

# RECORDS OF *XEROCRASSA MUEHLFELDTIANA* (ROSSMÄSSLER 1837) REFER TO *X. RHABDOTA* (STURANY 1901): REDESCRIPTION OF THE SPECIES AND DETAILED ANATOMICAL DESCRIPTION OF OTHER BALKAN *XEROCRASSA* SPECIES (GASTROPODA: PULMONATA: HYGROMIIDAE)

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**Abstract** The hygromiid land snail *Xerocrassa muehlfeldtiana* (Rossmässler 1837) was reported from several localities in the western Balkans by previous authors. Evaluation of the taxonomic history of Rossmässler's name revealed that it is a junior synonym of *Helicopsis striata* (O. F. Müller 1774), which therefore cannot be applied to populations from the Balkans. There is, however, an available and geographically appropriate name for that species: *Xerocrassa rhabdota* (Sturany 1901). In this paper, we redescribe the shell and anatomy of *X. rhabdota* based on newly collected material from Slovenia, Croatia and Bosnia-Herzegovina. Additionally, we compare the anatomy and shell of *X. rhabdota* with the type species of the genus (*X. seetzeni* (L. Pfeiffer 1847)), and the three congeners known from the central and the continental part of southeastern Europe (Balkan Peninsula), namely *Xerocrassa geyeri* (Soós, 1926), *Xerocrassa cretica* (L. Pfeiffer, 1841) and *Xerocrassa poecilodoma* (O. Boettger, 1894).

**Key words** drought tolerant land snail species, anatomy, taxonomy, nomenclature, Balkans

## INTRODUCTION

Arid, open areas such as shrublands, rocky beaches, grassy slopes and sand dunes are characteristic habitats of the Mediterranean Region. Only a few families of land snails are adapted to such dry, exposed conditions. These species are characterised by long periods of inactivity when water is short or not available. Several genera of the family Hygromiidae include drought tolerant species that primarily occur in these habitats. These snails all look rather alike, having flat or globose shells that are pale in colour in order to reflect sunlight. Moreover, the shells are very simple, they lack denticles or lamellae within the aperture. As a result of this parallel evolution, the generic subdivision of these snails is based solely on the anatomy of the reproductive system, and most species can only be correctly identified using characters related to genital anatomy. Human transportation has resulted in several species being accidentally introduced to new areas within Europe, or even to other continents (e.g. Puente, 1995; Aubry *et al.*, 2005; Baker, 2008). Moreover, several species of drought tolerant hygromiids have been reported as intermediate hosts of

agriculturally important parasites (Anderson, 2000; Rommel *et al.*, 2000). Therefore, in order to get exact information about their distribution, the spread or declining of populations and to reveal evolutionary relationships, all taxa have to be anatomically examined and the taxonomic position of questionable species has to be clarified.

One such questionable species was reported under the name *Xerocrassa muehlfeldtiana* from the western Balkans by several authors. *Helix candidula* var. *Muehlfeldtiana* Rossmässler 1837 was originally described from "der Türkenschanze bei Wien" (=the present day Türkenschanzpark in Vienna, Austria, 48°14.146'N, 16°20.086'E). Rossmässler's (1837) description is very short and lacks any accompanying figures. Rossmässler's collection is housed in the Senckenberg Museum, Germany (see Dance, 1986), but the type material of *Helix candidula* var. *Muehlfeldtiana* was not found during a recent search (Ronald Janssen pers. comm. January 2014). Rossmässler (1837: 26) did not introduced *Muehlfeldtiana* "Ziegler" as a valid name but in the synonymy of *Glischrus candidula* Studer 1820 (non *Helix candidula* Michaud, 1831, *incertae sedis*, described for the southern France), which is a junior synonym of *Helix unifasciata* Poiret 1801, now *Candidula unifasciata* (cfr. Forcart

1957). Nevertheless, the name became available with Rossmässler (1837) as author because it was adopted as the name of a taxon by Westerlund (1889) (Art. 11.6.1. ICZN). It is worth noting that Westerlund (1889: 253) also considered “var. *Mühhfeldtiana* Z.” as a form of “*Helix apicina* Lam.” (= *Xerotracha apicina* (Lamarck 1822)). Westerlund’s view has been recently recalled by Štamol (2010), who has pointed out the difficulties in distinguishing between the two species based on shell characters. To our knowledge, the first author who combined Rossmässler’s name with the genus *Xerocrassa* Monterosato 1892 was Jaekel (1954: 72). Jaekel probably based his results upon anatomy, even if he did not say so explicitly himself. In more recent times, this generic allocation has been maintained (Dhora, 2010; Štamol, 2010; Bank, 2011; Welter-Schultes, 2012).

