = 1)	0.44 (n = 1)	
P W	0.14 ± 0.02; 0.17 (0.16-0.11) (n = 4)	0.15 ± 0.02; 0.14 (0.18-0.13) (n = 3)	0.15 ± 0.04; 0.28 (0.18-0.10) (n = 3)	0.16 ± 0.04; 0.28 (0.19-0.13) (n = 2)	0.20 ± 0.02; 0.12 (0.22-0.18) (n = 3)	0.11 (n = 1)	0.12 (n = 1)	0.15 (n = 1)	0.16 (n = 1)	
Pl. L	0.13 ± 0.02; 0.19 (0.15-0.10) (n = 4)		0.22 ± 0.09; 0.40 (0.27-0.12) (n = 3)	0.27 ± 0.00; 0.01 (0.27-0.27) (n = 3)	0.14 ± 0.05; 0.37 (0.20-0.11) (n = 3)	0.19 (n = 1)	0.23 (n = 1)			
Pl. W	0.17 ± 0.03; 0.19 (0.21-0.14) (n = 4)		0.11 ± 0.04; 0.32 (0.15-0.08) (n = 3)	0.14 ± 0.01; 0.09 (0.15-0.13) (n = 3)	0.11 ± 0.01; 0.08 (0.12-0.11) (n = 3)	0.16 (n = 1)	0.11 (n = 1)			
Head length	0.49 ± 0.09; 0.17 (0.57-0.39) (n = 4)	0.56 ± 0.05; 0.10 (0.62-0.53) (n = 3)	0.70 ± 0.16; 0.22 (0.87-0.57) (n = 3)	0.66 ± 0.27; 0.41 (0.98-0.50) (n = 3)	0.73 ± 0.15; 0.21 (0.88-0.57) (n = 3)	0.59 (n = 1)	0.42 (n = 1)	0.39 (n = 1)		
PL/Head length	0.94 ± 0.37; 0.39 (1.40-0.51) (n = 4)	0.74 ± 0.17; 0.23 (0.94-0.63) (n = 3)	0.94 ± 0.25; 0.27 (1.16-0.67) (n = 3)	0.81 ± 0.14; 0.17 (0.96-0.68) (n = 3)	1.11 ± 0.45; 0.40 (1.63-0.79) (n = 3)	1.01 (n = 1)	1.02 (n = 1)	1.35 (n = 1)		

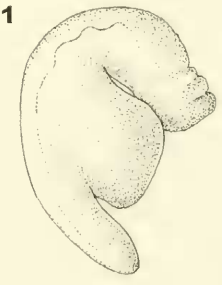
French *Islamia* species, which later Bodon et al. (2001: 199) considered to be a misinterpretation.

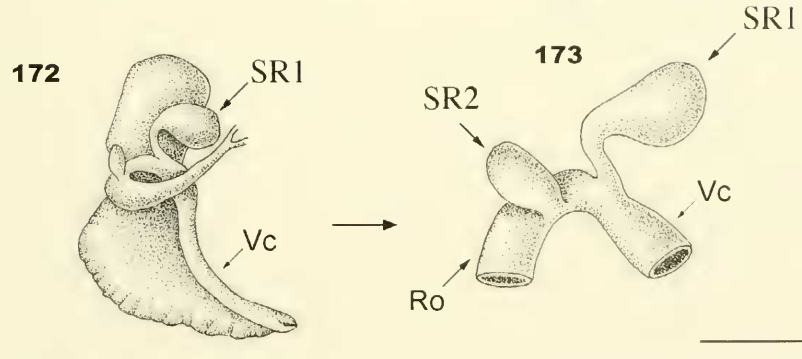
Milesiana schuelei shows a wide range of inter-population variability in shell shape, body pigmentation, and narrowing between the oviduct glands. Even the size of SR1 varies although it is always much larger than SR2. In addition to the size and shape of the seminal receptacles, other characters that distinguish *M. schuelei* from other Iberian *Islamia* species include: a flatter shell, larger umbilicus, a well-











FIGS. 166–173. Anatomy of *Milesiana schuelei*. FIG. 166: Partial nervous system; FIG. 167: Osphradium and ctenidium; FIG. 168: Stomach; FIG. 169: Prostate; FIG. 170, 171: Head of a male and penis; FIG. 172: Anterior female genitalia; FIG. 173: Detail of the seminal receptacles; Abbreviations in text. Scale bar = 500 µm (FIGS. 166–172).

TABLE 14. Female genitalia measurements (in mm) of *Milesiana schuelei* from the following populations: 1 - El Marchal, Almería; 2 - Turrillas (El Nacimiento), Almería; 3 - La Cimada, Málaga; 4 - Gaucín, Málaga; 5 - El Laujar de Andarax, Almería.

	1 Mean ± SD; CV (Max-Min)	2 Mean ± SD; CV (Max-Min)	3 Mean ± SD; CV (Max-Min)	4 Mean ± SD; CV (Max-Min)	5 Mean ± SD; CV (Max-Min)
Op L	0.72 ± 0.15; 0.21 (0.87-0.56) (n = 3)	0.56 ± 0.13; 0.23 (0.78-0.45) (n = 6)	0.87 ± 0.02; 0.03 (0.88-0.85) (n = 2)	0.76 ± 0.14; 0.19 (0.89-0.61) (n = 3)	0.63 ± 0.11; 0.18 (0.80-0.56) (n = 4)
Op W	0.29 ± 0.04; 0.15 (0.33-0.24) (n = 3)	0.26 ± 0.04; 0.15 (0.31-0.21) (n = 6)	0.30 ± 0.02; 0.07 (0.32-0.29) (n = 2)	0.32 ± 0.08; 0.24 (0.38-0.23) (n = 3)	0.27 ± 0.02; 0.08 (0.30-0.24) (n = 4)
Ag. L	0.28 ± 0.07; 0.25 (0.35-0.21) (n = 3)	0.21 ± 0.06; 0.31 (0.28-0.16) (n = 3)	0.34 (n = 1)	0.28 ± 0.07; 0.25 (0.33-0.20) (n = 3)	0.31 ± 0.07; 0.22 (0.38-0.25) (n = 3)
Cg. L	0.43 ± 0.20; 0.46 (0.66-0.27) (n = 3)	0.40 ± 0.10; 0.26 (0.49-0.28) (n = 3)	0.55 (n = 1)	0.44 ± 0.13; 0.30 (0.58-0.31) (n = 3)	0.34 ± 0.07; 0.21 (0.41-0.28) (n = 3)
SR1 L	0.11 ± 0.02; 0.18 (0.12-0.09) (n = 3)	0.13 ± 0.02; 0.17 (0.16-0.12) (n = 6)	0.16 ± 0.01; 0.03 (0.16-0.15) (n = 3)	0.11 ± 0.00; 0.03 (0.11-0.11) (n = 2)	0.10 ± 0.02; 0.23 (0.13-0.09) (n = 3)
SR2 L	0.04 ± 0.01; 0.26 (0.04-0.03) (n = 2)	0.04 ± 0.02; 0.46 (0.06-0.01) (n = 6)	0.07 ± 0.01; 0.20 (0.09-0.06) (n = 3)	0.05 ± 0.02; 0.51 (0.07-0.03) (n = 2)	0.06 ± 0.01; 0.22 (0.07-0.05) (n = 3)

developed ctenidium with large lamellae, rectum U-shaped, central tooth with two basal cusps, and a penial lobe located in a medial position instead of close to the penial tip. The pleuro-subesophageal connective is absent in *Milesiana*, whereas it is present in all the other European genera for which information on this character is available (Radoman, 1983), except in the genus *Josefus* described herein.

