New stygobiont genus and new species (Gastropoda, Hydrobiidae) from the Rif (Morocco)

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Abstract
Stygobiont valvatoid hydrobiids living in the groundwater were collected from a survey in the wells in the Rif region, in northern Morocco. The description of the shells, the male and the female genitalia revealed a character combination for a new genus, Rifia n.gen. The map of the distribution is given.

Key words: Morocco, groundwater, Gastropoda, Hydrobiidae, new genus.

Introduction
Five stygobiont hydrobiids species, from the groundwater of Morocco, with depigmented bodies and lacking eye spots, has been described on shell and/or anatomical characters: Atebbania bernasconi Ghamizi, Bodon, Boulal & Giusti 1999, Heideella andreae Backhyus & Boeters 1974, Heideella makhfamensis Bodon, Ghamizi & Giusti 1999, Iglica seyadi Backhyus & Boeters 1974 and Iglica soussensis Ghamizi & Boualal 2017 (Backhyus & Boeters 1974; Ghamizi et al. 1999; Bodon et al. 1999; Ghamizi & Boualal 2017). But, all these species have turriculate shells. The only valvatoid hydrobiids recently described from Morocco, Islamia tifertensis Glöer, Mabrouki & Taybi 2020, Ifrania zerroukansis Glöer, Mabrouki & Taybi 2020 and Fessia ouintensiis Glöer, Mabrouki & Taybi 2020, are collected in the springs. The first one is described only on empty shell (Glöer et al. 2020a) while for the others, a brief description of the penis is added to the characters of the shell and obviously with pigmented bodies and eye spots (Glöer et al. 2020b). Kristensen (1985) reported from Morocco the valvatoid genera Hadziella Kuščer 1932 and Horatia Bourguignat 1887 without description or taxonomical revision. Other valvatoid hydrobiid genera has been reported as nomina nuda of the threatened freshwater snails of the North Africa (Van Damme et al. 2010).

The new valvatoid hydrobiid described here, Rifia n. gen., is stygobiont and found widespread in the phreatic waters in the Rif region, north of Morocco. The anatomical characters are distinct from all known valvatoid hydrobiids.
Material and methods

Molluscs were collected from the northern part of Morocco (Fig. 1). They were collected from wells by phreatobiological net (Cvetcov 1968), by filtering subterranean waters by passing it through a nylon net of 200 µ mesh and sieving mud and sediment. The material was fixed in 70% ethanol. Bodies, isolated after crushing the shell, were dissected using very thin, pointed watchmaker's forceps. Images of the whole body and isolated parts of the genitalia were drawn using a Wild camera lucida. Shell surface details were photographed under scanning electron microscope at the Museum National d'Histoire Naturelle de Paris. Collecting sites of the material examined are cited with UTM references according to the 1:1.200.000 scale map of Morocco (UTM 10 km square map, Fig. 1).

![Figure 1. The distribution of *Rifia yacoubii* n.sp in north of Morocco and localisation of the type locality of *Islamia tifertensis*. UTM 10x10 km. AH : Al Hoceima ; Fe : Fes ; Ke : Kenitra ; Me : Meknes ; Na : Nador ; Oj : Oujda ; Ta : Taza ; Te : Tetouan.](image)

The terms used in the description of shell and soft parts are those in Hershler & Ponder (1998) and Bodon *et al.* (2001). Comparison were made using the synopsis of the European hydrobiid genera with valvatiform shell proposed by Bodon *et al.* (2001) and the comparison of character-state scores for thirty-four valvatoid genera (Radea *et al.* 2016, Table 2).

Type specimens are deposited in the Muséum d'Histoire Naturelle of Paris (France). Other material examined conserved in Coll. GHA (collection Ghamizi), at the Museum of Natural History of Marrakesh (Morocco), and in Bodon collection (Italy).

Results

The specimens collected from the nine wells along the Rif border in northern Morocco (Fig. 1) have the same shell structure and the same anatomical characters; the combination of which, with the type of habitat, would make it possible to introduce a new genus.

*Rifia* n. gen.

Type species: *Rifia yacoubii* n. sp. (see description below)

Diagnosis: The new taxa is clearly distinguished by the following combination of characters: shell valvatiform, almost planispiral; operculum with outgrowth at centre of inner face as well-developed peg;
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penis with two small non-glandular lobes and without stylet; female genitalia with two seminal receptacles and a medium-size bursa copulatrix; duct of bursa copulatrix entering bursa on anterior side.