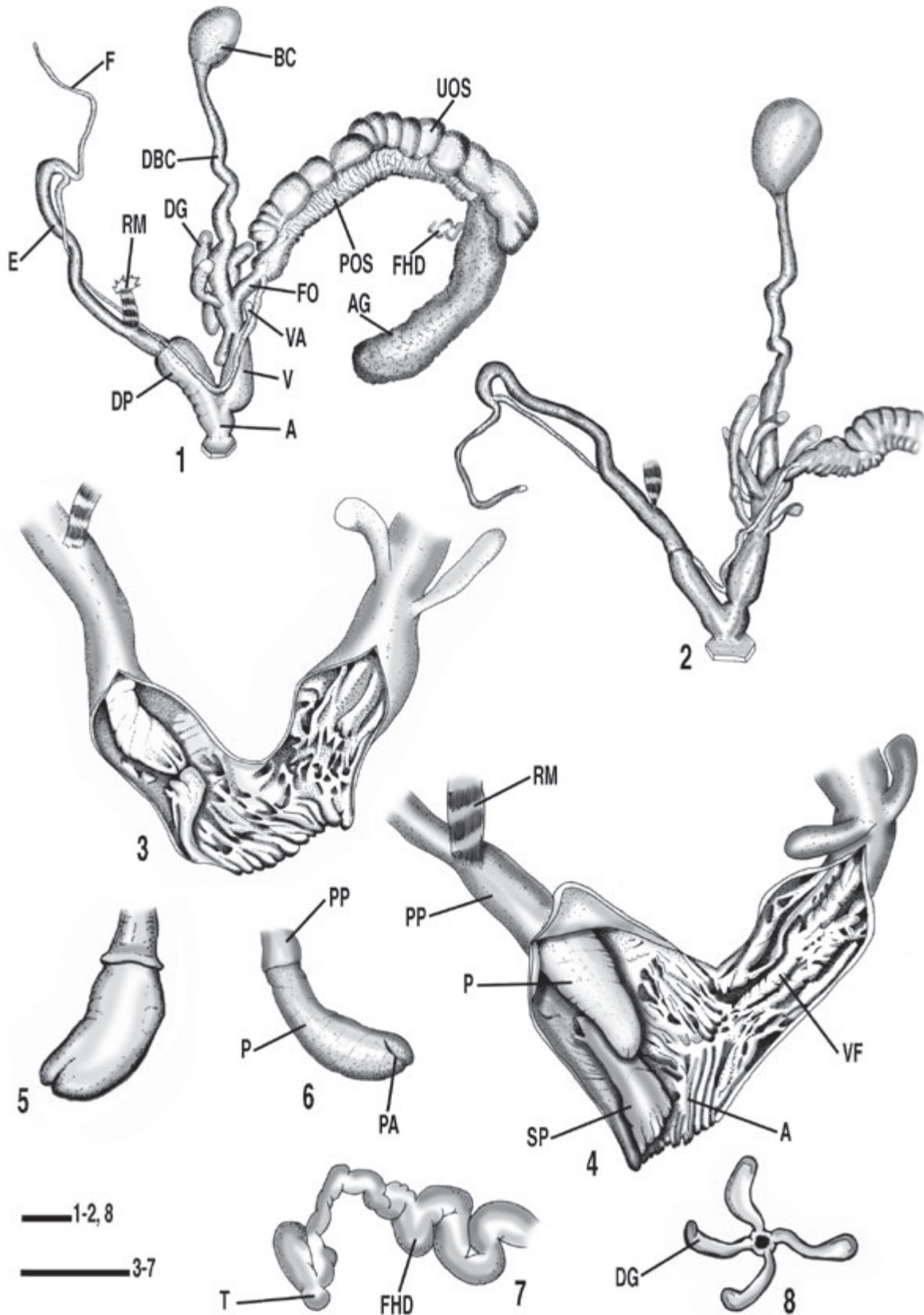
The first authors to introduce the name “*mühhfeldtiana*” (though correctly Latinised it would be *muehhfeldtiana*) for populations in the Balkans were Fuchs and Käufel (1936), who reported a small and globose, whitish hygromiid from the Island of Krk (Veli Vrh). The reasons for the choice of this name remain unclear. Jaekel (1954: 72) received some shells from “Mr. Schmidt” from Krizpolije (Velesbit, Croatia) with this name attached following the nomenclature of Fuchs and Käufel (1936). And that name has stuck; all subsequent authors have used it uncritically.

Von Proschwitz and Neubert (2011) considered *Xerocrassa muehhfeldtiana* as a junior synonym of *Helicopsis striata* (O. F. Müller 1774), and mentioned that records of this taxon from localities on the Balkan peninsula should be referred to *H. striata* or other species. Neubert (pers. comm. 2014 January) refers to a personal communication with Peter Reischütz, who stated that at the type locality (Türkenschanzpark, Vienna) only *Helicopsis striata* could be found, although that species had not been found there in the last ten years. Since the type locality (Türkenschanzpark, Vienna) is very exact and it is known to be (or at least to have been) inhabited only by *Helicopsis striata*, we also believe that *Helix mühhfeldtiana* Rossmässler, 1837 is a synonym of *Helicopsis striata* as actually suggested by von Proschwitz & Neubert (2011).

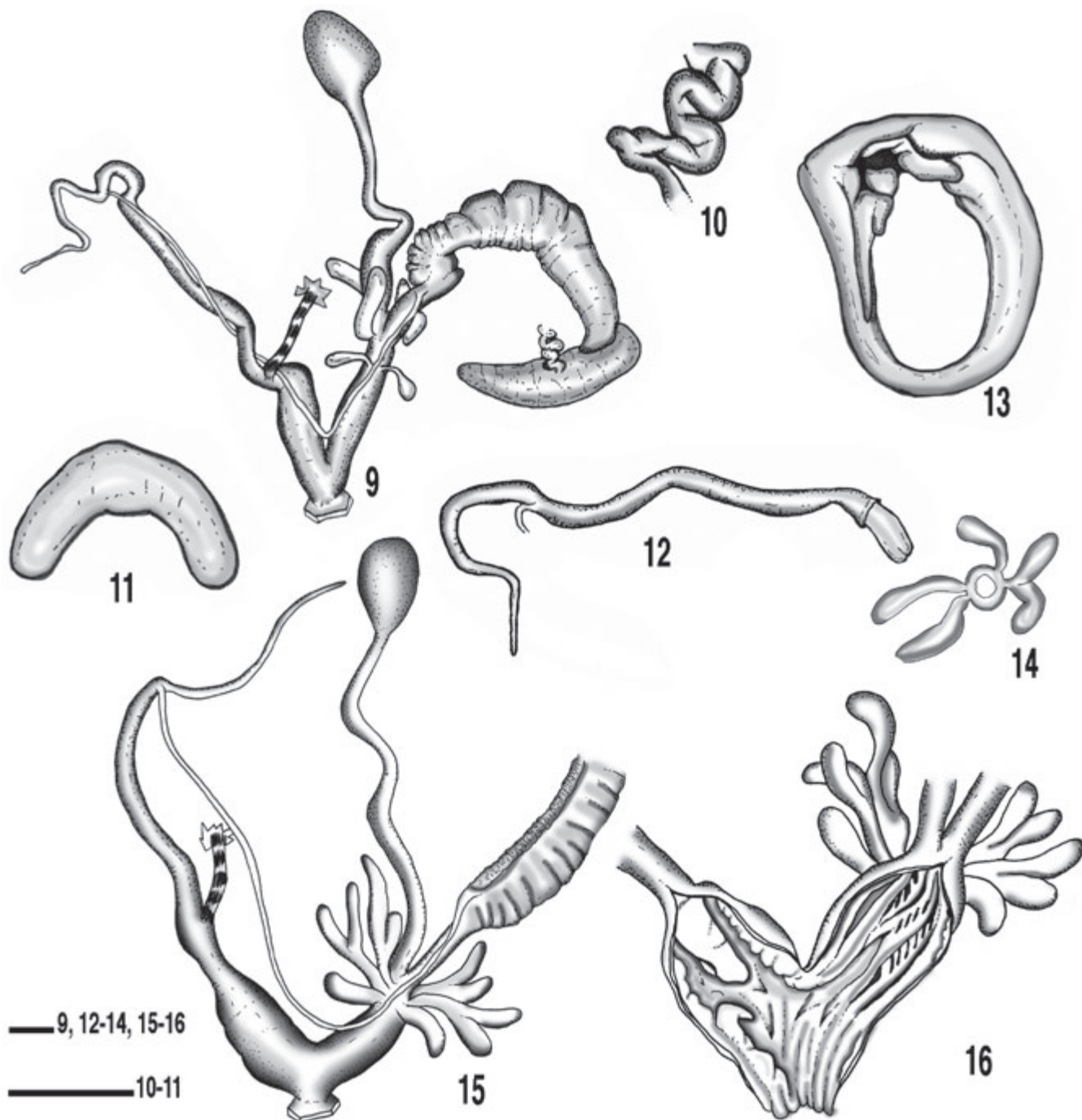
During a collecting-trip to Herzegovina we had the opportunity to collect some very small *Xerocrassa* specimens from a karst massif east of Mostar and 10 km south of Vidova-Prenj. Other