Due to the peculiar structure of the female genitalia, *M. schuelei* can only be compared with *Pezzolia* Bodon & Giusti, 1986, another European valvatiform genus from Liguria (Italy), which has a distal seminal receptacle equal to or larger than the proximal receptacle. Nevertheless, the distal seminal receptacle in *Pezzolia* has no evident duct. This genus may at times have a very reduced bursa copulatrix. It has neither eyes nor ctenidium, and has only one basal cusp on the central tooth of the radula. This genus and its type species, *Pezzolia radapalladis* Bodon & Giusti, 1986, were described using extremely variable diagnostic genital characters (Bodon et al., 2001: 147–149, 158, 166, 167). According to these authors, *Pezzolia* may have a simple penis (with no glandular lobe) or there may be one or two glandular lobes, located in a medial position or one in a medial position and the other near the base of the penis. *Pezzolia* female genitalia can lack a bursa copulatrix (or if present, it is very small), and proximal seminal receptacle that can be equal to or smaller than the distal seminal receptacle. This unusual and extreme anatomical variability suggests that in order to clarify their taxonomic status, the morphological characters of all known populations of the genus *Pezzolia* and particularly those of the species *Pezzolia radapalladis*, *P.* sp. 1 and *P.* sp. 2 need to be carefully reviewed and studied.

The combination of two diagnostic characters (a large and pedunculated distal seminal receptacle and a short and sessile proximal receptacle), which is consistent in all studied populations of this widely distributed species, together with the absence of bursa copulatrix, the absence of pleuro-supraesophageal connective and other distinguishing shell and anatomical features, differentiates *M. schuelei* from all other known European Hydrobiidae valvatiform species. Therefore, we consider it justified creating distinct supraspecific taxa for this species, which we have called *Milesiana*.

Josefus Arconada & Ramos, n. gen.

Type species

Josefus aitanica, n. sp.

Etymology

In memoriam of our friend and colleague Jose Bedoya "Josefo", who, through his skills working with the SEM, helped us to discover the huge morphological diversity and complexity of this small fauna.

Diagnosis

Shell small valvatiform or depressed-trochiform; operculum without peg; central tooth with two basal cusps on each side; penis with a non-glandular lobe located in distal position; female genitalia with two seminal receptacles adjacent to one another, on the same side of unpigmented renal oviduct; bursa copulatrix absent.

Josefus aitanica Arconada & Ramos, n. sp.

Type Specimens

Holotype MNCN 15.05/46560 (SEM preparation) (Fig. 174), Paratypes MNCN 15.05/46560, 3 May 1994, E. R. (ethanol and SEM preparation – Figs. 177, 181, 182, 184 – and ethanol).

Type Locality

Torremanzanas, Alicante, UTM.: 30SYH2476.

Etymology

The name *aitanica* refers to Sierra de Aitana, a mountain chain in the distribution area of this species.

Populations Studied

This species was found in the provinces of Valencia and Alicante (Fig. 17). Lapica spring, Las Viñuelas, Valencia, UTM.: 30SXJ7155, 28 May 1998, B. A. & J. A., MNCN 15.05/46561 (dried and frozen material); La Granata, Tabernes de La Valldigna, Valencia, UTM.: 30SYJ358302, 21 March 1994, E. R., MNCN 15.05/46562 (ethanol), 27 May 1998, B. A. & J. A., MNCN 15.05/46563 (ethanol, SEM preparation and frozen material); Gamellons spring, Onteniente, Valencia, UTM.: 30SXH975942, 5 Oct. 1994, E. R., MNCN 15.05/46564 (ethanol), 29 May 1998, B. A., MNCN 15.05/46565 (ethanol and frozen material); Gaspar spring, Beniganim, Valencia, UTM.: 30SYJ2113, 5 April 1994, E. R., MNCN 15.05/46566 (ethanol), 29 May 1998, B. A. & J. A., MNCN 15.05/46567 (ethanol and frozen material), Pi spring, Beniganim, Valencia, UTM.: 30SYJ2113, 5 April 1994, E. R., MNCN 15.05/46568 (ethanol); Gamello spring, Cuatretonda, Valencia, UTM.: 30SYJ2514, 1 April 1994, G. T., MNCN 15.05/46569 (ethanol and SEM preparation); La Mina source, Jarafuel, Valencia, UTM.: 30SXJ645341, 28 May 1998, B. A. & J. A., MNCN.15.05/33290; Bella spring, Jarafuel, Valencia, Flores spring, Requena, Valencia, UTM: 30SXJ615725, 29 March 1992, G. T., MNCN 15.05/33263 (ethanol and SEM preparation), 27 May 1998, B. A. & J. A., MNCN 15.05/33289 (ethanol and frozen material); El Tollo spring, Requena, Valencia, UTM.: 30SXJ671513, 5 May 1994, E. R., MNCN 15.05/46570 (ethanol); El Moro spring, L'Algar springs, Callosa d'en Sarriá, Alicante, UTM.: 30SYH527831, 8 Dec. 1990, G. T., MNCN 15.05/46595 (ethanol); 30 May 1998, B. A. & J. A., MNCN 15.05/46571 (ethanol and frozen material); Reyinyosa spring, Bolulla, Alicante, UTM.: 30SYH5185, 30 April 1994, E. R., MNCN 15.05/46572 (ethanol), 30 May 1998, B. A. & J. A., MNCN 15.05/46573 (ethanol); Molí Montes spring, Agres, Alicante, UTM.: 30SYH1595, 3 May 1994, E. R., MNCN 15.05/46574 (ethanol); Azut spring, Alfafar, Alicante, UTM.: 30SYH12394, 4 May 1994, E. R., MNCN 15.05/46575 (ethanol), 29 May 1998, B. A. & J. A., MNCN 15.05/46576 (ethanol and frozen material).

