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A NEW *ISLAMIA* SPECIES (GASTROPODA: HYDROBIIDAE) FROM CYPRUS

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ABSTRACT: A new valvatiform hydrobiid, *Islamia mylonas*, from the Troodos Mts, Cyprus, is described. The shell characters, radula and soft parts anatomy are studied in detail and illustrated. The differences between the new species and its congeners from the Balkan Peninsula and the Mediterranean Basin are extensively discussed.

KEY WORDS: Mollusca, Truncatelloidea, freshwater, spring, Troodos Mts

INTRODUCTION

Islamia Radoman, 1973 is a genus of minute hydrobiid gastropods inhabiting springs, rivers, lakes and subterranean waters (RADOMAN 1983, BICHAIN & PRIÈ 2005). It includes 42 recognised extant taxa (MOLLUSCABASE 2017) distributed in the Mediterranean Basin and the Balkan Peninsula; most of them are endemic to single springs or other local aquatic systems (e.g. RADOMAN 1983, REISCHÜTZ 1988, BODON et al. 2001, ARCONADA & RAMOS 2006, BODON & CIANFANELLI 2012, GLÖER & GREGO 2015, YILDIRIM et al. 2017). The characters of the reproductive organs are diagnostic for the genus: females with two seminal receptacles either close together or away from each other; distal seminal receptacle (RS1) without evident duct, proximal seminal receptacle (RS2) larger and with evident duct; no bursa copulatrix; males with large penis apically bifid due to the well-developed non-glandular penial lobe (RADOMAN 1983, BODON et al. 2001, ARCONADA & RAMOS 2006). Herein we describe a new species of *Islamia* from the Troodos Mts, Cyprus, Eastern Mediterranean Basin.

MATERIAL AND METHODS

Few specimens and empty shells of the hydrobiid in question were found during sorting of lot FC 13145 collected from a spring in the Troodos Mts in 2010. Shell characters were studied and four shell measurements (shell height and width, aperture height and width) were taken from 13 specimens using the micrometer of a Stemi 2000-C stereomicroscope. Additionally, four ratios were calculated: shell height : shell width, aperture height : aperture width, shell height : aperture height and shell width : aperture width. Three males and three females were anatomically examined after dissecting under a stereomicroscope Stemi 2000-C, Zeiss, Germany using very fine needles and pointed watchmaker's forceps. Prior to dissection, the shells were removed by soaking in Pereny solution. The soft parts characters were documented using a camera (Canon EOS 1000D) coupled with the stereomicroscope.

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The radulae and the opercula were cleaned with KOH solution (5 g/l) at room temperature, rinsed in distilled water and air-dried before being mounted on stubs and spray-coated with gold–palladium. They were photographed in a scanning electron microscope Jeol JSM–35 operating at 25 kV. The morphological terminology follows that of HERSHLER & PONDER (1998).

The following abbreviations are used in the Table and Figures: AG – albumen gland, Ah – aperture height, AP – penial apex, Aw – aperture width, CG – capsule gland, CT – ctenidium, CV* $(1+1/4n)*SD/\bar{x}$ – coefficient of variation corrected for sample size (SOKAL & ROHLF 1995), E – eye, FP – faecal pellets, IN – intestine, Max – maximum, Min – minimum, MD – mantle, MP – muscular pleat, n – number of specimens, O – renal oviduct, OL – oviduct loop, OS – osphradium, P – penis, PD – penial duct, PL – penial lobe, R – rectum, RS1– distal seminal receptacle, RS2 – proximal seminal receptacle, SD – standard deviation, Sh – shell height, SPL – secondary penial lobe, SS – style sac, ST – stomach, Sw – shell width, $\bar{x}$ – mean.

SYSTEMATIC PART

Family: Hydrobiidae Stimpson, 1865

Genus: *Islamia* Radoman, 1973

Type species: *Islamia valvataeformis* (Möllendorf, 1873)

***Islamia mylonas* n. sp.**

Material examined: FC 13145, Kakarmata Spring, Cyprus, 07/12/2010, leg. S. DEMETROPOULOS

Holotype: NHMC 38828

Paratypes: Two paratypes, NHMC 44572

Type locality: Kakarmata Spring, Cyprus, 34°55'10.1"N, 33°14'18.6"E, 622 m a.s.l.