specimens with similar shell features were also collected along the Dinarids ridge. These specimens are seemingly identical with the taxon “*Xerocrassa muehhfeldtiana*” of previous authors. After a literature survey, we reached the conclusion that the description of *Xerophila rhabdota* by Sturany (1901) matched this species exactly. Moreover, we collected living specimens very close to Vidova-Prenj, one of the type localities for *X. rhabdota*. *Xerophila rhabdota* Sturany 1901 was described from two localities near Jablanica in Bosnia-Herzegovina: Plasa [sic! =Plava] massif and Vidova-Prenj massif. Jaekel (1954: 72) reported some additional localities for this taxon (as *Helicella (Xerocrassa) muehhfeldtiana rhabdota*): western slopes of the Dinara massif, Livno; Plava and Vidova (Prenj) massif north of Mostar (BiH); Biokovo massif near Split; Velesbit massif near Karlobag (Croatia). Comparing Sturany’s type specimens of *Xerophila rhabdota* (NHMW 33571, Figs 28–29) with the ones we collected proved that they are conchologically identical. As regards the anatomy, all the individuals we collected that shared the same shell features revealed the same genital anatomy, proving that we are dealing with only a single taxon, *Xerocrassa rhabdota*. Probably all the previous records of *X. muehhfeldtiana* refer to *X. rhabdota*. The International Union for the Conservation of Nature report on *Helicopsis striata* (see von Proschwitz & Neubert, 2011) listed *Xerocrassa rhabdota* as a junior synonym of *Helicopsis striata*. The shell characters of Sturany’s type specimens and *H. striata* show, however, some differences (Figs 28, 40). Namely, *H. striata* has a narrower umbilicus, a remarkably ribbed shell, and a flatter spire. In addition, the genital morphology is substantially different (Schileyko, 2005: 1946 and 2014).

The genital features of Central European and the Balkans specimens investigated by us match the description given by Hausdorf and Sauer (2009), who recently redefined the genus *Xerocrassa*. The other Balkan (mainland) species of *Xerocrassa s.l.* are: *X. (X.) cretica* (L. Pfeiffer, 1841) and *X. (X.) poecilodoma* (O. Boettger, 1894) while the Central European species is *X. (X.) geyeri* (Soós, 1926). In the following account, we provide a detailed redescription of *X. rhabdota* and compare it with newly-collected material of *X. geyeri* from Italian Alps, *X. cretica* from Athens, *X. poecilodoma* from Antikithyra and *X. seetzeni* (Pfeiffer) (the type species of the genus) from Israel.



**Figures 1–8** *Xerocrassa rhabdota* genitalia: 1 entire genitalia, excluding Gonad; 3 details of distal genitalia; 5 penial papilla; 7 distal portion of first hermaphrodite duct with talon; 8 digitiform glands from Povratok (Preanj massif, Mostar). 2 distal genitalia; 4 details of distal genitalia and 6 penial papilla from Veli Vrh (Baška, Island of Krk).