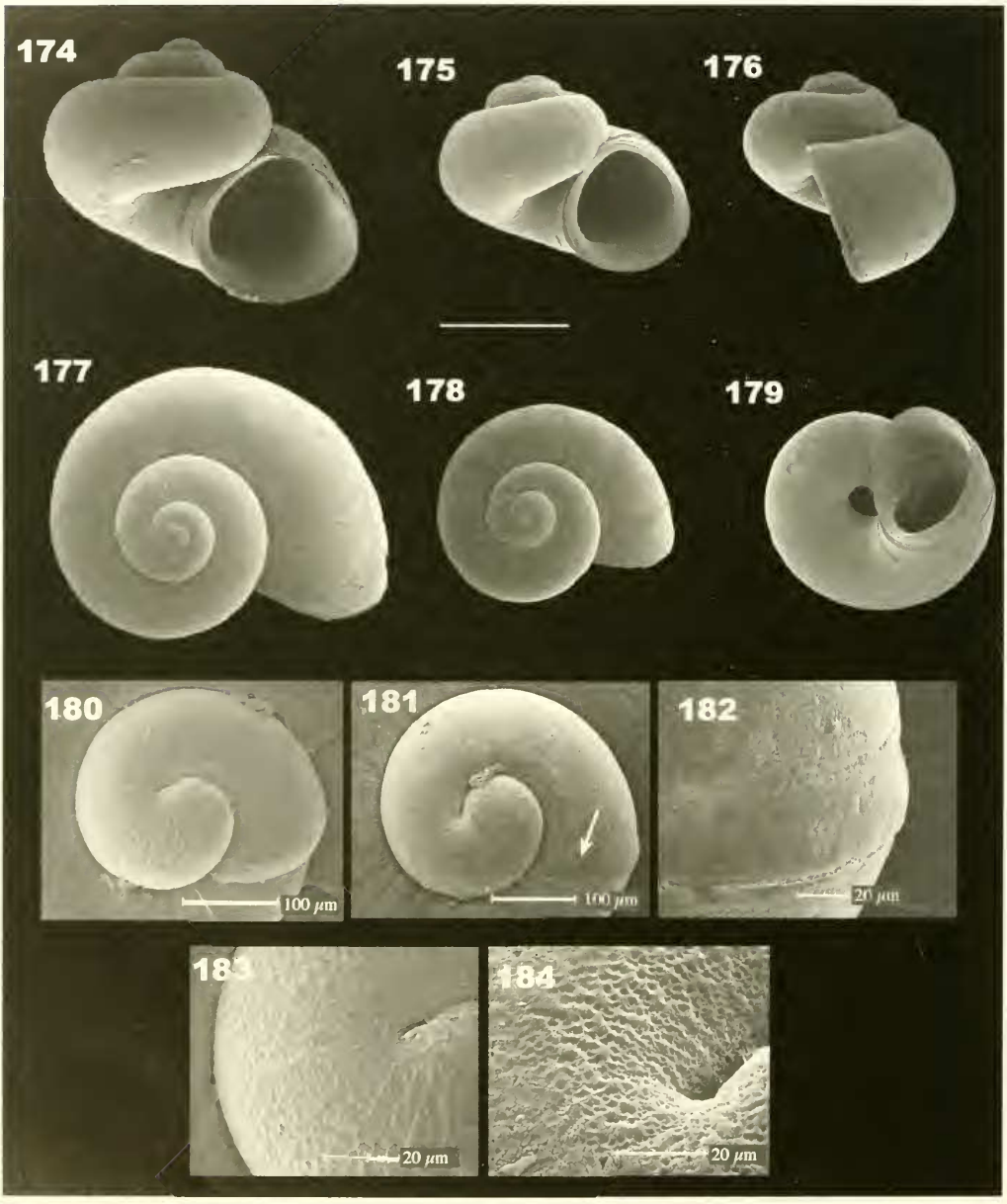
Specimens Examined for Morphometry and Histology

Shell and anatomical measurements (Tables 15, 17–19) correspond to populations from Alicante and Valencia. Operculum and radular measurements (Tables 15, 16) correspond to the population from type locality (more details in table captions). Male and females studied and measured were collected in the following months: March, April, May and Oct. For histology, one male and two females from type locality (May 1995) were studied.

Diagnosis

Operculum ovate; ctenidium absent; central tooth with two basal cusps on each side; eso-

phagus making a loop to the left posterior to cerebral ganglion complex; pleuro-subesophageal connective absent; rhomboid-shaped prostate gland; long pigmented penis with large non-glandular lobe located in distal position, never protruding from penis tip; two seminal receptacles small, sessile, rounded, equal in size, situated side by side on renal oviduct; all females with a nuchal node.



FIGS. 174–184. Shells of *Josefus aitanica*. FIGS. 174, 177, 181, 182, 184: Shells from Torremanzanas population (type locality); FIG. 174: Holotype (MNCN 15.05/46560); FIGS. 175, 176, 178–180, 183: Shells from Tabernes de la Valldigna population; FIGS. 181, 182: Varix separating protoconch and teleoconch. Scale bar = 500 µm (FIGS. 174–179).

Description

Shells: Valvatiform or depressed-trochiform (Table 15; Figs. 174, 175) with 3–3.5 whorls (Figs. 177, 178); about 1.5 spire whorls (Figs. 180, 181); highly developed body whorl (Figs. 177, 178); protoconch pitted (Figs. 183, 184), with 1.5 whorls; protoconch width 300 µm and width of nucleus approximately 105 µm; occasional varix observed at the end of protoconch seen in all populations (Figs. 181, 182); prosocline and rounded aperture; umbilicus of intermediate size, about 125 µm in diameter (Fig. 179); external lip (Figs. 176, 177) sometimes becoming thinner at its outer margin.

Operculum: Yellowish, oval, with rounded, big, central nucleus (Fig. 185); muscle attachment area rounded (Fig. 186).

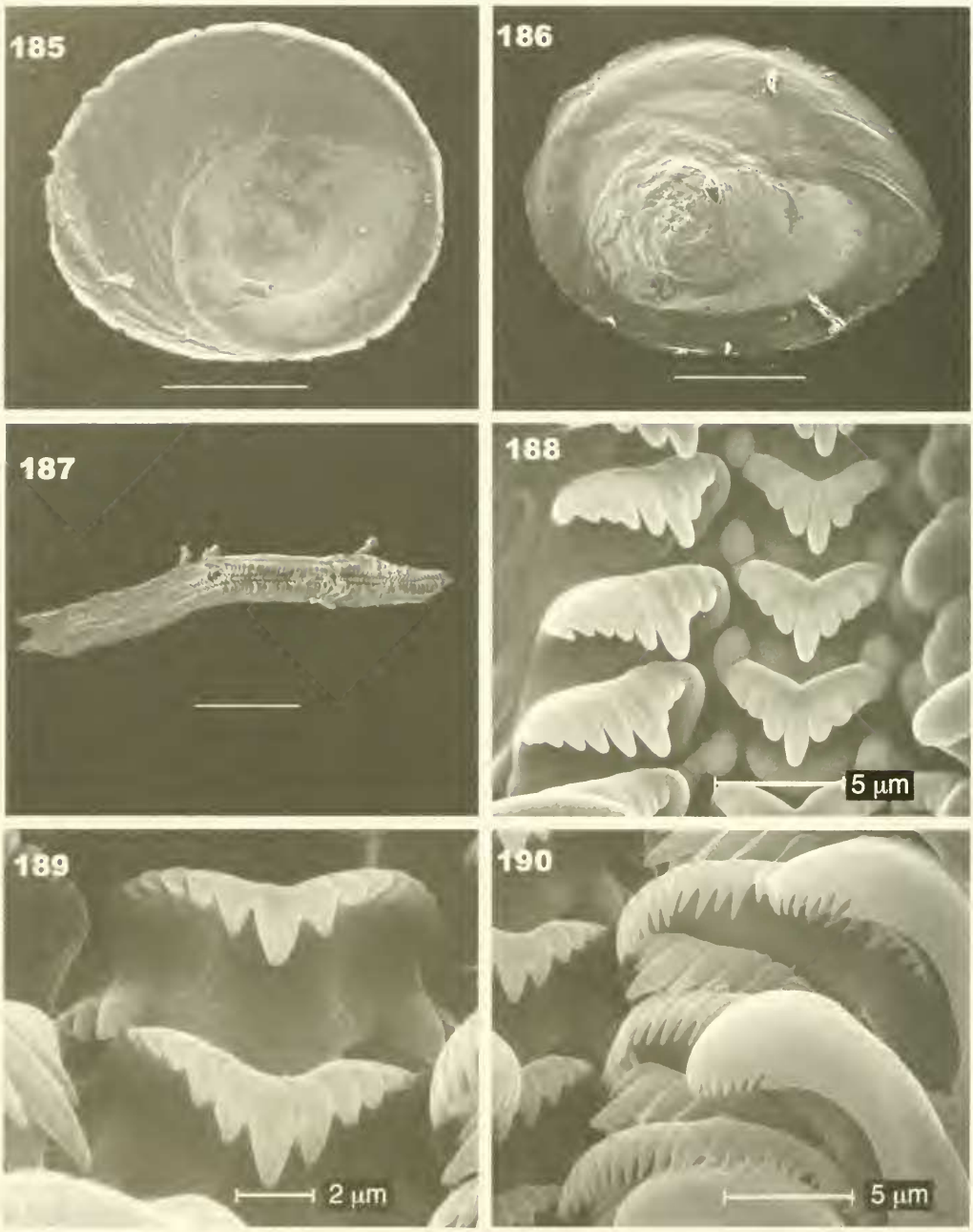
Body: Head with black-pigmented area from middle of tentacles to back of eye lobes (Figs. 191, 197); external body pigmentation dark.