Etymology: The specific name derives from the last name of Prof. Moissis Mylonas, who has given a strong impetus to the study of Greek and Cypriot malacofauna and inspired many Greek students, including ourselves.

Diagnosis: Shell minute, valvatiform, operculum circular paucispiral without peg; single pair of basal cusps on central radular tooth; penis with muscular pleat protruding on the left side and large trapezoidal penial lobe overgrowing the apex of penis proper; penial lobe with more or less prominent secondary lobe on its right apical edge; bursa copulatrix absent, two seminal receptacles arising at a distance from each other, renal oviduct with a secondary lateral loop.

Description:

Shell (Figs 1–11, Table 1). Valvatiform, minute (maximum height 0.76 mm, maximum width 1.15 mm) with up to 3.5 whorls, thin, colourless, transparent; spire more or less depressed; whorls rounded, regularly growing with shallow sutures. Periostracum cream-coloured; aperture roundish, prosocline adhering to the body whorl; peristome continuous, thickened and reflected at columellar margin, outer margin simple; umbilicus open, deep and wide.

Operculum (Figs 12–13). Circular, paucispiral, thin, corneous, light yellowish (in preserved specimens); inner surface weakly convex without any peg; nucleus central.

Soft body pigmentation. Preserved specimens unpigmented; large eye spots present.

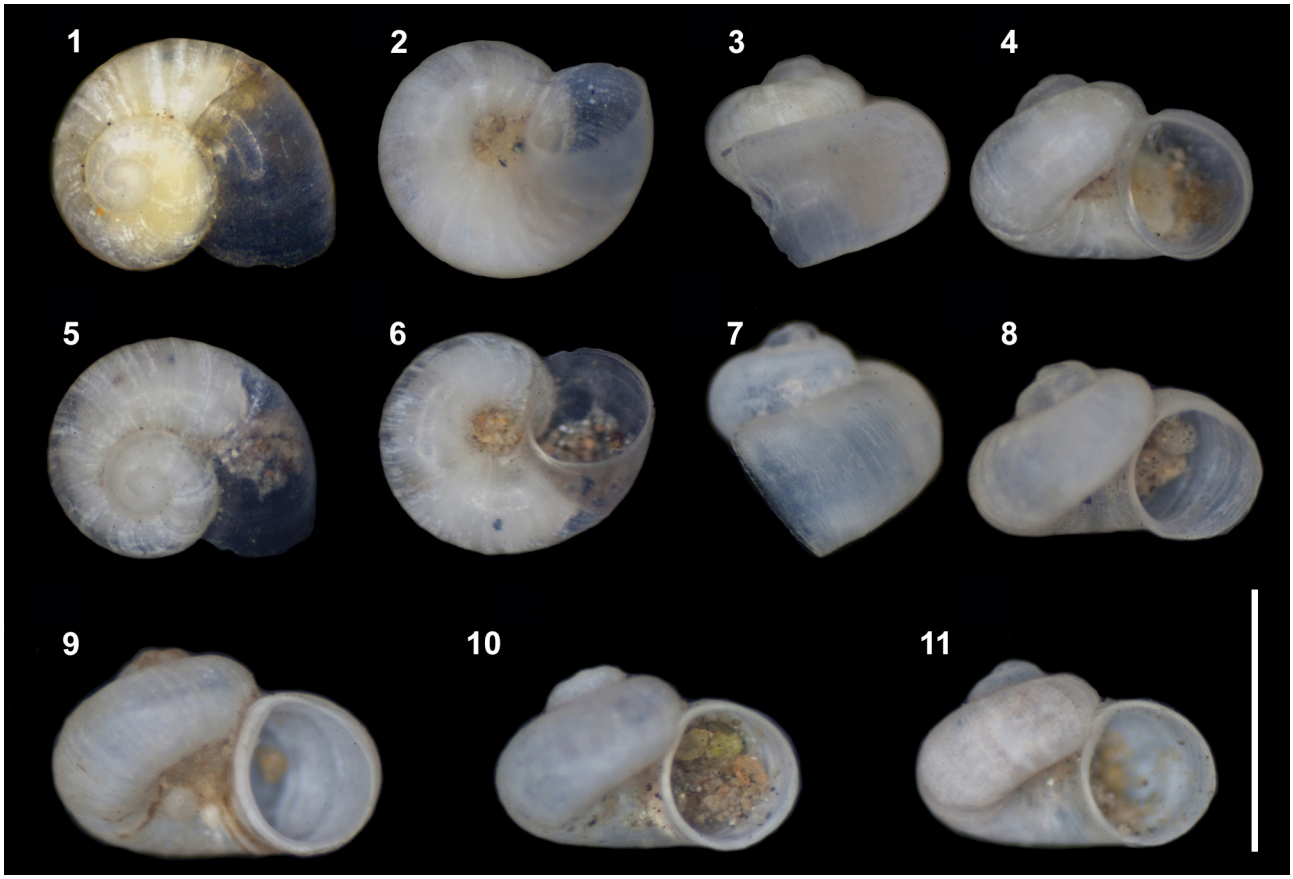
Ctenidium-osphradium (Fig. 14). Ctenidium with ca. 7 filaments; filaments broader than high; osphradium of medium width, less than twice longer than broad, opposite posterior part of ctenidium.