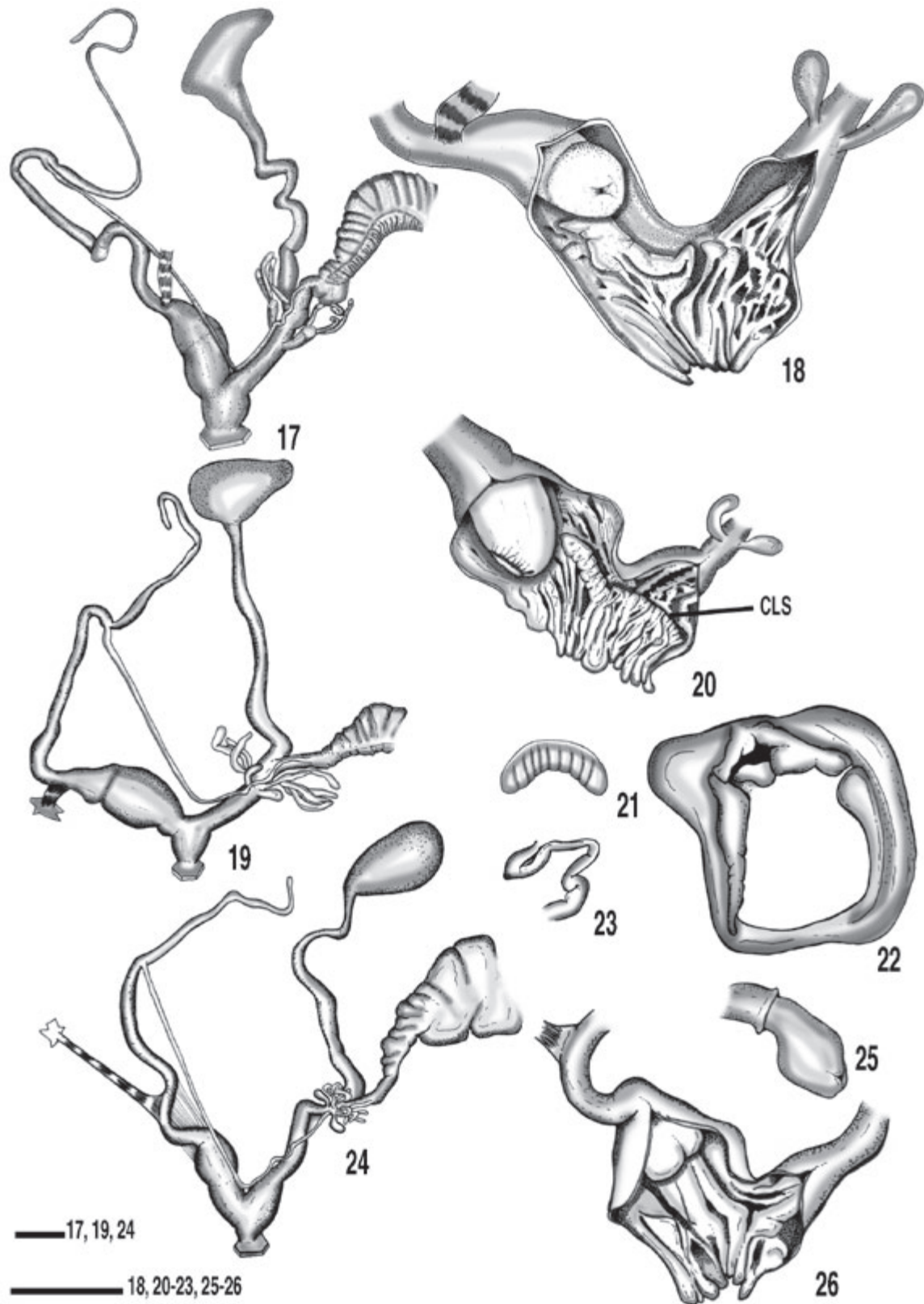


**Figures 9–16** *Xerocrassa rhabdota*: genitalia, jaw and mantle edge: **9** genitalia, excluding gonad and **13** mantle edge from Baške Oštarije (Karlobag, Croatia). **10** distal portion of first hermaphrodite duct with talon and **14** digitiform glands from Veli Vrh (Baška, Island of Krk). **11** jaw and **12** penial papilla-epiphallus complex from Povratak (Prenj massif, Mostar). *Xerocrassa geyeri*: **15** genitalia excluding gonad and **16** details of distal genitalia from Champlas Seguin (Cesana Torinese).

#### MATERIAL AND METHODS

The localities from which material of *Xerocrassa rhabdota* was studied are listed under the species subheading below. The collection data for the other species are as follows: *Xerocrassa*

*geyeri* – Champlas Seguin, Cesana Torinese (Piemonte, Italy), 44°56'36.85"N 6°49'24.83"E, 1760 m asl., I. Niero leg, 27.vii.2010, 2 dissected specimens (abbreviated to dsp henceforth); *Xerocrassa cretica* – Philopappou Hill (Athens,



**Figures 17–26** *Xerocrassa* spp. 17–18 *Xerocrassa cretica* from Philopappo Hill (Athens, Greece): 17 distal genitalia and 18 details of distal genitalia. 19–23 *Xerocrassa poecilodoma* from Antikythira (Peloponnisos, Greece): 19 distal genitalia, 20 details of distal genitalia, 21 jaw, 22 mantle edge and 23 distal portion of first hermaphrodite duct with talon. 24–26 *Xerocrassa seetzeni* from Nahal Keveshim (Be'er Sheva, Israel): 24 distal genitalia, 26 details of distal genitalia and 25 penial papilla.

Greece), 37°58'8.38"N 23°43'12.75"E, 670 m asl, WDM & JM leg, 06.i.2003, 2 dsp; *Xerocrassa poecilodoma* – Xeropotamo, Antikythira (Peloponnisos, Greece), 35°53'9.13"N 23°17'42.83"E, 20 m asl, WDM & JM leg, 25.v.2006, 3 dsp; *Xerocrassa seetzeni* – Nahal Keveshim (Be'er Sheva, Israel), 31°15'22.06"N 34°47'7.06"E, 270 m asl, H. Mienis leg, 06.v.2010, 2 dsp; *Helicopsis striata* – Ternitz (Vienna, Austria), 47°42'48.13"N 16°0'53.98"E, 460 m asl, WDM & JM leg, 15.viii.1999.

The snails were killed in fresh water, then fixed in 75% ethanol. The body was removed from the shell and dissected under a Leica stereoscope. Anatomical details were drawn using a camera lucida. Empty shells were measured (n=20 for each population). The material is deposited in the collection of Willy De Mattia & Jessica Macor (WDM-JM), collection of Ivano Niero (IN) and in the Malacological Collection of the Natural History Museum of Vienna (NHMW). All scale bars in the anatomical plates are 1 mm. All scale bars in the shell plates are 1 cm. The abbreviation dsp indicates the number of dissected specimens.

**Abbreviations** The following abbreviations are used in the figures: **A** atrium; **AG** albumen gland; **ASD** average shell diameter; **ASH** average shell height; **BC** bursa copulatrix; **CLS** crest-like structure of the genital atrium; **D** shell diameter; **DBC** duct of the bursa copulatrix; **DG** digitiform glands; **DP** distal penis; **E** epiphallus; **F** flagellum; **FHD** first hermaphrodite duct; **FO** free oviduct; **H** shell height; **P** penial papilla; **PA** penial aperture; **POS** prostatic ovispermiduct; **PP** proximal penis; **RM** penial retractor muscle; **RSD** range-shell diameter; **RSH** range-shell height; **T** talon; **SP** sponge pilaster; **UOS** uterine ovispermiduct; **V** vagina; **VA** vaginal appendiculae; **VD** vas deferens; **VF** vaginal folds.

