

HYPNOPHILA ZIRJENSIS N. SP., A NEW AZECID LAND SNAIL FROM THE CROATIAN ISLAND OF ŽIRJE (GASTROPODA: PULMONATA: ORTHURETHRA)

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Abstract *Hypnophila zirjensis* n. sp. is described from the Island of Žirje (Šibenik Archipelago, Croatia). The new species is characterized by shell and genital features, which distinguish it from the other Balkan species. These characters match those of species occurring in the western Mediterranean region making the new species very interesting from a biogeographical point of view.

Key words Land snails, new species, Balkan Peninsula, taxonomy, biogeography

INTRODUCTION

In the framework of the project "Fauna of the Croatian Adriatic Islands", one of the present authors (V.Š.) and Eduard Kletečki, curators of the Croatian Natural History Museum (Zagreb, Croatia), conducted field research on the non-marine malacofauna of Žirje Island (Šibenik Archipelago, Croatia) in late October and early November 2004. During the field survey, two azecid land snails were collected. One matched *Hypnophila pupaeformis* (Cantraine, 1835), hitherto known as the only azecid occurring on the Croatian islands and mainland (Gittenberger, 1993). The other was smaller and differed significantly in the shell shape, closely resembling species from the western Mediterranean, especially those occurring in Sardinia, the Tyrrhenian islands and Tuscany (Italy).

Study of the smaller azecid was postponed until more data was available, namely when specimens complete with soft parts were found in a subterranean pit by the biospeleologist Branko Jalžić. Anatomical study, facilitated by a revision of the genera of the family Azecidae in preparation by F. Giusti and G. Manganelli, confirmed the conclusions of the preliminary conchological study and provided the data necessary for describing the snail from Žirje as a new species.

MATERIAL AND METHODS

Material examined is listed as follows, when possible: locality, municipality and province names in parenthesis, altitude above sea level, UTM reference, collector(s), date, number of specimens and collection in which material is kept in parenthesis. Collection acronyms: CNHM (Croatian Natural History Museum, general collection of recent molluscs, Zagreb, Croatia); FGC (F. Giusti collection, Dipartimento di Scienze Fisiche, della Terra e dell'Ambiente, Università di Siena, Italy); MBC (M. Bodon collection, Genova, Italy); RMNH.MOL. (Nationaal Natuurhistorisch Museum, Leiden, The Netherlands).

Shells were photographed using a Canon EF 100mm 1:2.8 L IS USM macro lens plus EF25 II extension tube mounted on a Canon F6 camera.

Shell dimensions were measured to the nearest 0.1mm, using a Wild M5A microscope. Fifteen variables were considered: aperture height (AH), last whorl height (LWH), last two whorl height (L2WH), last three whorl height (L3WH), last four whorl height (L4WH), last five whorl height (L5WH), shell height (SH), aperture diameter (AD), shell diameter (SD), last whorl diameter (LWD), penultimate whorl diameter (PWD), third last whorl diameter (3WD), fourth last whorl diameter (4WD), fifth last whorl diameter (5WD), aperture width (AW) (Fig. 1).

During anatomical study, bodies were removed by crushing the shells and dissected under a Wild M5A light microscope using very fine pointed watchmaker's tweezers. Anatomical details

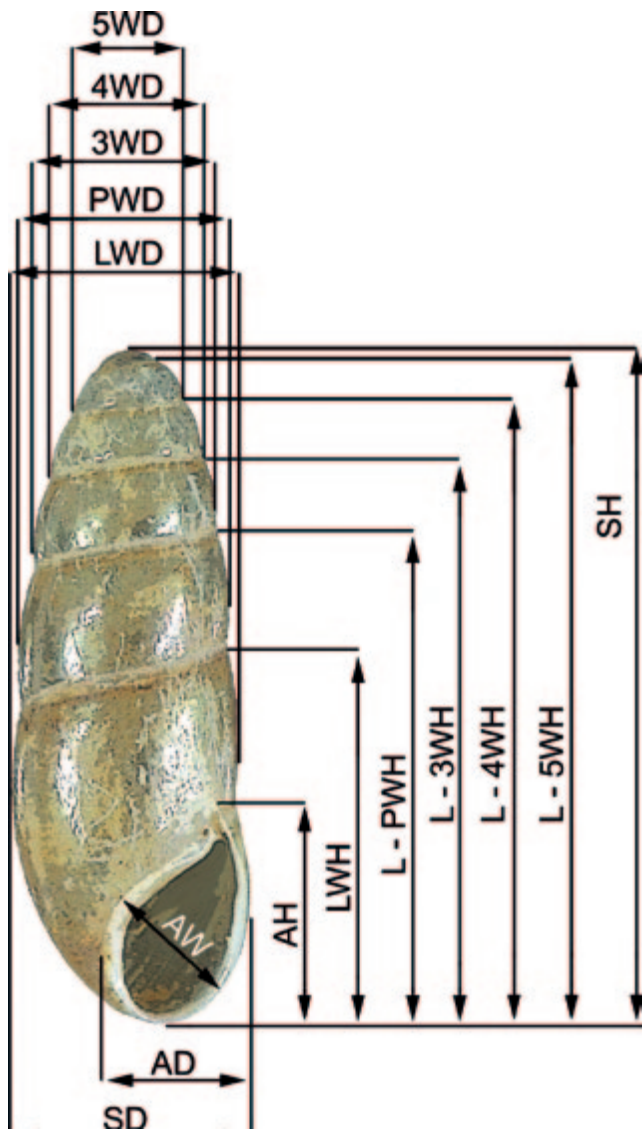


Figure 1 Dimensional variables considered for statistical analysis.

were drawn using a Wild M5A camera lucida. Anatomical acronyms: AG, albumen gland; BC, bursa copulatrix; BW, body wall; DBC, duct of bursa copulatrix; FHD, first hermaphrodite

duct; FO, free oviduct; P, penis; POS, prostatic portion of ovispermiduct; PR, penial retractor muscle; UOS, uterine portion of ovispermiduct; V, vagina with muff of “pigmentary cells”; VD, vas deferens.