Digestive system apart from radula (Fig 15). Style sac smaller than stomach, not protruding to intestinal loop, intestine Z-shaped.

Radula (Figs 16–17). Central tooth trapezoidal, its dorsal edge strongly concave; basal tongue broadly V-shaped and roughly equal to elongated lateral margin; one pair of medium-sized basal cusps (bc2); median cusp long, narrow, rounded, protruding, followed by 5 narrow cusps of decreasing size on each side, the fifth cusp being much reduced in size; lateral tooth face taller than wide; central cusp longer than lateral cusps, 4 lateral cusps on outer side, 3 smaller lateral cusps on inner side; inner marginal tooth with ca. 25–30 long, narrow cusps; cusps almost equal in size, the first 2–3 outer ones being very small; outer marginal tooth with ca. 14–18 cusps.

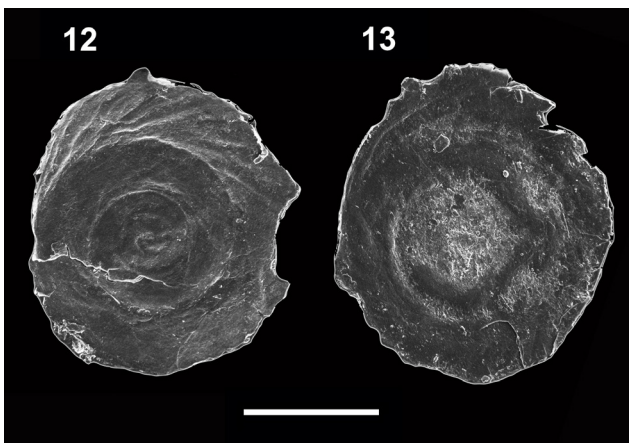
Table 1. Shell morphometry of *Islamia mylonas* sp. n. Measurements are in mm. For abbreviations see Material and Methods

Type locality		Sh	Sw	Ah	Aw	Sh/Sw	Sh/Ah	Sw/Aw	Ah/Aw
N = 13	Min	0.49	0.93	0.39	0.40	0.46	0.96	2.06	0.90
	Max	0.76	1.15	0.55	0.52	0.71	1.63	2.42	1.11
	$\bar{x}$	0.67	1.02	0.47	0.46	0.65	1.42	2.22	1.02
	SD	0.07	0.06	0.05	0.03	0.06	0.17	0.08	0.07
	CV*	0.10	0.06	0.10	0.07	0.10	0.12	0.04	0.07