## SYSTEMATICS

Family Hygromiidae Tryon 1866

Genus *Xerocrassa* Monterosato 1882

Type species: *Helix seetzeni* L. Pfeiffer 1847 (by monotypy).

**Definition** (According to Hausdorf & Sauer, 2009) *Xerocrassa* is characterised by a symmetrical dart apparatus, consisting of two small accessory sacs and usually four branched glandulae mucosae around the vagina, irregular

longitudinal folds on the inner side of the wall of the vagina, and the lack of a well-developed appendix at the atrium. The penis is innervated from the right cerebral ganglion. The genital anatomy and the shell features of *Xerocrassa seetzeni* are depicted in Figs 24–26 and 38.

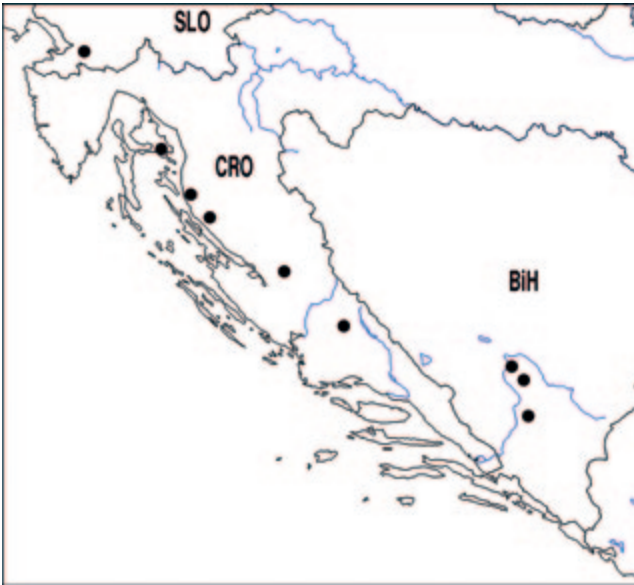
*Xerocrassa (Xerocrassa) rhabdota* (Sturany 1901)

(Figs 1–14, 28–35)

- Helicella muehlfeldtiana* Fuchs & Käufel 1936: 636.  
*Helicella (Xerocrassa) muehlfeldtiana* Jaekel 1954: 72.  
*Helicella muehlfeldtiana* Jaekel, Klemm & Meise 1957: 72.  
*Trochoidea muehlfeldtiana* Maier 1973: 371.  
*Candidula muehlfeldtiana* Reischütz 1982: 136.  
*Helicella muehlfeldtiana* Frank 1991: 356.  
*Xerocrassa muehlfeldtiana* Dhora & Welter-Schultes 1996: 155.  
*Xerocrassa muehlfeldtiana* Fehér & Eröss 2009: 35.  
*Xerocrassa (Xerocrassa) muehlfeldtiana muehlfeldtiana* Štamol 2010: 28.  
*Xerocrassa (Xerocrassa) muehlfeldtiana rhabdota* Štamol 2010: 28.  
*Xerocrassa muehlfeldtiana* Dhora 2010: 73.  
*Xerocrassa muehlfeldtiana* Welter-Schultes 2012: 525.  
*Xerocrassa (Xerocrassa) muehlfeldtiana* [?*rhabdota* Sturany 1922 (sic!: 1901)] (sic!) Bank 2011: 52.

**Type material** Plava bei Jablanica, leg. Penther, NHMW 33571 (syntype).

**Material examined** Vremščica (Auremiano) (Senožeče, Slovenia), 45°41'55.73"N 14°2'1.38"E, 855 m asl, WDM & JM leg, 26.iv.2009, 2 dsp; Veli Vrh, northern slopes (Baška, Island of Krk, Croatia), 45°0'45.17"N 14°40'29.52"E, 435 m asl, WDM & JM leg, 18.xii.2004, 12.xii.2008, 8 dsp; Vratnik pass (Senj, Croatia), 44°58'42.64"N 14°59'10.60"E, 700 m asl, WDM & JM leg, 16.x.1999, 2 dsp; Baške Oštarije (Karlobag, Croatia), 44°32'35.55"N 15°9'54.82"E, 1040 m asl, WDM & JM leg, 15.viii.2002, 2 dsp; Prezid pass (Gračac, Croatia), 44°14'58.68"N 15°48'37.79"E, 760 m asl, WDM & JM leg, 26.iv.2007, 4 dsp; Road Vrlika-Dernis, 1,1 km SSE of Vrlika (Vrlika, Croatia), 43°53'56.03"N 16°23'31.82"E, 630 m asl, WDM & JM leg, 24.iv.2004, 3 dsp; Povratak, Prenj masif (Mostar, Bosnia-Herzegovina), 43°29'40.27"N



**Figure 27** Geographical distribution of *Xerocrassa rhabdota*.

18°0'58.75"E, 1180 m asl, WDM & JM leg, 4.x.2011, 5 dsp; Podvelež (Mostar, Bosnia-Herzegovina), 43°20'10.14"N 17°52'56.98"E, 870 m asl, WDM & JM leg, 5.x.2011, 3 dsp.