**Etymology:** After the Rif region (Northern Morocco) where type species has been collected.

*Rifia yacoubii* n. gen. n. sp.
https://zoobank.org/urn:lsid:zoobank.org:act:D6DB8B52-4308-445E-8B5E-27784893740C

**Description:** Shell very small (1-1.2 mm of diameter), valvatiform, almost planispiral, thin, transparent when fresh; surface of protoconch malleated; spire consisting of 3 ¼ - 3 ½ rapidly growing whorls; last whorl large, slightly descending; aperture large, roundish; peristome complete, ticked, slightly reflected at columellar margin; umbilicus wide, about ¼ of shell diameter (Figs. 2 A,B,D,E; Fig. 3A). Operculum concave, paucispiral, thin, yellowish pale with well-developed peg at centre of its inner face (Fig. 2 C; Fig. 3 B). Body unpigmented; eye spots absent; stomach without posterior caecum; intestine with well-developed U-like bend on pallial wall; ctenidium consisting of 10 - 13 lamellae; osphradium oval (Figs. 3 G,F).

Male genitalia with prostate gland bulging at ¼ into paliall cavity; penis short, cylindro-conical, corrugated near base, pointed near apex, with two well-raised and non-glandular lobes, one on left side, tubular, about ½ of penis length, another, smaller, on ventral-right side about 1/3 of penis length; penial apex without stylet (Figs. 3 C,D,E,F).

Female genitalia with two seminal receptacles, elongated and equal in size; bursa copulatrix arising from renal oviduct, medium size, oval, with slender elongated duct entering bursa on anterior side (Fig. 3 G,H).

**Type material:** Holotype (Fig. 2 A), deposited at the National Museum of Natural History of Paris (France) (MNHN 27110); paratypes (two shells, Figs. 2 B,D; MNHN 27111); paratypes (16 shells, 5 dissections, Coll. Ghamizi, MHNMR55F7, 11.5.1993; 6 shells, MHNMR4, Fakher-Abiari leg. 16.9.1997); paratypes (7 shells, 5 dissections, Coll. Bodon, Italy, Yacoubi-Khebiza & Ghamizi leg. 11.5.1993).

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**Figure 2.** *Rifia yacoubii* n.sp., (from type locality: Well at 1 Km W of Guercif, near Taniat Labghal, UMT VC 69. Shells: A: umbilical view (Holotype), B: lateral view (Paratype) and D: apical view (Paratype); C: operculm, outer face, E: protoconch; Scale bar= 0.5 mm (A,B,D), =0.15 mm (C), =0.2 mm (E).
Figure 3. *Rifia yacoubii* n.sp.. A: shells: apical, umbilical and lateral views; B: operculm: inner, lateral and outer face. C: depigmented body of a male with pallial cavity open to show penis; D and E: penis in two males with dorsal and ventral view; F: male genitalia, stomach, intestine and pallial organs; G: genitalia (gonadal oviduct excluded) and pallial organs in a female; H: distal portion of genitalia in the second female. Scale bar=0.5 mm. Abbreviations: bc = bursa copulatrix; cd = vas deferens; ct = ctenidium; (RS1); int = intestine; mcp = posterior wall of pallial cavity; os = osphradium; p = penis; pa = penial lobe; pr = prostate gland; r = rectum; sr = seminal receptacle; st = style sac; te = testis.

Type locality: Well at 1 km of west of Guercif, near Taniat Labghal; UTM VC 69; altitude=500 m.; temperature=18°C; conductibility=870 μs/cm; protected well (by a small edge of the ground and by a cover at the top).
Other sites and material examined
The new species has been collected in eight other wells in addition to the type locality (Fig. 1). (UTM: Universal Transverse Mercator grid; Alt= Altitude; P= piezometric level in the well; H= height of the water column; Cond= Conductibility; T°= Temperature of the water; Coll.: collection; MHNM: Muséum d’Histoire Naturelle de Marrakech).