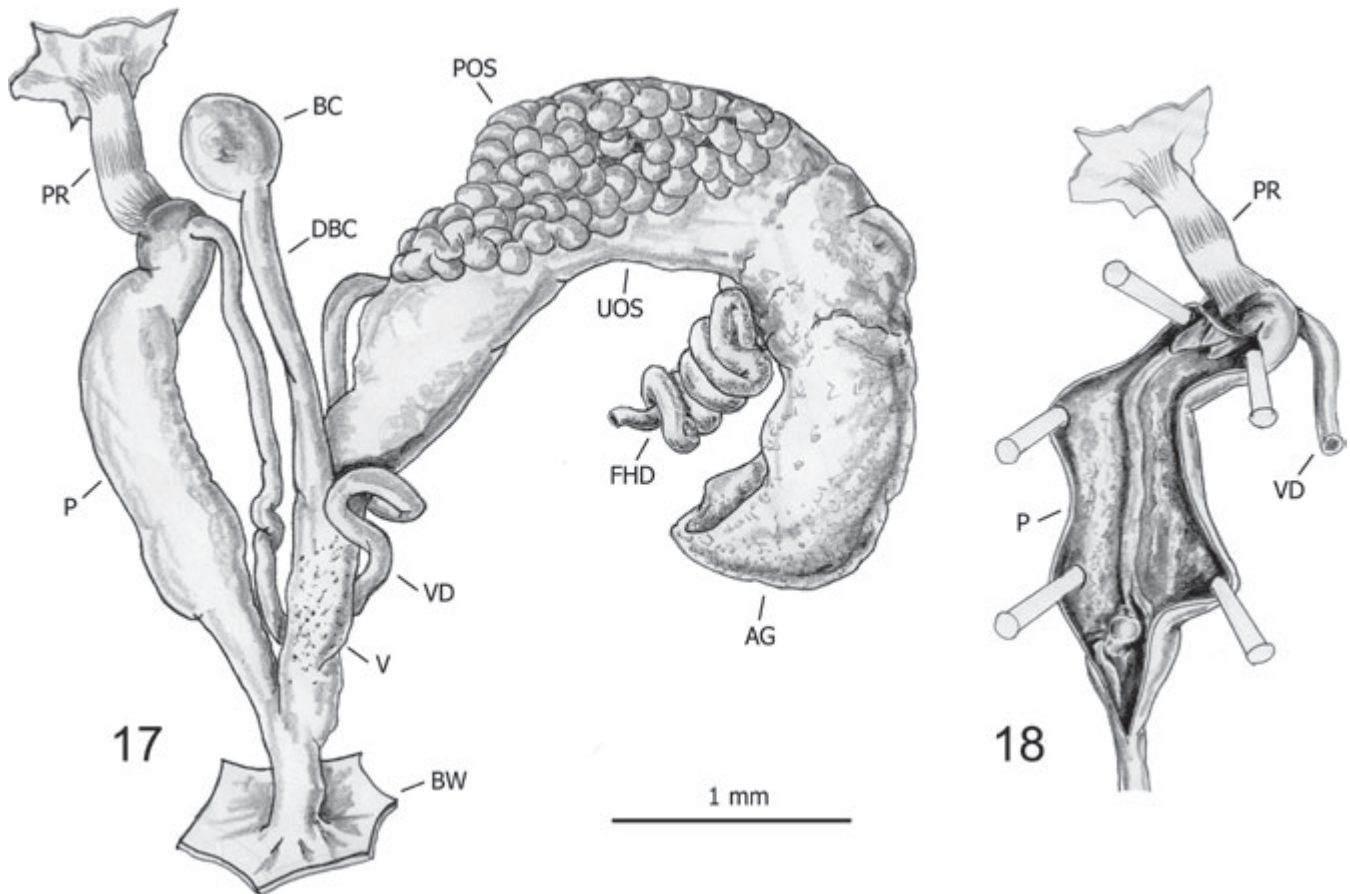
Multivariate ordination by Principal Component Analysis (PCA) was used to determine the degree of correlation between shell variables and their role in explaining variability. Since variation in size is the first determinant of biometric variation (e.g. Cadima & Jolliffe, 1996; Klingenberg, 2016), multivariate morphometrics to distinguish size and shape components by removing isometric effects are nowadays routinely applied in shell biometry studies (Madec *et al.*, 2003; Paquette & Lapointe, 2007; Fiorentino *et al.*, 2008; Caruso & Chemello, 2009). We performed two PCAs, one on the original matrices and one on the Z-matrices, the latter only consider shape components according to the methods proposed by Cadima & Jolliffe (1996).

Redundancy analysis (RDA; ter Braak, 1986) was then applied to the original shell matrices and shell Z-matrices in order to detect any multivariate relationships between shell variables and the taxonomic assignment. For each species, at least two populations (each represented by five specimens) were evaluated (see Appendix 1). The factors “population” and “species” were used as constraint factor. An ANOVA-like permutation test for constrained ordination was used to assess the significance (p-value) of the constraint for the first two RDA axes. Vegan package (Oksanen *et al.*, 2016) RStudio 0.99.473 version (RStudio Team, 2015) was used for processing.

For the list of populations and species examined for statistical analysis, see Appendix 1.

Figures 2–16 Shells of *Hypnophila* species. **2–5** *Hypnophila zirjensis* n.sp. Šibenik Archipelago, Žirje Island, Gradina (pit), Gradina (area) (Croatia), 33TWJ53, B. Jalžić leg. 1.6.2007. Holotype (Fig. 2; CNHM, General collection of recent molluscs no. 10918) and three paratypes (Figs 3–5; CNHM, General collection of recent molluscs no. 10919). **6–7** *Hypnophila* cf. *etrusca* (Paulucci, 1886). Tuscan Archipelago, Giglio Island, Il Franco (province of Grosseto, Italy), 32TPM59, L. Favilli & G. Manganelli leg. 21.2.1990 (FGC 5015). **8–9** *Hypnophila etrusca* (Paulucci, 1886). Monte Argentario, Fosso di Mare Morto (province of Grosseto, Italy), 32TPM7694, D. Barbato, A. Benocci & M. Bianchi leg. 16.4.2013 (FGC 41219). **10–11** *Hypnophila malagana* Gittenberger, 1983. Mountains west of Terremolinos (province of Malaga, Spain), 30SUF65, J. De Winter leg. 1.1.1983 (ML Mollusca 56253/23). **12–14** *Hypnophila emiliana* Bourguignat, 1858. Egadi Archipelago, Marettimo Island, above the village (province of Trapani, Italy), 33STC4206, F. Giusti leg. 2.4.1982 (FGC 17791). **15–16** *Hypnophila bisacchii* Giusti, 1970. Sardinia Island, Monte Tului (province of Nuoro, Italy), 32TNK55, collector unknown leg. 5.4.1978 (FGC 16561).





Figures 17–18 Genitalia (gonad excluded) (Fig. 17) and detail of penial complex (Fig. 18) of a specimen of *Hypnophila zirjensis* n.sp. Šibenik Archipelago, Žirje Island, Gradina (pit), Gradina (area) (Croatia), B. Jalžić leg. 10.2007.

SYSTEMATICS

Family Azecidae Watson, 1920

Hypnophila zirjensis n. sp.