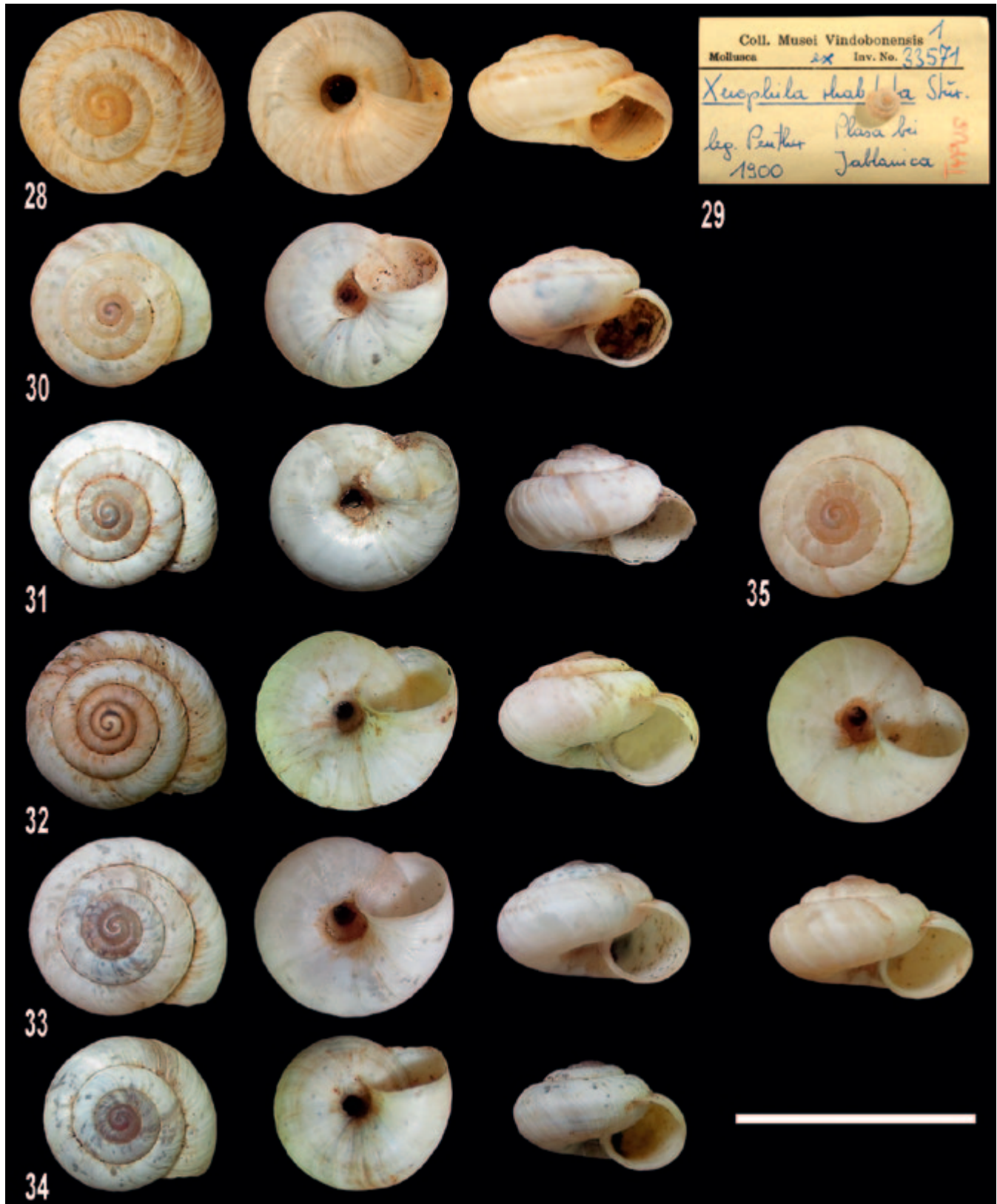
*Measurements* D:  $6.9 \pm 0.3$  mm (range 6.3–7.2 mm); H:  $4.7 \pm 0.2$  mm (range 4.5–5.0 mm) (n=20). Ratio D/H 1.4.

*Redescription* Shell (Figs 28–35) dextral, subglobose, hairless. Protoconch pale brown to brown. Teleoconch usually uniformly opaque white without any banding; infrequently with single delicate band on upper side of body whorl, fragmented into spots and segments. External, upper surface has variable sculpture with well-defined, irregularly-spaced growth lines. On last whorl these growth lines clearly visible from suture as far the umbilicus. Spire subglobose to somewhat conical, with 4.5 to 4.75, regularly increasing, rounded whorls separated by well-defined and deep suture. The protoconch consists of ca. 1 to 1.5 whorls. Body whorl large and rounded, more or less descending near aperture and contributing 0.80 total shell height. Umbilicus open but somewhat narrow, about 0.15 maximum shell diameter. The ratio D/H is 1.5. Aperture rounded, with weak thickening along inner side of body whorl. Peristome interrupted, simple and thin. Columellar margin reflected and somewhat thick.

*Body* Soft parts dark grey to black. Mantle border (Fig. 13) dark grey with 5 lobes. Right lateral lobe triangular with deep incision at half of its length; right dorsal lobe small and bean-like. Left dorsal lobe long and slender. Walls of pallial cavity grey, with darker spots, a strong pulmonary vein is visible. Jaw odontognathous, arched, smooth, with very faint cross lines (Fig. 11). Right ommatophore retractor passes between penis and vagina.

*Genital anatomy* (Figs 1–10 and 12, 14) General arrangement of reproductive system semidiaulic monotrematic. Convolutated first hermaphrodite duct arises from multilobed gonad and ends laterally in a talon (Figs 7 and 10). Albumen gland long and thin, and connected to wide ovispermiduct consisting of prostatic and uterine portions. Eventually, prostatic portion turns into thin vas deferens ending up in penial complex. Female portion of ovispermiduct joined distally to free oviduct and turns into vagina at level of duct of bursa copulatrix. Duct of bursa copulatrix usually wide, moderately long, and uniform in diameter. It ends in a variable bursa copulatrix which is oval to roundish. Four digitiform glands arise from proximal portion of vagina. These glands are short, cylindrical, with a moderately blunt apex and very rarely branched in 2 sections (Figs 8 and 14). 2 vaginal, digit-like appendiculae arise on same side of vagina. Appendiculae mark limit between proximal and distal vagina. Entire vagina 3–4 times longer than free oviduct. Inner walls of vagina with irregular longitudinal folds running from proximal portion as far aperture. Penis and vagina enter small genital atrium side by side. No other inner structure present except for folds. Atrium funnel-like, but never swollen, and its walls are thin.