Nervous System: Mid-sized pleuro-supraesophageal connective; pleuro-subesophageal connective absent (Fig. 192); supaesophageal ganglion small; RPG ratio 0.22 (concentrated). Esophagus making a marked loop posterior to left posterior to cerebral ganglia (Fig. 193).

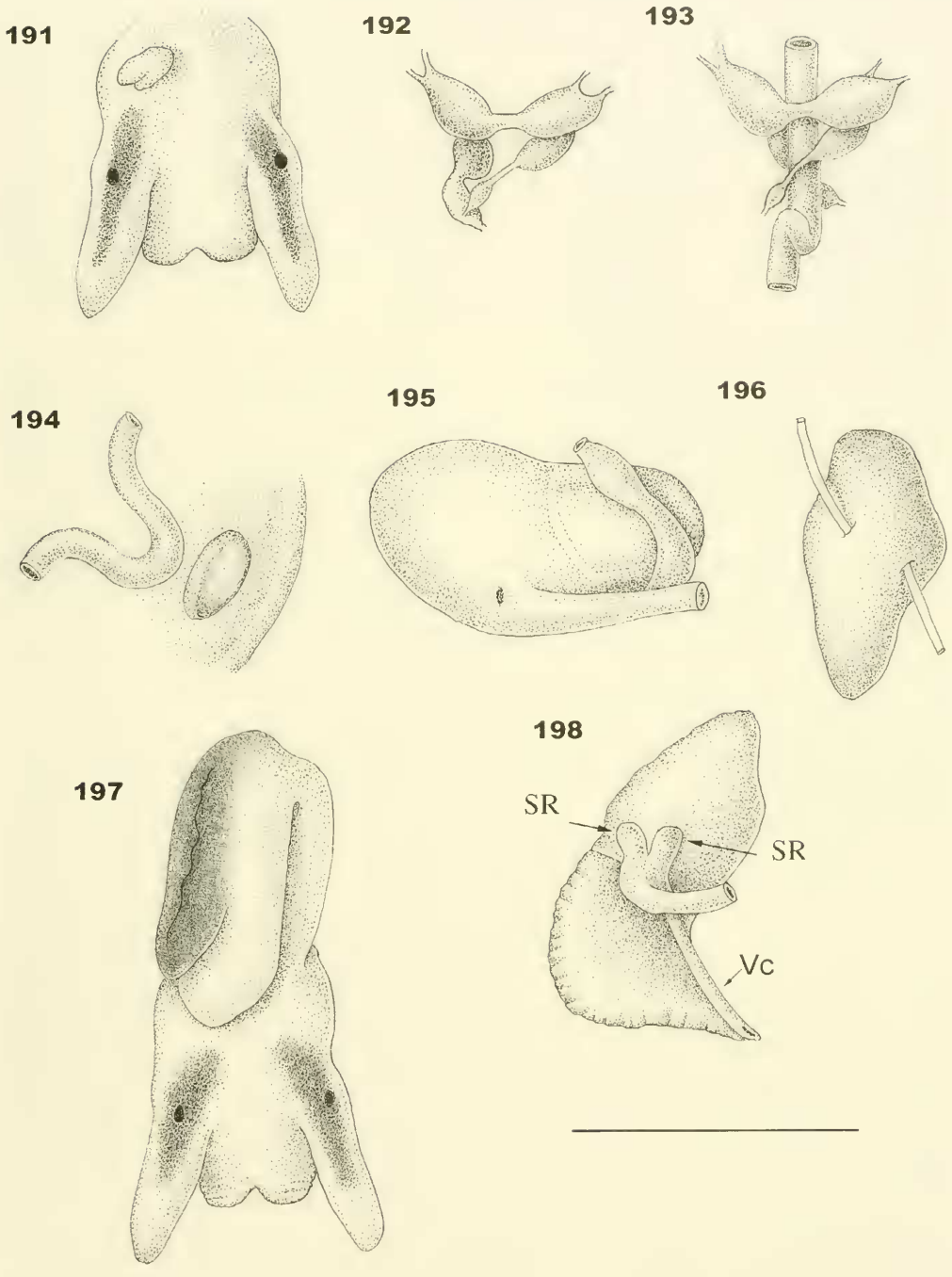
Ctenidium – Osphradium: Ctenidium absent (Fig. 194). Osphradium oval, two times longer than it is wide (Table 15).

TABLE 15. Shell. operculum and osphradium measurements (in mm) of *Josefus aitanica* from the following populations: 1 - Callosa d'en Sarriá, Alicante; 2 - Requena (Flores spring); 3 - type locality.

	1 Mean ± SD; CV (Max-Min) (n = 21)	2 Mean ± SD; CV (Max-Min) (n = 10)		3 Mean ± SD; CV (Max-Min)
SL	0.96 ± 0.06; 0.06 (1.07-0.83)	1.35 ± 0.17; 0.13 (1.53-0.97)	OL	0.60 ± 0.05; 0.08 (0.64-0.57) (n = 2)
SW	1.08 ± 0.08; 0.08 (1.24-0.83)	1.33 ± 0.14; 0.11 (1.58-1.06)	OW	0.47 ± 0.00; 0.01 (0.47-0.46) (n = 2)
SL/SW	0.89 ± 0.10; 0.11 (1.26-0.83)	1.01 ± 0.07; 0.07 (1.15-0.91)	OLWL	0.21 ± 0.04; 0.21 (0.25-0.18) (n = 2)
AH	0.62 ± 0.03; 0.05 (0.68-0.57)	0.84 ± 0.09; 0.11 (0.09-0.06)	OLWW	0.15 ± 0.01; 0.11 (0.16-0.13) (n = 2)
LBW	0.85 ± 0.05; 0.06 (0.94-0.70)	1.19 ± 0.14; 0.12 (1.34-0.89)	NL	0.27 ± 0.00; 0.00 (0.27-0.27) (n = 2)
WBW	0.75 ± 0.05; 0.07 (0.91-0.64)	1.07 ± 0.12; 0.11 (1.22-0.81)	NW	0.30 ± 0.00; 0.02 (0.30-0.29) (n = 2)
AL	0.60 ± 0.03; 0.05 (0.64-0.53)	0.79 ± 0.08; 0.10 (0.90-0.62)	OL/OW	1.29 ± 0.12; 0.09 (1.38-1.20) (n = 2)
AW	0.53 ± 0.03; 0.06 (0.60-0.48)	0.68 ± 0.07; 0.11 (0.78-0.54)	Os L	0.19 ± 0.08; 0.39 (0.30-0.10) (n = 5)
WPW	0.35 ± 0.04; 0.11 (0.41-0.24)		Os W	0.08 ± 0.03; 0.36(0.12-0.05) (n = 5)
WAW	0.14 ± 0.02; 0.17 (0.21-0.08)			
NSW	3.15 ± 0.18; 0.06 (3.50-3.00)	3.30 ± 0.16; 0.05 (3.50-3.00)		