- Well at Oulad Ben Hlima, Mikkes, 15 km NW of Fes; UTM UC 28; P=5 m; H= 15 m; Cond=960 µs/cm; protected well. 4.5.1993 (5 shells, kept in Coll. Ghamizi, MHNR1F2, 2 dissections, MHNR1F4)
- Well at Ben Draoua, 18 Km S of Ouezzane; UTM TD74; Alt=200m; Cond=1048 µs/cm; P=3.2 m; H=4 m; 4.5.1993 (3 shells, Coll. Ghamizi, MHNR5F2)
- Well at Karia Ben Awda, Arbaoua, 40 Km W of Ouezzane; UTM TD16; Alt=50 m; Cond=975 µs/cm; well without protection. 5.5.1993 (5 shells, Coll. Ghamizi, MHNR8F4)
- Well at Guercif; UTM VC78; Alt=350 m; P=12 m; H= 22.2 m; T°=19°C; Cond=990µs/cm; protected well into a private house. 11.5.1993 (8 shells, 3 dissections, Coll. Ghamizi, MHNR5F2)
- Well at Aïn El Behira, Taza; UTM VC48; Alt. 500 m; P=10 m; H= 1 m ; T°= 19°C; Cond= 1800 µs/cm; well without protection. 11.5.1993 (2 shells, Coll. Ghamizi, MHNR56)
- Well at Kasbah Beni Hitem, 10 Km E of Taza ; UTM VC49; Alt= 500 m; P=5; H=0.5m; T°=19°C; Cond=2500µs/cm; well without protection. 11.5.1993. (6 shells, 1 dissection, Coll. Ghamizi, MHNR57)
- Well at 10 Km E of Boured, near Azib, (Boured); UTM UD94; Alt=1160 m; P=2 m; H=3 m; T°=14°C; Cond=500 µs/cm; well without protection. 12.5.1993. (2 shells, Coll. Ghamizi, MHNR69F4)
- Well at Douar Qbail, near Ain Aïcha, 5 Km N of Tissa ; UTM UD 41 ; P=6.9 m; H=0.3 m. 13.5.1993. (3 shells, Coll. Ghamizi, MHNR78F3)

Etymology: species dedicated to Professor Mohamed Yacoubi-Khebiza (University of Marrakesh), working in subterranean Crustacea of Morocco and having participated in the collection of the stygobiont fauna from wells of the Rif mountains.

Taxonomy and discussion: The European valvatiform hydrobiids sharing penis with lobe(s) and three sac-like structures on renal oviduct, a bursa copulatrix and two seminal receptacles (see Radea et al. 2016, Table 2) are: *Pseudoislamia* Radoman 1978; *Daphniola* Radoman 1973; *Bracenica* Radoman 1973; *Goecea* Hadzisce 1956; *Karevia* Hadzisce 1959; *Ohrigocea* Hadzisce 1959; *Ohridohauffenia* Hadzisce 1959; *Prespolitorea* Radoman 1983; *Horatia* Bourguignat 1887; *Fissuria* Boeters 1981; *Pezzolia* Bodon & Giusti 1986; *Spathogyna* Arconada & Ramos 2002; *Corbellaria* Callot-Girardi & Boeters 2012; *Iberhoratia* Arconada et Ramos 2007; *Greacoarganiella* Falniowski & Szarowska 2011. The new genus *Rifia* differs from these genera by characters cited below.

*Pseudoislamia* Radoman 1978, described from Greece, has operculum without peg, penis with one lobe, small bursa copulatrix. *Daphniola* Radoman 1973, described from Greece, has operculum without peg, penis with one lobe, shell valvatiform-globose conical (Radoman 1973, 1983; Schütt 1980 ; Bodon et al. 2001). *Bracenica* Radoman 1973, described from Montenegro, has penis with one lobe (Radoman 1973; Radoman 1983). *Goecea* Hadzisce 1956, *Karevia* Hadzisce 1959, *Ohrigocea* Hadzisce 1959, *Ohridohauffenia* Hadzisce 1959 and *Prespolitorea* Radoman 1983, described from Macedonia and Albania (for *Prespolitorea*), have operculum without peg (spiralized on outer face in *Goecea*), penis with one lobe, distal seminal receptacle rudimentary in *Karevia*, *Ohrigocea* and *Prespolitorea*; shell partly despiralized (*Goecea*), biccinate (*Karevia*) or sometimes carinate (*Ohridohauffenia*) (see Bodon et al. 2001, for discussions on taxonomy of these genera). *Horatia* Bourguignat 1887, described from Croatia, has operculum without peg, penis with lobe; valvatiform to ovoid shell (see Bodon et al. 2001, for taxonomy discussions about this genus). *Fissuria* Boeters 1981, described from France, has operculum without peg, penis with 2-4 glandular lobes (Boeters 1981; Bodon et al. 2001). *Pezzolia* Bodon & Giusti 1986, described from Italy, has operculum without peg, penis with or without glandular lobe(s); bursa copulatrix very reduced or absent (Bodon & Giusti 1986; Bodon et al. 2001). The presence of multiple papillae found on the propodium of *Spathogyna* Arconada & Ramos 2002, is a peculiar characteristic that has not been previously reported in any other hydrobid (Arconada & Ramos 2002). *Corbellaria* Callot-Girardi & Boeters 2012, described from Spain, has operculum without peg, penis with one lobe; the absence of the ctenidium is reported as a diagnostic character for genus level for *Corbellaria* (Callot-Girardi & Boeters 2012). *Iberhoratia* Arconada & Ramos
2007, has operculum without peg, the penis with one non-glandular penial lobe (Arconada et al. 2007). *Greacoarganiella* Falniowski & Szarowska 2011, has a penis with one lobe (Falniowski & Szarowska 2011). Among all these genera, *Bracenica* has operculum with peg on inner face as the new taxa described here (and spiraled on outer face in *Gocea*). In the analytical key for identification of the *Hauffenia* species, the peg of operculum is variable in shape, reduced or absent (Bodon et al. 2001, Table 7). It is clear that this character is not diagnostic for genus level. If we do not consider it, two genera cited above having female genitalia with two seminal receptacles and male genitalia with two penial lobes, are *Fissuria* and *Horatia*. *Fissuria* has penis with 3-4 (rarely 2) glandular lobes of variable size and position (Boeters 1981, Figs.5-8; Bodon et al. 2001, Figs. 24, 30-34); rectum with S-like bend and *Horatia* has eye spots and rectum without bend (U-like in the new taxa, Fig. 3G).