Shell (Figs 2–5) Dextral, small, imperforate, slender fusiform, yellowish, sometimes with whitish spiral stripes or bands, glossy and transparent when fresh, with 5³/₄–7 slightly convex whorls separated by superficial sutures; aperture slightly prosocline, ovate pyriform, rather narrow at base, without apertural armature; peristome not reflected, not thickened (upper third very thin), with straight outer margin (in lateral view) and with variably evident continuous callous rim on columella and parietum ending in transversally elongated angular tubercle separated by deep notch from upper angle of aperture; protoconch with numerous close, spiral rows of very small pits in grooves; teleoconch smooth, with very faint scattered collabral growth lines

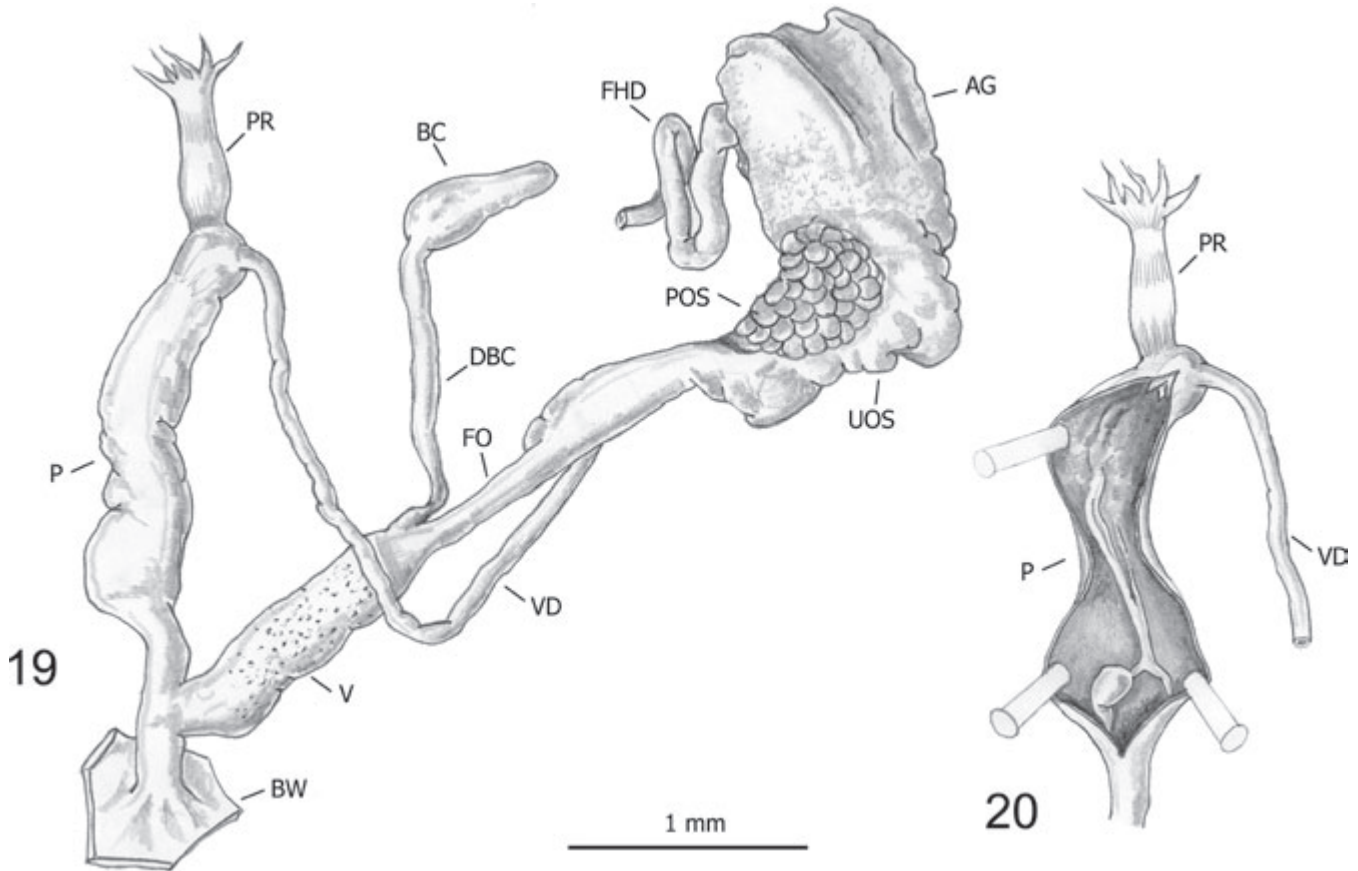
and very fine spiral grooves. Shell dimensions: H: 5.3±0.11mm; D: 1.9±0.04mm.

Body Eye spots present.

Radula Not examined.

Female distal genitalia (Figs 17, 19) Free oviduct short to long and variably wide. Bursa copulatrix roundish, bean-like or pyriform with long slender duct, initially barely flared. Vagina long and rather slender, proximally covered by faint, yellowish muff of “pigmentary cells”, internal surface smooth.

Male distal genitalia (Figs 17–20) Vas deferens rather long, almost uniform in diameter, entering penis sub-basally; opening of vas deferens inside penis bordered by sort of penial papilla consisting of bunch of short conical digit-like appendages fused at base. Penis long, its proximal and medial portions rather wide and



Figures 19–20 Genitalia (gonad excluded) (Fig. 19) and detail of penial complex (Fig. 20) of a specimen of *Hypnophila zirjensis* n.sp. Šibenik Archipelago, Žirje Island, Gradina (pit), Gradina (area) (Croatia), B. Jalžić leg. 10.2007.