Penial complex consisting of flagellum, epiphallus (which extends from insertion of vas deferens to penial papilla), and penis ending at atrium. Penial flagellum slender, gradually narrowing towards tip. Epiphallus is wide in diameter, twice to three times as long as flagellum (Fig. 12); its internal walls show 4 to 6 parallel, longitudinal, faint pleats which end at level of penial retractor. Penis, without any sheath, approximately 0.3 length of epiphallus; swollen, thick-walled and housing penial papilla. Penial papilla usually club-like, even if somewhat variable in shape with central duct (Figs 5–6). Apical opening



**Figures 28–35** shells of *Xerocrassa rhabdota*: **28** Plava massif (Jablanica, Mostar, Bosnia and Herzegovina), NHMW 33571 (syntype). **29** Original label (NHMW 33571). **30** from Povratak, Prenj massif (Mostar, Bosnia and Herzegovina). **31** from Podvelež (Mostar, Bosnia and Herzegovina). **32** from Veli Vrh, northern slopes (Baška, Island of Krk, Croatia). **33** Vratnik pass (Senj, Croatia). **34** from Road Vrlika-Dernis, 1.1 km SSE of Vrlika (Vrlika, Croatia). **35** from Vremščica (Auremiano) (Senožče, Slovenia).



**Table 1** Shell diagnostic features of *Xerocrassa* species.

	RSD; ASD mm (n=20)	RSH; ASH mm (n=20)	D/H	shell surface
<i>X. rhabdota</i>	6.3–7.2; 6.9±0.3	4.5–5.0; 4.7±0.4	1.4	opaque
<i>X. geyeri</i>	11.9–12.6; 12.4±0.2	8.1–9.2; 8.7±0.3	1.4	waxy
<i>X. cretica</i>	16.6–18.9; 17.5±0.4	12.8–17.1; 14.1±1.1	1.2	waxy
<i>X. poecilodoma</i>	10.9–12.5; 11.5±0.7	6.8–8.9; 7.6±0.9	1.6	waxy
<i>X. seetzeni</i>	18.7–22.0; 20.4±1.1	16.9–20.1; 18.1±1.2	1.1	waxy

slit-like, space between duct and external penial papilla filled with tissue. Large spongy pleat on inner side of distal penis wall, starting from base of penial papilla, and partially overrunning into genital atrium. Atrium small, funnel-like.

**Habitat** *Xerocrassa rhabdota* is strictly confined to limestone substrata. It exists in scattered populations on mountain peaks, in open fields and orophilous garrigue, xeric environments, from 400 m up to 1600 m asl.

**Geographic range** *Xerocrassa rhabdota* is endemic to the Dinarid Alps. It is present from the northern boundary of the ridge (Vremščica, Slovenia) as far as the massifs surrounding Mostar (Bosnia-Herzegovina) (Fig. 27) (Fuchs & Käufel, 1936; Jackel, 1954; Jaeckel *et al.*, 1957; Maier, 1973; Reischütz, 1982; Frank, 1991; Štamol, 2010; Bank, 2011; Welter-Schultes, 2012). The presence of *X. rhabdota* along the southern boundary of the Dinarids (Montenegro and Albania) has still to be properly verified (Dhora & Welter-Schultes, 1996; Fehér & Erőss, 2009; Dhora, 2010; Bank, 2011).

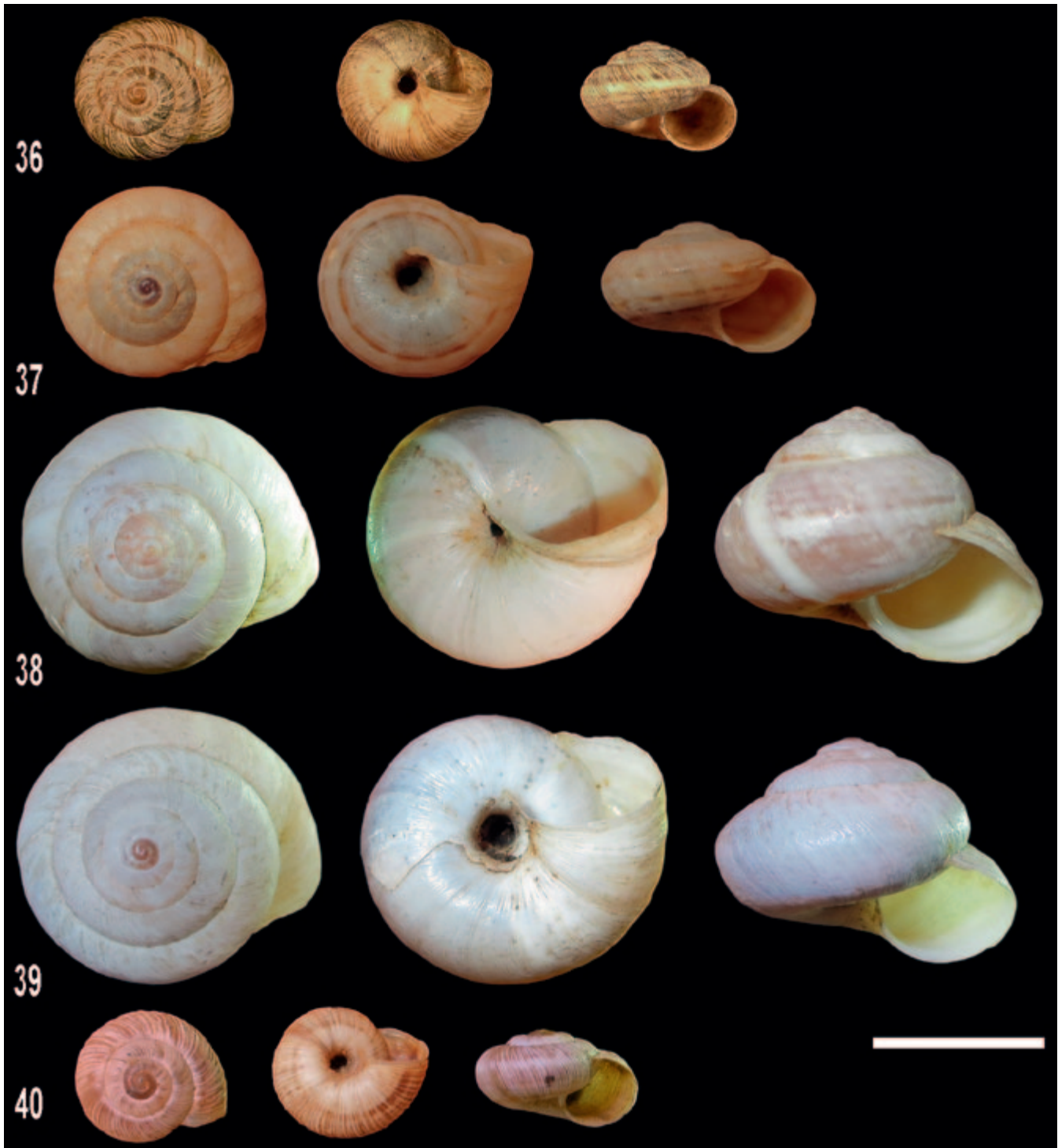
**Comparisons** See under Discussion.