FIGS. 185–190. Operculum and radula of *Josefus aitanica*. FIGS. 185, 186, 189, 190: Opercula and radula from Torremanzanas population (type locality); FIGS. 187, 188: Radula from Cuatretonda population; FIG. 185: Outer side of the operculum; FIG. 186: Inner side of the operculum; FIG. 187: Transverse rows; FIG. 188: Central and lateral teeth; FIG. 189: Central teeth; FIG. 190: Lateral, inner and outer marginal teeth. Scale bar = 200 µm (FIGS. 185, 186); 100 µm (FIG. 187).



FIGS. 191–198. Anatomy of *Josefus aitanica*. FIG. 191: Head of a female and nuchal node; FIGS. 192, 193: Partial nervous system; FIG. 194: Rectum and osphradium; FIG. 195: Stomach; FIG. 196: Prostate; FIG. 197: Head of a male and penis; FIG. 198: Anterior female genitalia; Abbreviations in text. Scale bar = 500 µm.

TABLE 16. Radula formulae and measurements (in mm) of *Josefus aitanica* from type locality.

Radula characters	Formulae and measurements (in mm)
Central teeth	5+C+5/2-2
Central teeth width	~ 6.3 µm
Left lateral teeth	5+C+3
Inner marginal teeth	~ 22 cusps
Outer marginal teeth	~ 24 cusps
Radula length	~ 400 µm
Radula width	~ 43 µm
Number of rows	~ 85

TABLE 17. Digestive system measurements (in mm) of *Josefus aitanica*. Populations from: (a) Torremanzanas, Alicante (type locality); (b) Callosa d'en Sarriá, Alicante; (c) Tabernes, Valencia; (d) Requena, Valencia.

	n = 1
Ss L	0.18(a); 0.27(b); 0.26(c); 0.24(d)
Ss W	0.18(a); 0.22(b); 0.14(c); 0.21(d)
St L	0.36(a); 0.30(b); 0.28(c); 0.36(d)
St W	0.33(a); 0.37(b); 0.28(c); 0.34(d)

Stomach – Radula: Length and width equal, stomach chambers same size; style sac protruding anteriorly into the intestinal loop (Table 17, Fig. 195). Rectum U-shaped (Fig. 194). Radula (Table 16, Fig. 187) long (41%) relative to maximum shell dimension; central trapezoidal tooth with two basal cusps on each side that points towards the lateral margins (Figs. 188, 189); cutting edge markedly concave, five denticles in decresing order of size at each side of central denticle,

TABLE 18. Male genitalia measurements (in mm) of *Josefus aitanica* from the following localities: 1 - Torremanzanas, Alicante (type locality); 2 - Beniganim, Valencia; 3 - Onteniente, Valencia; 4 - Tabernes, Valencia; 5 - Callosa d'en Sarriá, Alicante; 6 - Requena (El Tollo), Valencia; 7 - Agres, Alicante.

	1 Mean ± SD; CV (Max-Min)	2 Mean ± SD; CV (Max-Min)	3 Mean ± SD; CV (Max-Min)	4 Mean ± SD; CV (Max-Min)	5	6	7
Pr L	0.37 ± 0.03; 0.07 (0.39-0.36) (n = 2)						0.44 (n = 1)
Pr W	0.19 ± 0.03; 0.16 (0.21-0.17) (n = 2)						0.22 (n = 1)
P L	0.64 ± 0.24; 0.37 (0.94-0.34) (n = 5)	0.73 ± 0.12; 0.16 (0.81-0.65) (n = 2)	0.93 ± 0.11; 0.12 (1.03-0.81) (n = 3)	0.70 ± 0.04; 0.05 (0.72-0.66) (n = 3)	0.39 (n = 1)	0.63 (n = 1)	1.01 (n = 1)
P W	0.17 ± 0.06; 0.33 (0.24-0.10) (n = 5)	0.12 ± 0.00; 0.01 (0.12-0.12) (n = 2)	0.18 ± 0.02; 0.12 (0.21-0.16) (n = 3)	0.17 ± 0.02; 0.13 (0.19-0.15) (n = 2)		0.15 (n = 1)	0.22 (n = 1)
Pl.L	0.16 ± 0.05; 0.29 (0.23-0.10) (n = 5)	0.12 ± 0.03; 0.27 (0.14-0.09) (n = 2)	0.17 ± 0.02; 0.09 (0.19-0.16) (n = 3)	0.12 ± 0.02; 0.14 (0.10-0.14) (n = 3)	0.16 (n = 1)	0.14 (n = 1)	0.13 (n = 1)
Pl.W	0.11 ± 0.04; 0.38 (0.18-0.07) (n = 5)	0.08 ± 0.00; 0.04 (0.09-0.08) (n = 2)	0.14 ± 0.02; 0.12 (0.15-0.12) (n = 3)	0.08 ± 0.02; 0.22 (0.10-0.07) (n = 3)	0.09 (n = 1)	0.10 (n = 1)	0.12 (n = 1)
Head length	0.57 ± 0.13; 0.23 (0.75-0.46) (n = 5)	0.66 (n = 1)	0.74 ± 0.05; 0.07 (0.77-0.70) (n = 2)	0.59 ± 0.06; 0.10 (0.66-0.54) (n = 3)	0.57 (n = 1)	0.46 (n = 1)	0.81 (n = 1)
P L/ Head length	0.87 ± 0.52; 0.14 (1.57-0.14) (n = 5)	0.98 (n = 1)	1.3 5± 0.02; 0.01 (1.36-1.33) (n = 2)	1.19 ± 0.18; 0.15 (1.35-1.00) (n = 3)	0.69 (n = 1)	1.37 (n = 1)	1.25 (n = 1)

TABLE 19. Female genitalia measurements (in mm) of *Josefus aitanica* from the following populations: 1 - Torremanzanas, Alicante (type locality); 2 - Callosa d'en Sarriá, Alicante; 3 - Requena (Flores spring), Valencia; 4 - Tabernes, Valencia.