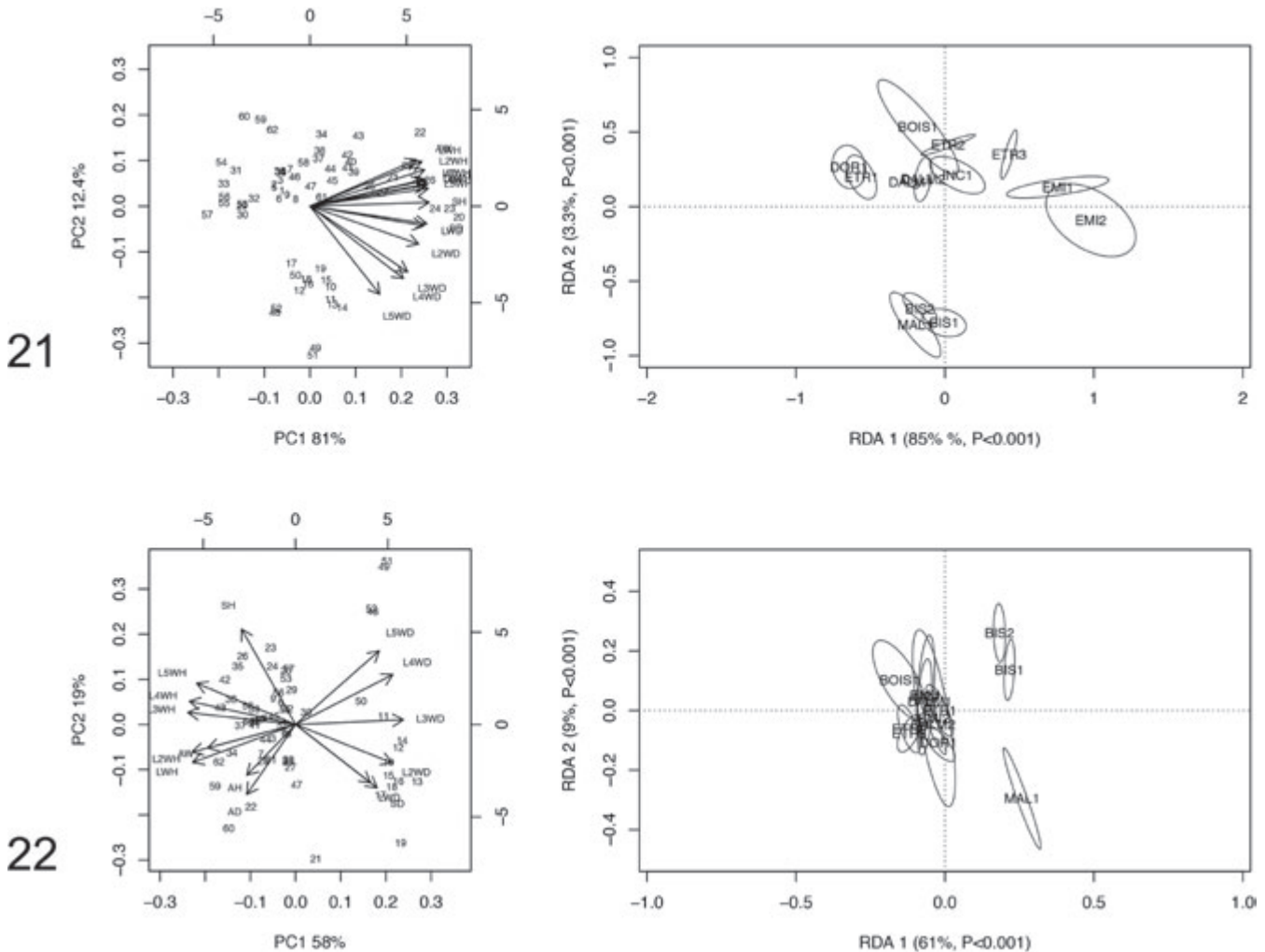
cylindrical, swollen in final segment; distal portion tapering progressively before entering genital atrium. Penial retractor short and robust, inserted sub-basally. Internal surface of penis with one longitudinal pleat split into two more slender branches level with swollen medial portion, one branch with evident knob; internal penial walls covered with sparse, irregular, sponge-like tissue.

Type locality Croatia, Dalmatia, Šibenik Archipelago, Island of Žirje, Gradina (area), Gradina (pit), 30–33m a.s.l., UTM: 33TWJ53.

Type material Holotype (shell) and 61 paratypes. Holotype (shell), B. Jalžić leg. 1.6.2007 (CNHM 10918). Paratypes: B. Jalžić leg. 10.2004 (7 adult + 24 juv. shells); E. Kletečki and V. Štamol leg. 31.10.2004 (2 adult + 4 juv. shells); B. Jalžić leg. 1.6.2007 (14 adult + 3 juv. shells); B. Jalžić leg. 10.2007 (7 specimens, 3 dissected) (CNHM 10919).

Other material Šibenik Archipelago, Island of Žirje, Jajni vrsi (summit), 80m a.s.l., UTM: 33TWJ53; E. Kletečki and V. Štamol leg. 1.11.2004 (2 adult + 1 juv. shells), CNHM 10925; Kruševica (bay), 5–10m a.s.l., UTM: 33TWJ53, E. Kletečki and V. Štamol leg. 1.11.2004 (1 adult shell), CNHM 10921; Smrikovac (summit), 70–80m a.s.l., UTM: 33TWJ53, E. Kletečki leg. 30.10.2004 (2 adult + 2 juv. shells), CNHM 10924; Stupica (village), 2–5m a.s.l., UTM: 33TWJ53, E. Kletečki and V. Štamol leg. 30.10.2004 (1 adult shell), CNHM 10922; Vela glava (summit), 90–103m a.s.l., UTM: 33TWJ43, E. Kletečki and V. Štamol leg. 1.11.2004 (2 adult + 2 fragments + 4 juv. shells), CNHM 10920; Zvizdulja (summit), 85–91m a.s.l., UTM: 33TWJ53, E. Kletečki and V. Štamol leg. 30.10.2004 (1 adult + 2 juv. shells), CNHM 10923.

Etymology From the island of Žirje (Italian: Zuri; Latin: Zurium) where it occurs.