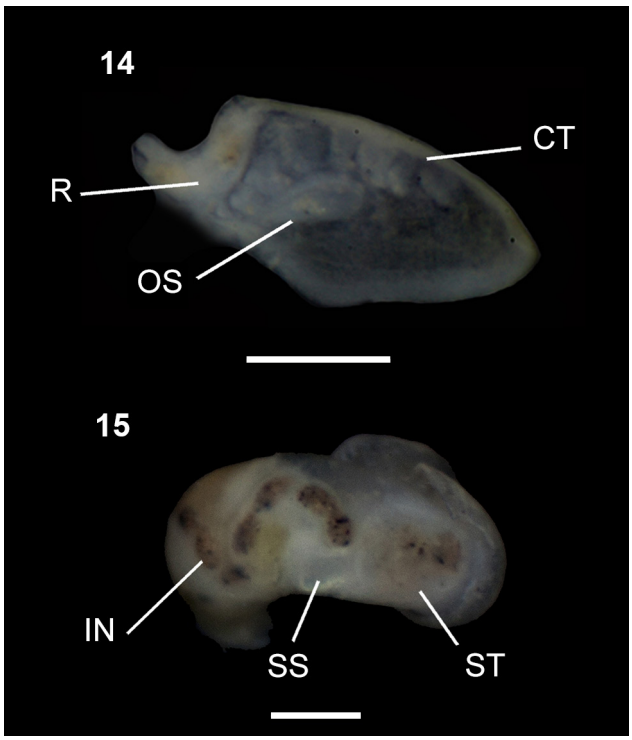


Figs 1–11. Shells of *Islamia mylonas* n. sp.: 1, 5 – apical view; 2, 6 – umbilical view; 3, 7 – lateral view, 4, 8–11 – apertural view. Scale bar 1 mm

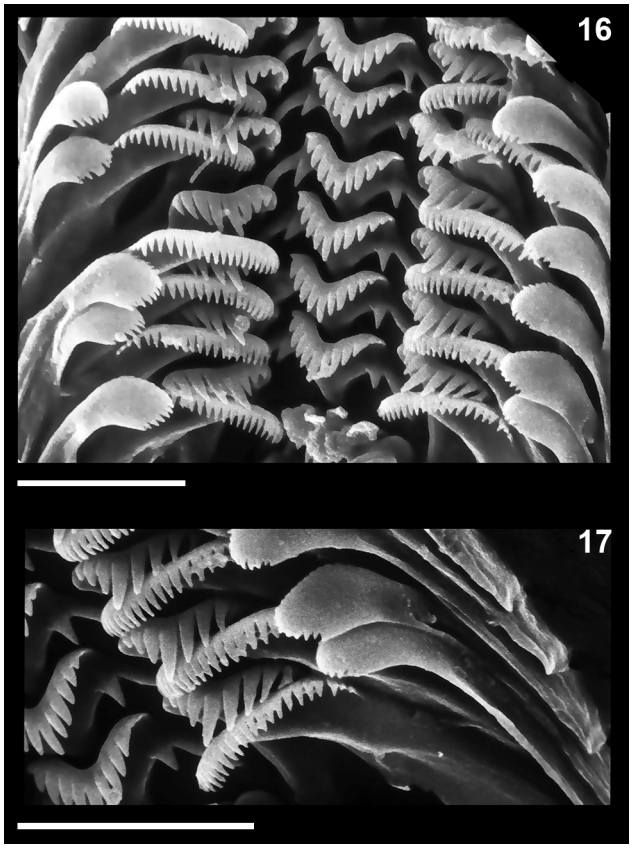
Penis (Figs 18–19). Large relative to head, long, wide, dorso-ventrally flattened, folded, apically bifid due to the penial lobe on its left side and penis proper on the right side; penial lobe large, exceeding the tapered distal end of penis proper, trapezoidal with a more or less distinct secondary lobe on its right apical edge and an ovate refringent area on the left; base of penis expanded; large muscular pleat in the middle of penial lobe on ventral side of penis protruding at the left side of penis; penial duct undulat-



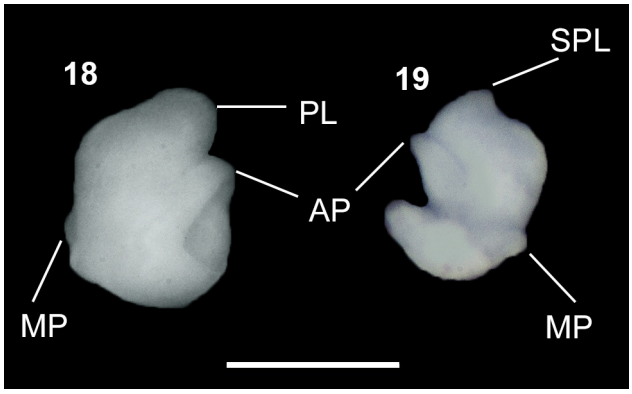
Figs 12–13. Operculum of *Islamia mylonas* n. sp.: 12 – outer view; 13 – inner view. Scale bar 200 μm