	1 Mean ± SD; CV (Max-Min)	2 Mean ± SD; CV (Max-Min)	3 Mean ± SD; CV (Max-Min)	4 Mean ± SD; CV (Max-Min)
Op L	0.58 ± 0.09; 0.15 (0.70-0.47) (n = 5)	0.64 (n = 1)	0.65 ± 0.10; 0.15 (0.72-0.58) (n = 2)	0.64 (n = 1)
Op W	0.20 ± 0.03; 0.15 (0.16-0.15) (n = 5)	0.26 (n = 1)	0.27 ± 0.04; 0.14 (0.30-0.24) (n = 2)	0.28 (n = 1)
Ag. L	0.26 (n = 1)	0.34 (n = 1)	0.24 ± 0.02; 0.09 (0.26-0.22) (n = 2)	0.37 (n = 1)
Cg. L	0.36 (n = 1)	0.30 (n = 1)	0.42 ± 0.12; 0.29 (0.50-0.33) (n = 2)	0.27 (n = 1)
SR1 L	0.08 ± 0.02; 0.19 (0.10-0.07) (n = 3)	0.05 ± 0.01; 0.16 (0.05-0.04) (n = 2)	0.08 ± 0.02; 0.18 (0.10-0.07) (n = 2)	0.07 ± 0.01; 0.08 (0.07-0.06) (n = 2)
SR2 L	0.05 (n = 1)	0.05 ± 0.01; 0.16 (0.05-0.04) (n = 2)	0.06 ± 0.01; 0.13 (0.06-0.05) (n = 2)	0.06 (n = 1)

lateral teeth with five denticles on each side a central one (Fig. 188); denticles of inner marginal teeth larger than those of outer marginal teeth (Fig. 190).

Male Genitalia: Prostate gland (Fig. 196; Table 18), almost rhomboidal, more slender anteriorly and located quite posterior to rectum loop; posterior vas efferens entering near middle prostate region and anterior vas efferens exits close to this point; penis large, dark pigmented (Fig. 197), with a well-developed, non-glandular, subterminal, unpigmented lobe that is longer than penis tip; penial duct undulating along penis length at right edge.

Female Genitalia: Two seminal receptacles, small, sessile, rounded, equal in size, arising side by side on the renal oviduct facing the albumen gland (usual position where SR2 arises from proximal oviduct) (Fig. 198); renal oviduct not widening posteriorly to SR2 and makes a tight circle over pallial oviduct; oviduct glands (albumen + capsule glands) do not usually narrow, although some females narrow slightly at outer edge, between capsule and albumen gland; albumen gland smaller than capsule gland, and occupying approximately 40% of total length of pallial oviduct; ovary overlying posterior chamber of stomach. Unpigmented nuchal node (Fig. 191) in an analogous position to that of penis, occupying $^1/_4$ of total head length, 0.14 µm approximately.

Discussion

Josefus aitanica shows little interpopulation variability in the size of the oviduct glands, the presence/absence of narrowing between capsule and albumen glands, and the size and colour of the penis. All females studied and collected in different months throughout the year – March, April, May, Oct. – had a nuchal node, similar to that described in females of the genus *Islamia*. No cases of parasitism were detected. The esophagus forms a tight pleat below the left posterior portion of the pleuro-oesophagal ganglionic complex, whereas it is only slightly curved in *I. henrici*, the only Hydrobiidae species in which this character has been described. The new species can be distinguished from all the other Hydrobiidae by the shape and position of the seminal receptacles, which are both sessile, equal in size

and emerge adjacent to each other on the same side of the renal oviduct. In the very few *Islamia* species where the two seminal receptacles have been observed close to one another (*I. valvataeformis* or *I. pallida*), they appear on opposite sides of the renal oviduct and, unlike in *J. aitanica*, are never equal in size and shape. The loop made by the renal oviduct is rather small and quite tight, and there is no widening of the oviduct before the loop.

DISCUSSION

Habitat Status and Conservation

The species described here live in apparently non-polluted springs, rich in aquatic vegetation. Specimens can be found on vegetation, stones, wet walls and in mud. *Milesiana schuelei* has the widest geographical distribution range of the species studied. In the last decade, *M. schuelei* has been severely threatened in Almería Province due to engineering projects aimed at optimising water resources in this extremely arid area, thus depleting groundwater resources essential for hydrobiid survival. In contrast, *Islamia globulus* populations are well conserved, since water resources are sufficient in its distribution area. *Islamia ateni* is only known from its type locality (Balneario de San Vicente), a thermal spring that was seriously affected by the construction of a motorway. Since then, no specimens have been found, suggesting they are probably now extinct. Specimens of *I. pallida*, *I. henrici henrici* and *I. h. giennensis* are rare in the springs where they were discovered. Both species have a very narrow distribution and are highly threatened by human activities. The populations of the last two subspecies have been declining since they were first found. Channelization has dessicated many of the natural habitats of *I. h. giennensis*. The species has disappeared from some of the springs that previously held many of the better-conserved populations.

The same is occurring with *Josefus aitanica*, although the majority of its populations are not yet threatened. *Islamia lagari* is restricted to a very small area (Sierra de Can Parés), although no live specimens have been collected for years. Following IUCN criteria we classify these species as follows: Extinct (EX) – *Islamia ateni*; Critically Endangered (CR) – *Islamia pallida*, *I. lagari* and both subspecies of *I. henrici* as; Lower Risk (LR) – *Islamia globulus*, *Josefus aitanica* and Conservation Dependent (cd) – *Milesiana schuelei*.

Genital Morphology and Functionality

Taxonomy at the rank of genus and family levels has been traditionally based on anatomical characters, especially those of the male and female genitalia. Among these, penis structure and number and position of the sac-like structures associated with the renal oviduct have usually received more taxonomic weight as they are generally constant in species and species groups.

The exact function of the sac-like structures on the renal oviduct of females of *Islamia* and *Neohoratia* has long been in question. It has been thought that these structures are either two seminal receptacles or a small bursa copulatrix and a seminal receptacle. In the past, authors described these structures in many species as a seminal receptacle and a pin-like or sessile bursa copulatrix (Bole, 1970; Bernasconi, 1975). Histological observations and other direct morphological evidence have clarified many previous doubts regarding these structures. Pearly-whitish refringence is undoubtedly related to the way spermatozoa are organized in the seminal receptacles or in other sperm storage areas of the renal oviduct (Davis & Kang, 1990; Davis et al. 1990; Ramos et al., 2001). The bursa copulatrix is almost translucent and its contents are never refringent. The location of the sac-like structures in relation to the ovary and the pallial glands (albumen + capsule glands) is also useful for identification. When the bursa copulatrix is absent and there are two seminal receptacles, the proximal seminal receptacle (SR2) emerges from the oviduct close to the end of the loop, and the distal seminal receptacle (SR1) originates at a point closer to where the oviduct enters the albumen gland, close to but more proximally located than the usual position of the bursa copulatrix (Bodon et al., 2001).

The epithelium differs between the bursa and the seminal receptacles, as does the physiological function of these organs and the way spermatozoa are dispersed within them. In the receptacles, the spermatozoa face the cilia of the inner epithelial cells, while they have no directional pattern in the bursa (see Genital Histology above). Bodon et al. (2001) stated that *Islamia ateni*, *I. globulus*, and *I. lagari* have two seminal receptacles. Histological evidence and morphological observation of the female genitalia of *Milesiana schuelei*, *Islamia globulus*, *I. h. henrici*, and *Josefus aitanica* indisputably confirm their assertion, and we apply it to all the species studied herein. Given

that the female genitalia of *Neohoratia subpiscinalis* (Kuscer, 1932) are currently described as having a poorly developed bursa copulatrix and a single seminal receptacle (Bole, 1993; Bodon et al., 2001), we redefine the taxonomic status of some Iberian taxa that were previously referred to and included in the genus *Neohoratia* (as *N. globulus globulus*, *N. g. lagari*, *N. ateni*) and ascribe them to *Islamia*, following previous papers (Bodon et al., 2001).