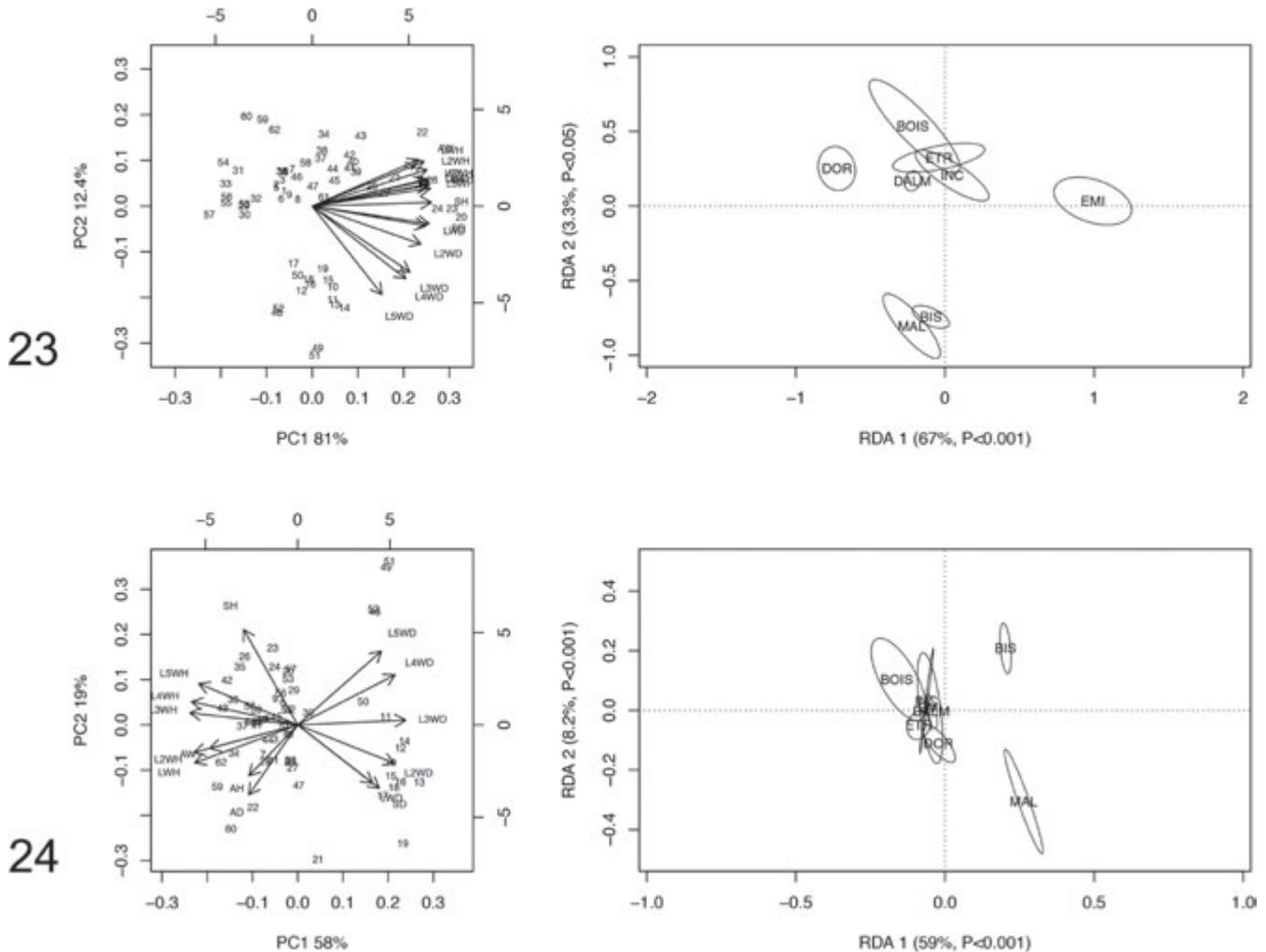
Figures 21–22 RDA with population constraint. RDA on the original matrix showed that RDA 1 (85%, $P<0.001$) tended to separate three small groups (DOR1 plus ETR1; ETR3; and EMI1 plus EMI2) from two larger clusters (BOIS1-ETR2-INC1-DALM1-DALM2 and MAL1-BIS1-BIS2) in intermediate position (Fig. 21). The preliminary classic PCA revealed size as the first determinant of morphological variance (PC1 81%) since PC1 was a positive combination of all variables: indeed, DOR1 had the smallest size and EMI2 the largest. On the contrary, RDA 2 (3.3%, $P<0.05$) showed a statistically significant separation between the group formed by MAL1 plus BIS1 and BIS2 and the large group consisting of all the other species. In that regard, PC2 (12.4%) accounted for a shape component since it represents a contrast between variables related to shell height and shell width. RDA on shape matrix (Z) confirmed a statistically significant separation between MAL1 and BIS1 plus BIS2 on one hand and all the other populations on the other hand (Fig. 22). Shape-related PCA indicated that L3WH and L3WD were the two principal shape determinants.

DISCUSSION

Excluding the new species, the genus *Hypnophila* includes 16 species (Appendices 2–3) distributed in two distinct sectors of the western Palearctic: along the western border of the Balkan Peninsula and scattered around the western Mediterranean (Giusti & Manganelli, 1984). Four species, including the type species of the genus *Hypnophila* Bourguignat, 1858 (*Hypnophila pupaeformis*),

occur in the eastern sector (Appendix 2) and 12 others occur in the western sector (Appendix 3).

The eastern group is characterized by shell markedly ovoidal with transversally elongated angular tubercle and protoconch without rows of pits; distal male genitalia with almost uniformly slender vas deferens; penis long with two longitudinal pleats bearing thickened parts on internal penial surface; pleats fuse proximally giving rise to small, pointed cup-like crest bordering



Figures 23–24 RDA with species constraint. RDA on the original matrix showed that RDA 1 (67%, $P < 0.001$) tended to separate DOR from EMI, with groups BOIS-ETR-INC-DALM and MAL-BIS in intermediate position (Fig. 23). The preliminary classic PCA revealed size as the first determinant of morphological variance (PC1 81%) since PC1 was a positive combination of all variables: indeed, DOR had the smallest size and EMI the largest. On the contrary, RDA 2 (3.3%, $P < 0.05$) showed a statistically significant separation between MAL-BIS and the other species. In that regard, PC2 (12.4%) accounted for a shape component since it represents a contrast between variables related to shell height and shell width. RDA on the shape (Z) matrix confirmed a statistically significant separation between MAL and BIS on one hand and all the other species on the other hand (Fig. 24). Shape-related PCA indicated that L3WH and L3WD were the two principal shape determinants.

opening of vas deferens inside penis (no penial papilla-like structure consisting of bunch of short conical digit-like appendages present); penial retractor inserted basally on penis (Giusti and Manganelli, in preparation).

The western group is more complex and comprises two very distinct species, the systematics of which are under revision (*Hypnophila boissii* and *Hypnophila girottii*), plus a large assemblage containing all the other species. *Hypnophila boissii* (Dupuy, 1851), type species of the genus-group taxon *Gomphroa* Westerlund, 1903, is

characterized by slender fusiform shell without transversally elongated angular tubercle and protoconch with rows of pits; distal male genitalia with almost uniformly slender vas deferens; very small penis with only two fine longitudinal pleats on its internal surface (presence of a penial papilla-like structure impossible to be ascertained due to very small size); penial retractor inserted basally on penis.

Hypnophila girottii Esu, 1978, is characterized by very elongate, cylindrical-conical or cylindrical-fusiform shell without transversally

elongated angular tubercle but with a very faint, often absent, tubercle on the parietum close to columellar margin of peristome and protoconch with rows of pits. Finally, the main western Mediterranean group, including most western Mediterranean species, is characterized by slender fusiform shell with transversally elongated angular tubercle and protoconch with rows of pits; distal male genitalia with almost uniformly slender vas deferens; medium to long penis with longitudinal pleats and with knobs and transverse crests on its internal surface and penial papilla-like structure, consisting of bunch of short conical digit-like appendages fused side by side for most of their length, which encircle opening of vas deferens inside penis; penial retractor inserted latero-basally on penis (Giusti and Manganelli, in preparation). The species from the Island of Žirje matches the latter group.

The large western Mediterranean group currently includes 12 species, apart from *Hypnophila bisacchii* (Giusti, 1970) and *Hypnophila malagana* (Gittenberger, 1983), all described in the nineteenth century. Two other Sicilian taxa in need of revision have also sometimes been reported as *Hypnophila* species (Appendix 4). The two North African species (*Hypnophila maroccana* (Mousson, 1873) and *Hypnophila psathyrolena* (Bourguignat, 1864)) are not known anatomically; indeed, they are only known from the original description and/or late nineteenth and early twentieth century re-descriptions. We therefore excluded them from the differential analysis.