The two valvatoid hydrobiid genera recently described from Morocco and collected from the springs, have pigmented bodies and eye spots (Glöer et al. 2020b, Figs. 2(2), 3(5)); the genus *Ifrania* Glöer, Mabrouki & Taybi 2020 (Type species: *Ifrania zerroukansis* Glöer, Mabrouki & Taybi 2020) has a long and thin penis without penial lobes and genus *Fessia* Glöer, Mabrouki & Taybi 2020 (Type species: *Fessia aouintii* Glöer, Mabrouki & Taybi 2020) has a penis described as «flat, relatively thick at the basis with a small bulge and tapered at the distal end» (Glöer et al. 2020b). *Islamia tifertensis* Glöer, Mabrouki & Taybi 2020 was collected from a spring and is described only on empty shell (Glöer et al. 2020a) and assigned to *Islamia* without known its anatomy; however, hydrobiid species are characterized by the penis and the shell shape (Szarowska 2006). The new genus *Rifia* differs quite from the above three valvatoid genera reported from Morocco by its penis with two small non-glandular lobes at mid part of the penis (Figs. 3 C, D, E). This character coupled with the female genitalia with two seminal receptacles (Figs. 3 G, H) and associated with endemic distribution resulting from its poor dispersal capacity and its stygobiont features (depigmented body and no eye spots) suggesting that a new genus should be introduced. The new species *Rifia yacoubii* n.sp. differs by its almost planispiral shell, that more depressed than in *I. tifertensis* which anatomical characters and operculum are lacking. *I. tifertensis* has been collected from a spring as empty shells will be probably a subterranean species. The spring Tifert, type locality of *I. tifertensis* (Glöer et al. 2020a) is situated at 180 km from the nearest well (type locality) where *R. yacoubii* has been collected (Fig. 1). If we consider that is the same phreatic basin (Moulouya basin), *I. tifertensis* could be assigned to the new genus *Rifia* as a second species. The genus *Islamia* Radoman 1973, having penis bilobed and no bursa copulatrix (Radoman 1983; Bodon et al. 2001; Arconada & Ramos 2006), should therefore be disregarded, as its presence in Morocco is not yet anatomically confirmed.

**Habitat and distribution:** All specimens collected are from wells. The new species seems to be widespread in phreatic waters and found, until now, in nine wells along the south border of the Rif region, in the upstream of Moulouya, Sebou and Loukkos basins (Fig. 1). Specimens collected with whole animal have depigmented bodies, without eye spots and are adapted to groundwater (stygobiont species).

**Status:** the species is reported as *nomina nudum* (*Pseudoislamia yacoubii*) and listed as Critically Endangered species (CR) among the threatened freshwater molluscs of North Africa (Van Damme et al. 2010).

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**References**
Arconada, B. & Ramos, M. A. (2002) *Spathogyna*, a new genus for *Valvata* (? *Tropidina*) *fezi* Altimira, 1960 from eastern Spain: a second case of natural pseudohermaphroditism in a Hydrobiidae species (Mollusca, Prosobranchia). *Journal of Molluscan Studies*, 68, 319-327.
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Arconada, B. & Ramos, A. (2006) Revision of the genus *Islamia* Radoman, 1973 (Gastropoda, Caenogastropoda, Hydrobiidae) on the Iberian Peninsula and description of two new genera and three new species. *Malacologia*, 48, 77–132.