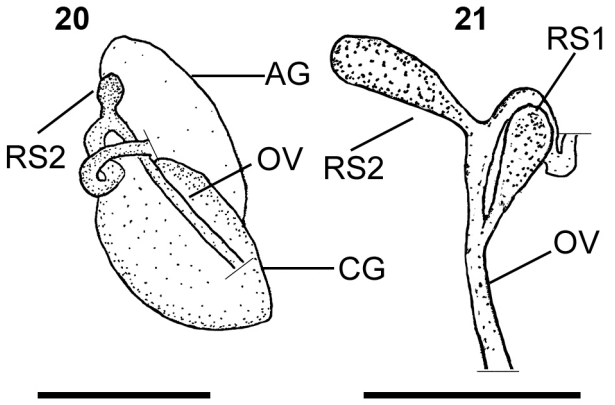
Figs 14–15. Osphradium, ctenidium and part of digestive system of *Islamia mylonas* n. sp.: 14 – osphradium and ctenidium; 15 – part of digestive system. Scale bars 0.25 mm. For abbreviations see Material and Methods



Figs 16–17. Scanning electron micrographs of radula of *Islamia mylonas* n. sp.: 16 – portion of radular ribbon; 17 – lateral, inner and outer marginal teeth. Scale bars 10 μm



Figs 18–19. Male reproductive organs of *Islamia mylonas* n. sp.: 18 – dorsal view of folded penis; 19 – ventral view of distal part of penis. Scale bar 0.25 mm. For abbreviations see Material and Methods



Figs 20–21. Female reproductive organs of *Islamia mylonas* n. sp.: 20 – ventral view of anterior reproductive organs; 21– dorsal view of renal oviduct and seminal receptacles after removing oviduct glands. Scale bars 0.25 mm. For abbreviations see Material and Methods

ing, nearly centrally positioned on the penis proper and opening at its apex.

Anterior female reproductive system (Figs 20–21). Albumen gland of irregular shape; bursa copulatrix absent; renal oviduct unpigmented and well-developed with a narrow vertical primary loop and a secondary lateral loop; two elongate seminal receptacles located at a distance in opposite positions of renal oviduct; proximal seminal receptacle (RS2) with an orange-pink pearl shine emerging from the top of renal oviduct primary loop; distal seminal receptacle (RS1) smaller than proximal one, without distinct duct; one female with pseudopenis on the head.

The protoconch and the nervous system were not studied because of the small number of available specimens and the fragility of the preserved shells.

Habitat and distribution. Known only from the type locality, a spring in Periochi Tzionia CY2000013 which is a Site of Community Importance (SCI) and a Special Protection Area (SPA) of Natura 2000 network.

DISCUSSION

The freshwater hydrobiid fauna of Cyprus has not been extensively studied so far. Only two hydrobiid species, *Pseudamnicola malickyi* Schütt, 1980 and *Islamia* sp., have been recorded in this country (Schütt 1980, Fischer 1994, Mienis et al. 2012). Several species of *Islamia* have been found and described in adjacent countries such as Greece, Israel, Lebanon and Turkey (Radoman 1983, Schütt 1991, Bodon et al. 2001).

The new species, having a well-developed penial lobe and a muscular pleat on the ventral side of penis, belongs to the "oriental" group of *Islamia* species which inhabits France, part of Italy, Croatia, Bosnia and Herzegovina, Greece, Turkey, Israel and Lebanon (Bodon et al. 1995, Bodon & Cianfanneli 2002, 2012). In Spain and part of Italy, *Islamia* species are characterised by the absence of the muscular pleat

and in some cases the penial lobe is very small (Bodon et al. 1995, Bodon & Cianfanneli 2002, Arconada & Ramos 2006). As can be deduced from Radoman (1983), the species of the "oriental" group, at least those from Bosnia and Herzegovina, Greece and Turkey, have seminal receptacles arising from the same point of the renal oviduct. The seminal receptacles of *I. mylonas* arise at a distance from each other as is the case of several *Islamia* taxa from Italy and Spain (Arconada & Ramos 2006, Bodon & Cianfanneli 2012). The presence of pseudopenis on the head of one female specimen is an interesting character of the new species since only two other known *Islamia* taxa have this character: *Islamia h. henrici* Arconada et Ramos, 2006 and *I. pallida* Arconada et Ramos, 2006 from Spain (Arconada & Ramos 2006).