Sound differential analysis of the new species is problematical: the taxonomy of *Hypnophila* species is weak, since most are distinguished largely on the basis of their separate geographical distributions. Species are distinguished on the basis of shell characters but no significant analysis of intra- and interpopulation variability has ever been done. Giusti (1968) began anatomical study on them but it was not easy due to the small size of these snails. Since it is also difficult to obtain a sufficient number of sexually mature adults, few specimens have been studied and it is therefore difficult to interpret anatomical differences (species-specific divergence, artefacts due to pre-mortem stress, different fixation, different sexual maturation?). This may limit the validity of the following discussion, but is the best we can do pending molecular study.

Though limited to only 13 populations and eight species (Appendix 1) due to lack of available material, RDAs sometimes showed high intra- and interpopulation shell variability (Figs 21–22). Shell shape only distinguished the Žirje species from *Hypnophila bisacchii* and *Hypnophila malagana* and shell size from *Hypnophila emiliana* (Bourguignat, 1858) and probably *Hypnophila cylindracea* (Calcara, 1840). The other species (*Hypnophila dohrni* (Paulucci, 1882), *Hypnophila etrusca* (Paulucci, 1886), *Hypnophila incerta* (Bourguignat, 1858) and probably *Hypnophila* cf. *boissii* and *Hypnophila remyi* (Boettger, 1949)) largely match the shell shape and size of *Hypnophila zirjensis*.

Nevertheless, *Hypnophila zirjensis* is distinguished from all the other species which are anatomically known. The large and long penis (wide in caliber and longer than vagina plus free oviduct) distinguishes it from *Hypnophila boissii*, *Hypnophila dohrni* and *Hypnophila remyi*, which are characterized by a very small to small penis (slender and shorter than vagina plus free oviduct). Internally the penis has only one longitudinal pleat split, level with the swollen portion, into two more slender branches. Little after its beginning, one of these branches gives origin to an evident knob. All the other species have a larger and longer penis (*Hypnophila bisacchii*, *Hypnophila* cf. *cylindracea*, *Hypnophila emiliana*, *Hypnophila etrusca*, *Hypnophila incerta* and *Hypnophila malagana*) with two or more internal longitudinal pleats, sometimes lacking an evident knob level with the swollen portion of penis (for references, see Appendix 3).

The finding of a *Hypnophila* species in the Šibenik Archipelago (northwest Balkan Peninsula) is extremely interesting from a biogeographical point of view, considering that its slender fusiform shell and male distal genitalia structure match those of the western Mediterranean species. Future molecular research will shed more light on its relationships, origin and history.

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APPENDIX 1 MATERIAL CONSIDERED FOR STATISTICAL ANALYSIS

Hypnophila cf. *boissii* (Dupuy, 1851) – **BOS1**: Callelongue, Marseille (Marseille, Bouches-du-Rhône, Provence-Alpes-Côte-d’Azur, France), UTM: 31TFJ9186, M. Bodon leg. 30.12.1989 (7 shells, MBC).

Hypnophila bisacchii Giusti, 1970 – **BIS1**: Sardinia Island, Monte Tului (province of Nuoro, Italy), 32TNK55, collector unknown leg. 5.4.1978 (FGC 16561); **BIS2**: Sardinia Island, Cala Gonone (province of Nuoro, Italy), UTM: 32TNK55, L. Pintér leg. 2.7.1981 (FGC 29595).

Hypnophila dohrni (Paulucci, 1882) – **DOHR1**: Sardinia Island, Tavolara Island (province of Olbia-Tempio Pausania, Italy), UTM: 32TNL52, unknown collector (FGC 16896), M. Cobolli, M. Lucarelli & A. Vigna Taglianti leg. 27.09.85 (FGC 16898), Pasini leg. (FGC 16902).

Hypnophila emiliana Bourguignat, 1858 – **EMI1**: Egadi Archipelago, Favignana Island, Contrada Ballone (province of Trapani, Italy), UTM: 33STC60, G. Manganelli leg. 25.3.1983 (FGC 17790); **EMI2**: Egadi Archipelago, Marettimo Island, above the village (province of Trapani, Italy), UTM: 33STC4206, F. Giusti leg. 2.4.1982 (FGC 17791).

Hypnophila etrusca (Paulucci, 1886) – **ETR1**: Monte Argentario, Fosso di Mare Morto (province of Grosseto, Italy), UTM: 32TPM7694, D. Barbato, A. Benocci & M. Bianchi leg. 16.4.2013 (FGC 41219); **ETR2**: Promontorio di Piombino, Fosso del Pino (province of Livorno, Italy), UTM: 32TPN2160, G. Manganelli & L. Manganelli leg. 6.12.2015 (FGC 44905); **ETR3**: Tuscan Archipelago, Giglio: Il Franco (province of Grosseto, Italy), UTM: 32TPM59, L. Favilli & G. Manganelli leg. 21.2.1990 (FGC 5015).

Hypnophila incerta Bourguignat, 1858 – **INC1**: Aeolian Archipelago, Stromboli Island, Ginostra (province of Messina, Italy), UTM: 33SWC1693, F. Giusti leg. 3.11.1969 (FGC 11005).

Hypnophila malagana Gittenberger, 1983 – **MAL1**: Mountains west of Terremolinos (province of Malaga, Spain), UTM: 30SUF65, J. De Winter leg. 1.1.1983 (ML Mollusca 56253/23).

Hypnophila zirjensis n. sp. – **DALM1**: Šibenik Archipelago, Žirje Island, Gradina (pit), Gradina (area) (Croatia), 33TWJ53, B. Jalžić leg. 1.6.2007; **DALM2**: Šibenik Archipelago, Žirje Island, Gradina (pit), Gradina (area) (Croatia), UTM: 33TWJ53, B. Jalžić leg. 10.2004 (CNHM 10919).

APPENDIX 2 SPECIES OF *HYPNOPHILA* FROM BALKAN PENINSULA

Hypnophila cyclothyra (Boettger, 1885)

Cochlicopa (*Hypnophila*) *cyclothyra* Boettger, 1885: 121.

Type locality – Greece: Peloponnese, Santomeri (verbatim: “Santameri Achaiae”).

Main references – Shell: Pilsbry (1908), Zilch (1962), Gittenberger (1993), Welter-Schultes (2012). Anatomy: unknown.

Distribution – Greece (Gittenberger, 1993; Welter-Schultes, 2012).

Status – A very little known species, still unknown anatomically. A revision of Balkan species is desirable in order to better define their relationships and distribution.