Arconada, B., Delicado, D. & Ramos, A. (2007) A new genus and two new species of Hydrobiidae (Mollusca, Caenogastropoda) from the Iberian Peninsula. *Journal of Natural History*, 41, 2007–2035.

Backhuys, W. & Boeters, H.D. (1974) Zur Kenntnis marokkanischer Binenmollusken, I. *Archiv für Molluskenkunde*, 194(4/6), 107–11.

Bodon, M. & Giusti, F. (1986) A new valvatoid shelled hydrobiid from Liguria (Italy) (Gastropoda: Prosobranchia). *Archiv für Molluskenkunde*, 117, 61–71.

Bodon M., Ghamizi M. & Giusti F. (1999) The Moroccan stygobiont genus *Heideella* (Gastropoda, Prosobranchia: Hydrobiidae). *Basteria*, 63, 89-105.

Bodon, M., Manganelli, G. & Giusti, F. (2001) A survey of the European valvatiform Hydrobiid genera, with special reference to *Hauffenia* Pollonera, 1898 (Gastropoda: Hydrobiidae). *Malacologia*, 43 (1-2): 1103-215.

Boeters, H. D. (1981) Unbekannte westeuropäische Prosobranchia, 2, *Archiv für Molluskenkunde*, 111(1/3), 55–61.

Callot-Girardi H. & Boeters H.D. (2012) *Corbellaria celtiberica* gen. et sp. nov. (Gastropoda: Hydrobiidae), mollusque valvatiiforme stygobie de la province de Soria (Péninsule Ibérique). *Spira*, 4(3–4), 149–160.

Cvetcov L. (1968) Un filet phréatobiologique. *Bulletin de l’Institut Zoologique du Museum de Sofia*, XXII, 215-219.

Falniowski, A. & Szarowska, M. (2011) A new genus and new species of valvatiform hydrobiid (Rissooidea; Caenogastropoda) from Greece. *Molluscan Research*, 31, 189–199.

Ghamizi M., Bodon M., Boulal M. & Giusti F. (1999) *Atebbania bernasconii*, a new genus and species from subterranean waters of the Tiznit plain, Southern Morocco (Gastropoda: Hydrobiidea). *Journal of Molluscan Studies*, 65, 89-98.

Glöer, P., Mabrouki, Y. & Taybi, A.F. (2020a) Two new valvatoid genera (Gastropoda, Hydrobiidae) from Morocco. *Ecologica Montenegrina*, 30, 124-128.

Glöer, P., Mabrouki, Y. & Taybi, A.F. (2020b) A new genus and two new species (Gastropoda, Hydrobiidae) from Morocco. *Ecologica Montenegrina*, 28, 1–6.

Hershler, R. & Ponder, W.F. (1998) A review of morphological characters of Hydrobioid snails. *Smithsonian Contributions to Zoology*, 600 (iii), 1-55.

Kristensen, T. K. (1985) Guide pratique des Gastéropodes d’eau douce Africains. 7. Espèces présentes en Afrique du Nord-Ouest. Danish Bilharziosis Laboratory (ed.), Charlottenlund, pp 1-30.

Radea C., Parmakelis A., Giokas S. (2016) *Myrtoessa hyas*, a new valvatiform genus and a new species of the Hydrobiidae (Caenogastropoda, Truncatelloidea) from Greece. *Zookeys*, 640, 1-18.

Radoman, P. 1973. New classification of fresh and brackish water Prosobranchia from the Balkans and Asia Minor. *Prirodjaci Mijeti u Beogradu, Posebna Izdanja*, 32, 1–30.

Radoman, P. (1983) *Hydrobioidea, a superfamily of Prosobranchia (Gastropoda). I. Systematics*, Serbian Academy of Sciences and Monographs, 547, 1–256.

Schütt, H. (1980) Zur kenntnis griechischer Hydrobiiden. *Archiv für Molluskenkunde*, 110 (4- 6), 115-149.

Szarowska, M. (2006) Molecular phylogeny, systematics and orphological character evolution in the Balkan Rissooidea (Caenogastropoda). *Folia Malacologica*, 14(3), 99-168.

Van Damme, D., Ghamizi, M., Soliman, G., McIvor, A. & Seddon, M.B. (2010) The status and distribution of freshwater mollusks. In Garcia, N., Cuttelod, A. & Abdul Malak, D. (eds.), *the Status and Distribution of Freshwater Biodiversity in Northern Africa*. IUCN.xiii, Gland, Switzerland, Cambridge, UK and Spain, pp 1–141.