A unique character of *I. mylonas,* which has not been described in any other known *Islamia* species, is the secondary lateral loop of the renal oviduct. A similar lateral loop is found in *Pseudamnicola* Paulucci, 1878 (see e.g. Radoman 1983: 27, fig. 10).

The new species differs from the other members of the "oriental" group in several characters of shell and soft parts, and displays some similarities to them. It differs from the type species of the genus *Islamia* described from Bosnia and Herzegovina, namely *I. valvataeformis* (Möllendorf, 1873), in the position of the seminal receptacles which arise very close to one another in the latter species (Radoman 1983: 124–125, fig. 69A, B). However the two species share the same character state in their radulae since *I. valvataeformis* has only one pair of basal cusps on the central radular tooth (Giusti et al. 1981: 26, fig. 1.1–3).

The Greek species *I. trichoniana* Radoman, 1978 and *I. graeca* Radoman, 1973 have shells larger than those of *I. mylonas* and their seminal receptacles arise very close to one another as it can be deduced from Radoman (1983: 124). Additionally, the penis of *I. graeca* seems to have a very small penial lobe (Radoman 1983: 125, fig. 70C) while the muscular pleat in the penis of *I. trichoniana* does not protrude to the left (Radea et al. 2017: 6, figs 10–12). Both *I. mylonas* and *I. trichoniana* have one pair of basal cusps on the central radular tooth (Radea et al. 2017: 6, fig. 14). The assignment to *Islamia* of two other Greek hydrobiids, *I. epirana* (Schütt, 1962) and *I. bendidis* P. L. Reischütz, 1988, was mainly based on shell characters and the allocation of these taxa remains very uncertain (Bodon et al. 2001). Besides, *I. hadei* (E. Gittenberger, 1982) was transferred to the genus *Daphniola* by Falniowski & Szarowska (2011).

The new species differs in its shell morphology and male genitalia from *I. mienisi* (Schütt, 1991) from Israel and from *I. gaillardoti* (Schütt, 1991) from Israel and Lebanon. The shell of *I. mienisi* is ovate-conical and its penis has a pointed lobe and pointed apex (Schütt 1991: 134, fig. 5a–c; 135); *I. gaillardoti* has a larger shell than that of *I. mylonas* and a different general penis shape (Schütt 1991: 135–136, fig. 6b, Bodon & Cianfanelli 2002: 28).

The main features discriminating between *I. mylonas* and the known Turkish *Islamia* species, namely *I. bunarbasa* (Schütt, 1964), *I. pseudorientalica* Radoman, 1973, *I. anatolica* Radoman, 1973, and *I. burduricus* Yildirim, Kaya, Gürlek et Koca, 2017, are the characters of shell and genitalia. All the Turkish species are larger compared to *I. mylonas*; the shell of *I. bunarbasa* is ovate-conical and those of *I. pseudorientalica*, *I. anatolica* and *I. burduricus* are trochiform (Radoman 1983: 206, Table 7, 228, figs 154–156, Yildirim et al. 2017: 11–12, fig. 3A). All four species are characterised by a relatively narrow penis with a long slit between the penis proper and the penial lobe of the latter reaching or slightly exceeding the penis tip (Radoman 1983: 125, D–F, Yildirim et al. 2017: 11–12, fig. 3B, C, respectively). An additional character discriminating between *I. mylonas* and the Turkish *Islamia* is that the seminal receptacles, at least in the first three species, are located very close to one another as it can be inferred from Radoman (1983: 124).

I. mylonas exhibits interesting similarities with the cavernicolous *I. emanuelei* Girardi, 2009 from France: the latter species also has a secondary lobe at the right edge of the primary penial lobe (Girardi 2009: 34–35, fig. 1A) and the seminal receptacles arise at a distance from each other (Girardi 2009: 35, fig. 1D). However, the shell of *I. emanuelei* is much larger than that of the new species.

The new species shares several anatomical characters with *Islamia* taxa belonging either to the oriental or to the occidental group. Regrettably, the extremely small number of specimens found did not allow molecular studies of phylogenetic relationship of *I. mylonas* with its congeners.

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