Hypnophila polita (Porro, 1838)

Bulimus politus Porro, 1838: 54, Pl. 2, fig. 8c [shell].

Type locality – Greece: Ionian Islands, Corfù, coastal rocks south of Ermones, after the neotype designation (Gittenberger, 1993) (originally “Grecia”).

Main references – Shell: Pilsbry (1908), Gittenberger (1993), Welter-Schultes (2012). Anatomy: unknown.

Distribution – North western Greece and Greek islands (Gittenberger, 1993; Welter-Schultes, 2012).

Status – A very little known species, still unknown anatomically.

Hypnophila pupaeformis (Cantraine, 1835)

Bulimus pupaeformis Cantraine 1835: 380.

Type locality – Croatia: Zadar. Originally Zadar (as “Zara”) and Split (as “Spalato”), but after lectotype designation restricted to Zadar (Gittenberger, 1993).

Main references – Shell: Bourguignat (1858, 1860), Kobelt (1894), Pilsbry (1908), Gittenberger (1993), Schileyko (1998), Dhora & Welter-Schultes (1996), Welter-Schultes (2012). Anatomy: Giusti & Manganelli (unpublished data).

Distribution – Balkan Peninsula from Croatia to Albania (Gittenberger, 1993; Dhora & Welter-Schultes, 1996; Welter-Schultes, 2012).

Status – Type species of *Hypnophila*. A little known species, under revision by Giusti & Manganelli (in preparation). It includes *Achatina dentiens* Rossmässler, 1839 (Zilch, 1962; Gittenberger, 1993) as junior synonym.

Hypnophila zacynthia (Roth, 1855)

Azeca zacynthia Roth, 1855: 39, Pl. 1, Figs 10–11 [shell].

Type locality – Greece: Ionian Islands, Zakynthos (verbatim “unicum tantum specimen abstuli de littore insulae Zacynthi”).

Main references – Shell: Roth (1855), Bourguignat (1858, 1860), Kobelt (1894), Gittenberger (1993), Welter-Schultes (2012). Anatomy: Giusti & Manganelli (unpublished data).

Distribution – North western Greece and Greek islands (Gittenberger, 1993; Welter-Schultes, 2012).

Status – A very little known species. It includes *Azeca integra* Mousson, 1859 (Gittenberger, 1993) as junior synonym.

APPENDIX 3 SPECIES OF *HYPNOPHILA* FROM WESTERN MEDITERRANEAN

Hypnophila bisacchii Giusti, 1970

Hypnophila bisacchii Giusti, 1970: 68–71, Figs 1, 4F [shell], Fig. 2B [genitalia], Fig. 3 [radula and jaw].

Type locality – Italy: Sardinia, near Cala Gonone (verbatim: “presso Cala Gonone dopo Dorgali”).

Main references – Shell: Giusti (1970), Bodon *et al.* (2010), Welter-Schultes (2012). Anatomy: Giusti (1970), Giusti & Manganelli (unpublished data).

Distribution – Sardinia (Giusti & Manganelli, 1984; Manganelli *et al.*, 1995; Welter-Schultes, 2012).

Status – One of the most distinguished species of *Hypnophila* due to its distinctive ovoid-fusiform shell shape.

Hypnophila boissii (Dupuy, 1851)

Zua Boissii Dupuy, 1851: 332–333, Pl. 15, fig. 9 [shell].

Type locality – France: French Pyrenees (verbatim: “Pyrénées françaises”).

Main references – Shell: Kobelt (1894), Pilsbry (1908), Germain (1930), Giusti (1976), Kerney (1980, 1983), Gittenberger (1983), Gómez & Angulo (1987), Schileyko (1998), Gómez (1990), Kerney & Cameron (1999), Welter-Schultes (2012). Anatomy: Gómez (1990), Giusti & Manganelli (unpublished data).

Distribution – North eastern Spain and south western France (Gittenberger, 1983; Kerney & Cameron, 1999; Welter-Schultes, 2012).

Status – Type species of *Gomphroa*. It most often lacks the angular tubercle and has a very small penis, possibly without penial papilla (the small size of penis makes it difficult to ascertain). Taxonomic setting of French populations under revision by M. Bodon (Genova, Italy).

Hypnophila cylindracea (Calcara, 1840)

B[ulimus]. cylindraceus Calcara, 1840: 33.

Type locality – Italy: Sicily, Palermo, near the bridge of Corleone (verbatim: “... vicino al Ponte di Corleone”).

Main references – Shell: Bourguignat (1858, 1860), Benoit (1857–62), Kobelt (1894), Pilsbry (1908), Liberto *et al.* (2010), Welter-Schultes (2012), Reitano *et al.* (2012). Anatomy: Giusti & Manganelli (unpublished data).

Distribution – Sicily (Giusti & Manganelli, 1984; Manganelli *et al.*, 1995; Welter-Schultes, 2012).

Status – A little known species described from north western Sicily. A revision of Sicilian species is desirable in order to define relationships between island and mainland species and the status of taxa sometimes included in *Hypnophila* (e.g. *Achatina nebrodensis* Benoit, 1862 and *Azeca silvicula* Benoit, 1882).

Hypnophila dohrni (Paulucci, 1882)

Azeca dohrni Paulucci, 1882: 271, 379, Pl. 8, fig. 1 [shell].

Type locality – Italy: Sardinia, near Sassari (verbatim: “prope urbem Sassari”).

Main references – Shell: Kobelt (1894), Pilsbry (1908), Giusti (1968, 1970, 1976), Welter-Schultes (2012). Anatomy: Giusti (1968, 1976), Giusti & Manganelli (unpublished data).

Distribution – Sardinia and perhaps Corsica (Giusti & Manganelli, 1984; Manganelli *et al.*, 1995; Welter-Schultes, 2012).

Status – Hitherto considered to include Tuscan *Hypnophila etrusca* as a junior synonym. Actually the two differ by virtue of different penis size. *Hypnophila dohrni* apparently shares small penis size with the Corsican *Hypnophila remyi* (Giusti & Manganelli, unpublished data).

Hypnophila emiliana Bourguignat, 1858

Hypnophila (Azeca) emiliana Bourguignat, 1858: 531, Pl. 18, Figs 1–3 [shell].

Type locality – Italy: Favignana Island, Grotta del Consiglio. Bourguignat (1858) credited the species to Benoit who claimed to know this species only from a cave (Grotta del Consiglio) on the island of Favignana (Benoit, 1862: 234). Thus this site may be plausibly regarded as the type locality (see also Benoit, 1876: 146, 1882: 82).

Main references – Shell: Benoit (1857–62), Bourguignat (1858, 1860), Kobelt (1894), Pilsbry (1908), Welter-Schultes (2012). Anatomy: Giusti & Manganelli (unpublished data).