## DISCUSSION

To date, only two species of *Xerocrassa* were known from the continental part of south-eastern Europe (Balkan Peninsula): *X. (X.) poecilodoma* and *X. (X.) cretica*. The former is believed to be endemic to the island of Antikythira (Peloponnisos), even though there is very little is known about the hygromiid fauna of that area (Boettger, 1894; Gittenberger & Goodfriend, 1993). The latter has a wide distribution: Aegean Islands, Greek mainland (Attiki), the west coast of Turkey, Cyprus, Libya, and Egypt (Brandt, 1959; Hausdorf & Sauer, 2009), although further studies are required to define its actual range (cf. Vardinoyannis & Triantis, 2011).

*Xerocrassa rhabdota* is easily distinguished from the other south-eastern European *Xerocrassa* species, both anatomically and conchologically. Conchologically (Tab. 2), its small dimensions and its uniformly opaque whitish surface enable it to be readily differentiated. *Xerocrassa cretica* (Fig. 39) and *X. seetzeni* (Fig. 38) both have substantially larger shells with a more conical shape and a uniformly whitish and waxy surface. *Xerocrassa poecilodoma* (Fig. 37) has a medium-sized, subglobose to depressed shell that is usually brownish with three discontinuous brown bands. Anatomically, *X. rhabdota* is easily distinguished by virtue of its short flagellum and the long epiphallus, its short and blunt vaginal glands, and its smooth jaw. The major anatomical differences with the other species are as follows (and also in Table 2). *Xerocrassa cretica* (Figs 17–18) has the flagellum longer than the epiphallus and a ribbed jaw, whilst *X. seetzeni* has a very long vagina (Fig. 24). *Xerocrassa poecilodoma* shows some very peculiar features with respect of the inner structure of distal genitalia. The spongy pilaster in the distal penis is absent, while a crest-like structure (Fig. 20) is well developed in the atrium. Due to the numerous taxonomic and anatomical uncertainties of some *Xerocrassa* species we prefer not to consider in depth the phylogenetic significance of such anatomical features in *X. poecilodoma*. A completely new approach is needed to define this group, as has already been undertaken by Hausdorf and Sauer (2009) for the island of Crete.

Bank (2011) cited *Xerocrassa geyeri* (Soós 1926) from northern alpine Slovenia. This species is distributed mainly in central-western Europe, but has a scattered occurrence from the island of Gotland to north-eastern Spain. Apart from Slovenia, it is thought to be native in Belgium, France, Germany, Spain and Sweden (Falkner *et al.*, 2011; Gittenberger, 1993: 307). However, recent data are lacking for most countries. The



**Figures 36–40** shells of *Xerocrassa* and *Helicopsis* spp. **36** *X. geyeri* from Champlas Seguin, Cesana Torinese (Piemonte, Italy). **37** *X. poecilodoma* from Xeropotamo, Antikythira (Peloponnisos, Greece). **38** *X. seetzeni* from Nahal Keveshim (Be’er Sheva, Israel). **39** *X. cretica* from Philopappou Hill (Athens, Greece). **40** *H. striata* from Ternitz (Vienna, Austria).

available literature is often unreliable as *X. geyeri* can be easily confused with conchologically similar species and an accurate anatomical approach is essential for a correct identification

(Gittenberger, 1993). As a result, the Slovenian data for this species still need confirmation.

No substantial differences are to be found between the shells of *X. geyeri* and *X. rhabdota*.

**Table 2** Anatomical diagnostic features of *Xerocrassa* species. CLS crest-like structure, DP distal penis, E epiphallus, F flagellum, FO free oviduct, SP sponge pilaster, V vagina.

	F/E	E/DP	SP	V/FO	CLS in atrium	jaw
<i>X. rhabdota</i>	0.4	4	SP	3	no CLS	smooth
<i>X. geyeri</i>	1	1.7	SP	1.3	no CLS	ribbed
<i>X. cretica</i>	1.3	3	SP	2.5	no CLS	ribbed
<i>X. poecilodoma</i>	0.8	3	no SP	3	CLS	ribbed
<i>X. seetzeni</i>	1	2.5	SP	4.5	no CLS	ribbed

The first species has more ribbed whorls and a narrower umbilicus. It is usually bigger (see. Tab. 1), brownish in colour with three almost continuous dark bands (Fig. 36). The genital morphology is slightly different and allows an easy separation. Amongst others, the main features to be considered as regards *X. geyeri* are the shorter epiphallus and the longer flagellum. The vaginal appendiculae arise immediately at the base of the digitiform glands. These glands are usually branched and longer than in *X. rhabdota* (Figs 15 and 16).

There are several other hygromiids occurring in the same region as *X. rhabdota* which are more or less similar conchologically, namely *Trochoidea pyramidata* (Draparnaud 1805), *Trochoidea trochoides* (Poiret 1789), *Xeropicta derbentina* (Krynicky 1836), *Xerotricha apicina* (Lamarck 1822), *Xerotricha conspurcata* (Draparnaud 1801), *Candidula unifasciata* (Poiret 1801), *Cerņuella virgata* (Da Costa 1778), *Cerņuella neglecta* (Draparnaud 1805) and *Xerolenta obvia* (Menke 1828) (Bank, 2011). Most of these taxa can be separated from *X. rhabdota* based on shell characters with experience, however they are all clearly distinguishable in terms of genital anatomy (see Schileyko, 2005).

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