Without providing real histological evidence (serial sections), some authors have interpreted the refringent area, or "*banda traslucida*", in the penial lobe of *Islamia* species to be a mass of glandular cells (Giusti et al., 1981: 51, Bodon et al., 2001: 133). This area can also be observed in the penis when mounted on microscope slides. This interpretation led Bodon et al. (2001: 134) to conclude that *Islamia* had a "penis with one glandular (rarely non-glandular) lobe". This is the first study to investigate the penial lobe of *Islamia* species using histological serial sections. The males we observed show this refringency in the penial lobe (also seen in microscope slides), although it lacks glandular tissue. We conclude that morphological refringence in penial structures cannot be attributed to a mass of glandular cells.

Bodon et al. (2001) studied two males from the type locality of *I. valvataeformis* as well as *I. globulus* from two population of Huesca. He concluded that the refringence observed in the penial lobe of both species was made up of a mass of glandular cells. We were unable to study specimens of the type species of the genus, but the serial sections of the *I. globulus* we examined clearly demonstrated that the refringence observed in its penial lobe was of a non-glandular nature. In view of our findings, we suggest eliminating from the diagnosis of the genera any reference to the nature of the tissue observed in the refringent area of the penial lobe if the tissue has not been studied using serial sections. Further histological studies of this kind for the type species *I. valvataeformis* are particularly needed.

Character Variability in the Genus *Islamia*

Radoman (1973a) introduced the genus *Islamia* (type species: *Horatia servaini* Bourguignat, 1887, a junior synonym of *Hydrobia valvataeformis* Möllendorf, 1873, according to Radoman, 1983, from Vrelo Bosne, near Sarajevo), with two subgenera, *Islamia* and *Adriolitorea* (type species: *I.* (*Adriolitorea*) *zermanica* Radoman 1973, from the Zrmanja River, in the middle freshwater section). Each subgenus contained two species from the Balkans: *I.* (*Islamia*) *servaini* (Bourguignat, 1887), *I.* (*Islamia*) *bosniaca* Radoman, 1973; *I.* (*Adriolitorea*) *zermanica* Radoman, 1973; and *I.* (*Adriolitorea*) *latina* Radoman, 1973. Radoman (1973a) stated that the four species are anatomically identical except for a slight difference in penis structure, which justified their separation into two groups ("*Bien que l'anatomie de toutes ces espéces soit identique, il y a une légère difference dans la structure du pénis, ce qui les sépare en deux groupes*"): The penis is slightly split at the top in *Islamia,* whereas the penial branches are longer and slightly more slender in *Adriolitorea*. Based on this difference the author suggested that there were two ancestors for these two groups of species, one from central Bosnia (*Islamia* s.s.) and the other from the coastal area (*Adriolitorea*). Later on, Radoman (1973b) included the following species in *Islamia*: a new species from Greece (*I. graeca* Radoman 1973), two new species from Turkey (*I. pseudorientalica* Radoman 1973, and *I. anatolica* Radoman 1973), plus one previously described species *I. burnabasa* (syn. *Horatia burnabasa* Schütt, 1964). The last three live in sympatry (type locality: Kirkgöz, Anatolia, Turkey). Although these descriptions were based on conchological characters, Radoman (1973b) concluded that all the species were anatomically identical to other species of the genus *Islamia.* In his 1983 paper, he assigns all eight above-mentioned species from Bosnia-Herzegovina, Croatia, Greece and Turkey plus *I. trichoniana* Radoman, 1978, from Greece to *Islamia*. The subgenus *Adriolitorea* was, therefore, regarded as a synonym of *Islamia*. According to Radoman (1973a, 1983) *Islamia* is characterised by: "(1) shell valvatoid, with a roundish-ovoid aperture and wide umbilicus, (2) central tooth of the radula with two basal cusps (one on each side, according to drawings of Radoman, 1973a), (3) a long pleuro-supraintestinal and a short pleuro-subintestinal connective, and (4) two seminal receptacles present (rs1 and rs2), nearby at the same level, draining into the oviduct. A genital chamber absent." The penis is described as "very large, muscular, wide, split at the top, vas deferens draining at the point of the right branch. Near the penis point, on the ventral side, a muscular fold is present. Penis shape is to some extent variable in different species of this genus" (Radoman, 1983: 124, figs. 69, 70). In fact, while the size and shape of the two penial branches differ among

these species, all possess a muscular pleat at the centre of the ventral side of the penis. Radoman did not mention any glandular tissue inside the penis branches. Description of the female genital system was only provided for the type species (*I. valvataeformis*) (Radoman, 1973a, 1983), and according to Radoman's comments (1973a, b) female genitalia do not seem to vary among species. In other words, only conchological and penial characters differ among *Islamia* species.

The tenth species assigned to *Islamia* was *Valvata pusilla* Piersanti, 1952 (Giusti et al., 1981), from Italy (type locality: Grotta delle Fontanelle, Napoli). In the description of this species, the authors introduced for the first time the concept that the translucid band observed on the penial lobe corresponded to a mass of glandular cells. They also described three other groups of populations as "*Islamia* sp. forma A", "forma B", and "forma C" from three different areas of Italy without giving them a taxonomical category. These four groups of populations, as well, were differentiated only by penial and conchological characters.

According to Bodon et al (2001), *Islamia* includes 19 species to date, in addition to those of Spain. In this paper, the authors considered *Mienisiella* Schütt, 1991, to be a junior synonym of *Islamia*, thus expanding the distribution area of the genus to Lebanon – *I. gaillardoti* (Germain, 1911) – and to Israel – *I. mienisi* (Schütt, 1991), the type species of *Mienisiella*. Whereas the penial and conchological characters in these latter two species differ, they both have female genitalia that are similar to those previously described for *Islamia* species.

Considering all these species, Bodon et al. (1995) distinguished a group comprised of "oriental" species from the Balkan Peninsula (Croatia, Bosnia, Greece) and Turkey and an "occidental" species' group located in France, Spain, and Italy. The oriental taxa shared two penial characters: a very well-developed glandular penial lobe and a non-glandular (muscular) pleat on the ventral side of the penis. These two characters are also found in *Islamia pusilla* (Piersanti, 1952), the unique species inhabiting south central Italy (Giusti et al., 1981), and in *I. cianensis* Bodon et al., 1995, from Sicily, although the penial lobe is more reduced in the last species. The degree of development of the muscular pleat of the penis and the distance between seminal receptacles in the female genitalia have sometimes been considered to be "minor anatomical features" (Bodon et al., 2001: 199) and at times, if constant, "sufficient to support the existence of two groups of species representing two distinct branches in the radiation of *Islamia*" (Bodon et al., 2001: 201): The "oriental" species' group located in the Balkan Peninsula (including type species, *I. valvataeformis*), Turkey, Israel, and part of Italy (two species: *I. pusilla* and *I. cianensis*) have two seminal receptacles that are very close to each other and a penis with a well-developed muscular pleat.