Distribution – Egadi Islands (Giusti & Manganelli, 1984; Manganelli *et al.*, 1995; Welter-Schultes, 2012).

Status – A little known species described from the island of Favignana and regarded to be endemic to the Egadi Archipelago.

Hypnophila etrusca (Paulucci, 1886)

Azeca etrusca Paulucci, 1886: 36–37, Pl. 2, fig. 5 [shell].

Type locality – Italy, Tuscany: Promontorio dell'Argentario (verbatim: *su tutto il territorio del monte Argentaro*). Paulucci (1886) reported four sites (Grotta di Santa Liberata; road to Telegrafo above Convento dei Passionisti; above Calagrande; Fonte dell'Appetito near Santo Stefano).

Main references – Shell: Kobelt (1894), Pilsbry (1908), Giusti (1968, 1970, 1976), Meluzzi (1980), Welter-Schultes (2012), Manganelli *et al.* (2015). Anatomy: Giusti (1968, 1976), Giusti & Manganelli (unpublished data).

Distribution – Tuscan Archipelago and Tuscan coast (Giusti & Manganelli, 1984; Manganelli *et al.*, 1995, 2015; Welter-Schultes, 2012).

Status – Until recently regarded to be a junior synonym of Sardinian *Hypnophila dohrni*, but the two differ by virtue of different penis size.

Some island populations apparently differ by virtue of shell shape and size and anatomical details (Giusti & Manganelli, unpublished data).

Hypnophila girottii Esu, 1978

Hypnophila girottii Esu, 1978: 16–17, Figs 10–12 [shell].

Type locality – Italy, Sardinia: Casteddu Su Nuraghe, Plio-Pleistocene fluvio-lacustrine formation.

Main references – Shell: Esu (1978), Welter-Schultes (2012). Anatomy: Giusti & Manganelli (unpublished data).

Distribution – Sardinia (Giusti & Manganelli, 1984; Manganelli *et al.*, 1995; Welter-Schultes, 2012).

Status – A little known species first described as Plio-Pleistocene fossil and then found as live specimens (Manganelli *et al.*, 1995). A revision of its taxonomic status and systematic relationships is underway by Giusti & Manganelli (in preparation).

Hypnophila incerta Bourguignat, 1858

Hypnophila (Azeca) incerta Bourguignat, 1858: 531, 108, Pl. 18, Figs 15–17 [shell].

Type locality – Italy, Sicily: Lipari Island, Renella. Bourguignat (1858) credited the species to Benoit who stated that it occurred on the island of Lipari in a site named Renella or Monte della Fossa (Benoit, 1862: 232).

Main references – Shell: Benoit (1857–62), Bourguignat (1858, 1860), Kobelt (1894), Pilsbry (1908), Welter-Schultes (2012). Anatomy: Giusti (1970, 1973), Giusti & Manganelli (unpublished data).

Distribution – Aeolian Archipelago (Giusti & Manganelli, 1984; Manganelli *et al.*, 1995; Welter-Schultes, 2012).

Status – A little known species described from the island of Lipari and regarded to be endemic to the Aeolian Archipelago.

Hypnophila malagana Gittenberger, 1983

Hypnophila malagana Gittenberger, 1983: 301, 304–307, Fig. 2 (distribution), Fig. 3 [shell].

Type locality – Spain: San Pedro de Alcántara, along the road C339 to Ronda.

Main references – Shell: Gittenberger (1983), Gómez (1990), Welter-Schultes (2012). Anatomy: Gómez (1990).

Distribution – South eastern Spain and Morocco (Gittenberger, 1983; Seddon & Holyoak, 1990).

Status – A somewhat particular species due to its distinctive elongated slender fusiform shell shape (it has more whorls than other *Hypnophila* species).

***Hypnophila maroccana* (Mousson, 1873)**

Cionella (Azeca) maroccana Mousson, 1873: 154.

Type locality – Morocco: according to Gittenberger (1983) most probably Gorges de Moulay Brahim (verbatim: “Travertin des Rerayathales”).

Main references – Pilsbry (1908), Gittenberger (1983).

Status – Only known from the original description based on a single damaged shell. It is uncertain whether it is an extant, subfossil or fossil species.

***Hypnophila psathyrolena* Bourguignat, 1858**

Hypnophila (Azeca) psathyrolena Bourguignat, 1858: 531, Pl. 18, Figs 10–12 [shell].

Type locality – Algeria: Edough (verbatim: “... la forêt d’Edough, à peu distance de la Calle en Algérie”).

Main references – Bourguignat (1858, 1860, 1864), Kobelt (1894), Pilsbry (1908).

Distribution – North western Africa (Giusti & Manganelli, 1984).

Status – Only known from original description and other late nineteenth and early twentieth century contributions. Regarded as endemic to Algerian North Africa.

***Hypnophila remyi* (Boettger, 1949)**

Azeca (Hypnophila) remyi Boettger, 1949: 167–168, Figs 1–2 [shell].

Type locality – France: Corsica, Grotte d’i Paladini (municipality of Solaro) (verbatim ...

“*Ins. Corsica: Grotta di Paladini, Comune di Solaro* ...).

Main references – Shell: Boettger (1949), Giusti (1976). Anatomy: Giusti & Manganelli (unpublished data).

Distribution – Corsica (Giusti & Manganelli, 1984; Manganelli *et al.*, 1995; Welter-Schultes, 2012).

Status – A little known species described from north eastern Corsica. It apparently shares small penis size with Sardinian *Hypnophila dohrni* (Giusti & Manganelli, unpublished data).

APPENDIX 4 SICILIAN SPECIES SOMETIMES INCLUDED IN *HYPNOPHILA* PENDING TAXONOMIC REVISION

? *Hypnophila nebrodensis* (Benoit, 1862)

Achatina nebrodensis Benoit, 1862: 235, Pl. 10, fig. 6.

Type locality – Italy: Sicily, Madonie Mountains (verbatim: “trovasi ... su le Madonie...”).

Status – Uncertain, because only a short description is available and Pl. 10 was never published. Since its description, Benoit (1862) placed it in *Ferussacia*, stating that it was intermediate between this genus and *Azeca* (i.e. *Hypnophila*). Regarded as a species of *Ferussacia* by Westerlund (1887), Pilsbry (1908) and Alzona (1971) and a species of *Hypnophila* by Giusti & Manganelli (1984) and Liberto *et al.* (2010).

? *Hypnophila silvicula* (Benoit, 1882)

Azeca silvicula Benoit, 1882: 82–83.

Type locality – Italy: Sicily, Madonie mountains (verbatim: “dalle Madonie”).

Status – Regarded as a distinct species of *Hypnophila* by Westerlund (1887), Pilsbry (1908) and as an uncertain species of *Hypnophila* by Alzona (1971).