The "occidental" species' group from France (*I. minuta*, *I. consolationis*, *I. globulina*, *I. spirata*) and Spain have two seminal receptacles that are generally substantially separated from each other and a penis with a less developed or completely absent muscular pleat. The Italian species, *I. gaiteri*, is an exception to this hypothesis, because it has two very closely adjacent seminal receptacles (as in most *Islamia* species), a penis with no muscular pleat, and a knob-like penial lobe that projects only slightly and without light microscope evidence of internal glandular tissue (Bodon et al., 1995: 51, figs. 20, 24–27). None of the Iberian species has a penis with muscular pleat. The degree of variation of this character throughout the distribution area of *Islamia* suggests that an East-West sort of cline exists in the development of the muscular pleat. It is prominent in oriental species, weakens westward and disappears completely in westernmost species. Variability observed in the female genitalia of Iberian species ranges from seminal receptacles that appear at the same point (*I. pallida*), are separated (*I. globulus*, *I. lagari* and *I. henrici*), or even at substantial distances from each other (*I. ateni*). The variability found in these two genital characters (distance between seminal receptacles and a penis with or without muscular pleat) among the supposedly "occidental" species' group suggests that neither of these features alone, nor a combination of these characters, are adequate enough to differentiate taxa at the genus or subgenus level. Therefore, it would be more appropriate to consider them as "species-specific anatomical features".

In hydrobioid taxa, the structures associated with the renal oviduct in the female genitalia are relatively more important taxonomically than those of the male genitalia (Davis & Carney, 1973). In a more recent study of Asian hydrobioids (Davis et al., 1992), involving 48 informative anatomical characters, 33% were derived from the female reproductive system, 23% from the male reproductive system, while only 19% were derived from the digestive sys-

tem and 4% from the nervous system.

Apart from the distance between seminal receptacles, other female genitalia characters of Iberian *Islamia* species also differ greatly, such as the size and shape of the two seminal receptacles. In general, the proximal seminal receptacle is larger than the distal receptacle (according to previously published diagnoses), but they can be almost equal in size in some, as they are in *I. pallida*. Another important character that has yet to be considered is the insertion point of the seminal receptacles. Both receptacles emerge on opposite sides of the renal oviduct in all known *Islamia* species. This character may have been overlooked due to the minute size of the female genitalia and to the fact that the renal oviduct is contorted. However, it is worth noting that while the seminal receptacles of all the *Islamia* species in the literature seem to have been correctly drawn, they have been incorrectly simplified in taxonomic schemes (e.g., in Bodon et al., 2001: figs. 180, 181).

Another female genital characteristic, the presence of a narrowing at the outer margin of the pallial oviduct between the capsule and albumen gland, described by Boeters (1988) as diagnostic for the Iberian "*Neohoratia*" species, does not always hold true in all species. It is sometimes present in *I. globulus*, *I. ateni*, and *I. h. gienensis* and absent in *I. pallida* and *I. h. henrici*. The same situation was reported for Italian species: while *I. cianensis* and *I. piristoma* Bodon & Cianfanelli, 2002, show a slight narrowing in the transition area between the two oviduct glands, *I. pusilla* and *I. gaiteri* lack this character (Giusti et al., 1981; Bodon et al., 1995; Bodon & Cianfanelli, 2002). Therefore, even though this feature could be useful at the species level, it is obviously irrelevant at the supraspecific level.

Other characters that are variable among *Islamia* species, although constant at the species level are: the number of basal cusps of the central tooth, the presence/absence of body or ocular pigmentation, and the presence/absence of a nuchal node or a reduced non-functional penis-shaped structure on the head of females. *Islamia h. henrici* and *I. pallida* are the only known *Islamia* taxa that have this last character. Despite this uniqueness, and because the influence of environmental parameters on the development of this structure is still a matter of discussion, and because water parameters have not been measured in all localities, we prefer to adopt a conservative position and not consider this character to be diagnostic. If in fact this character turns out to be diagnostic, a taxonomic re-arrangement of these species may be warranted. The absence/presence of ctenidium is also constant at the intraspecific level, except in the two *I. henrici* subspecies. The RPG ratio is also constant at the species level, except in the two *I. henrici* subspecies, but it is not quite useful at genus level, unless for the three genera here described. The nervous system is slightly elongated in *I. ateni* (although it has the smallest value in this category, 0.50), moderately concentrated in *I. globulus* (0.43), *I. pallida* (0.42) and *I. h. henrici* (0.30), and concentrated in *I. h. gienensis* (0.14), *M. schuelei* (0.24) and *J. aitanica* (0.22).

The shells of the *Islamia* species known to date (Radoman, 1973a, b, 1983; Giusti & Pezzoli, 1981; Schütt, 1991; Bodon et al., 1995) vary little in shape. They are mostly valvatiform, although some French species have the spire raised to different degrees (Bodon et al., 2001). *Islamia pallida* and *I. henrici* also have planispiral or valvatiform shells, whereas shells of *I. globulus*, *I. lagari* and *I. ateni* are ovate-conic (bythinelliform). It is well known that shell features are not sufficiently diagnostic at the genus level if they are not supported by anatomical differences. Therefore, the variability here described should be included in the diagnosis of *Islamia*, which reinforces the need to review a number of species described from different sites in Europe and Turkey and assigned to *Islamia* on the basis of shell characters (Bodon et al., 2001). This would probably lead to the conclusion that *Islamia* is a taxonomic mess and probably polyphyletic, as unpublished molecular genetic data suggests (Wilke, pers. comm.).

An interesting character is the shape of the esophagus posterior to the pleuro-esophageal ganglionic complex of the nervous system, a character never mentioned nor figured to date for any Hydrobiidae species. The esophagus runs straight in all species studied in this paper except in *I. henrici*, in which it shows a weak curvature to the right side of body (Figs. 17B, 18A), and in *J. aitanica*, in which it makes a marked loop to the left (Fig. 25C). As the shape of the esophagus is constant in all studied specimens of all the species, we rule out the possibility that curvatures are caused by manipulation or retraction of the animal during fixation. More research will reveal if this feature has potential taxonomic value or not.

Islamia has been related genetically to other European genera: *Alzoniella* Giusti & Bodon, 1984, *Fissuria* Boeters, 1981, and *Avenionia* Nicolas, 1882. These genera have been ten-

tatively assigned to the nominal subfamily Islamiinae Radoman, 1973 (Wilke et al., 2001). Neverthess, important differences in morphological character and character states clearly distinguish them from each other: *Alzoniella* has a conical or cylindrico-conical shell, a bursa copulatrix with a short to medium anterodorsal duct and two seminal receptacles, and a penis with one or more "glandular" penial lobes located in its concave side (Giusti & Bodon, 1984; Bodon, 1988; Boeters, 1999, 2000); *Fissuria* has a valvatiform shell, an oval bursa copulatrix of variable size, a short to long anterodorsal bursal duct, two equally-sized seminal receptacles, and a penis with 3–4 lobes containing "mass of glandular tissue" (Bodon et al., 2001); *Avenionia* has a cylindro-conical, bythinelloid shell, a rudimentary gastric caecum, a penis with a very large subapical lobe, with three "glandular" swellings on its apical border, a "glandular" lobe located on the dorsal side of the penis close to the base of the subapical lobe, and female genitalia with a wide bursa copulatrix, a short and anteroventral bursal duct, and two seminal receptacles (Bodon et al., 2000). *Islamia* is also distinguished from the two new Iberian genera, *Milesiana* and *Josefus*, by a set of character and character states that have been previously discussed.

Difficulties in defining synapomorphies between the so-called "hydrobioids" (Davis, 1979), together with the many conflicts that exist between morphological and molecular genetics (Wilke et al., 2001), call attention to the need for detailed anatomical studies designed to provide ways to accurately group species and to effectively distinguish closely related genera of this complex group.

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