

SHORT COMMUNICATION

TWO INVALID GENERA IN THE FAMILY BYTHINELLIDAE LOCARD, 1893 (CAENOGASTROPODA: TRUNCATELLOIDEA)

ALEKSANDRA JASZCZYŃSKA^{1,2*}, SEBASTIAN HOFMAN³, ANDRZEJ FALNIOWSKI¹

¹ Department of Malacology, Institute of Zoology, Jagiellonian University, Poland (e-mail: a.jaszczynska@uj.edu.pl); AJ  <https://orcid.org/0000-0002-9395-9696>; AF  <https://orcid.org/0000-0002-3899-6857>

² Department of Invertebrate Evolution, Institute of Zoology and Biomedical Research, Jagiellonian University, Poland

³ Department of Comparative Anatomy, Institute of Zoology, Jagiellonian University, Poland;  <https://orcid.org/0000-0001-6044-3055>

* corresponding author

ABSTRACT: Within the genus *Bythinella* Moquin-Tandon, 1856, with about 250 nominal species, the separation of several genera would be helpful in understanding the phylogenetic relationships between these snails, but neither morphology nor molecular loci studied so far can be used to distinguish any natural taxon over the range of species within this genus. Apart from *Bythinella* there are two other genera listed in the Bythinellidae by WoRMS: *Terrestribythinella* Sitnikova, Starobogatov et Anistratenko, 1992, and *Strandzhia* Georgiev et Glöer, 2013. Considering the cytochrome c oxidase subunit I (COI) sequences, as well as poor morphological data, *Terrestribythinella* should be considered a junior subjective synonym of *Bythinella*. In the case of *Strandzhia*, both COI and 18S sequences studied by us, as well as morphology re-examined (misinterpretation of the penis morphology in the original description) clearly show the assignment of *Strandzhia* to the genus *Grossuana* Radoman, 1983, thus *Strandzhia* becomes a junior objective synonym of *Grossuana*.

KEY WORDS: *Bythinella*; *Terrestribythinella*; *Strandzhia*; morphology; mtDNA; synonymes

Bythinella Moquin-Tandon, 1856, with its type species *Bulimus viridis* Poiret, 1801, belongs to the family Bythinellidae Locard, 1893. For a long time, it was classified within the Amnicolidae Tryon, 1863, but both morphology (SZAROWSKA 2006) and molecular data (WILKE et al. 2001, 2013) confirmed the distinctness of the Bythinellidae. There are about 250 nominal species of *Bythinella* (WORMS 2024). However, neither morphology (GIUSTI & PEZZOLI 1977, FALNIOWSKI 1987, 2018, MAZAN 2000, HAASE et al. 2007, JASZCZYŃSKA in press), nor molecular loci studied so far (BICHAIN et al. 2007a, b, BENKE et al. 2009, 2011, FALNIOWSKI et al. 2009a, WILKE et al. 2010, FALNIOWSKI & SZAROWSKA 2011, SZAROWSKA

et al. 2016, JASZCZYŃSKA in press) may be used to separate any natural taxon of the genus level within the *Bythinella*.

SITNIKOVA et al. (1992) described from Ukraine a genus *Terrestribythinella* Sitnikova, Starobogatov et Anistratenko, 1992, with its type species *T. baidashnikovi* Sitnikova, Starobogatov et Anistratenko, 1992. The other species: *T. carpathica* Sitnikova, Starobogatov et Anistratenko, 1992 was described and new family Terrestribythinellidae Sitnikova, Starobogatov et Anistratenko, 1992 was created in the same publication (SITNIKOVA et al. 1992). Later, the third species of *Terrestribythinella*: *T. amphibiotica* Anistratenko, 1995 was described (ANISTRATENKO 1995).



According to SITNIKOVA et al. (1992) there is no tubular penial gland in the male reproductive organs of *Terrestribythinella*. There should be said that in such case the presence of a big flagellum would be enigmatic, and most probably the tubular gland was small and thus overlooked. In the female reproductive organs, according to SITNIKOVA et al. (1992), there was a diauly [meaning the existence of a distinct sperm duct (DAVIS 1967, HERSHLER & PONDER 1998) – resulting in two separate female genital openings]. The diauly is characteristic for the Amnicolidae, but not for the Bythinellidae, since in the latter very broad folds forming the ventral channel mimic a spermathecal duct (SZAROWSKA 2006). According to SITNIKOVA et al. (1992), there is also a somewhat curious bursa with duct, and no receptaculum seminis. In fact, both bursa and receptaculum are extremely variable in *Bythinella* (e.g. GIUSTI & PEZZOLI 1977, FALNIOWSKI 1987, 2018, MAZAN 2000), the receptaculum may be as small as to be easily overlooked.

Considering the poor fidelity of the reproduction of the drawings of the shells and reproductive organs of *Falniowska neglectissima* (Falniowski et Šteffek, 1989), the type species of *Falniowska* Bernasconi, 1990, redrawn from the original description (FALNIOWSKI & ŠTEFFEK 1989), the drawings and descriptions of SITNIKOVA et al. (1992) are thus even less convincing. Thus, these morphological characters alone may not constitute the base of systematics in the case of *Bythinella* and other truncatelloidean gastropods (FALNIOWSKI 2018). Molecular data are therefore necessary for clearer taxonomic conclusions.

For *Terrestribythinella* we performed molecular data analysis following standard methods (FALNIOWSKI et al. 2023). The cytochrome c oxidase subunit I (COI) – a marker commonly used in animals' barcoding – definitely placed *Terrestribythinella* within the *Bythinella*, as two species (mOTU A and B; Fig. 1), forming a sister clade with *B. viseuiana* Falniowski, Szarowska et Sirbu, 2009 (FALNIOWSKI et al. 2009b; mOTU C),

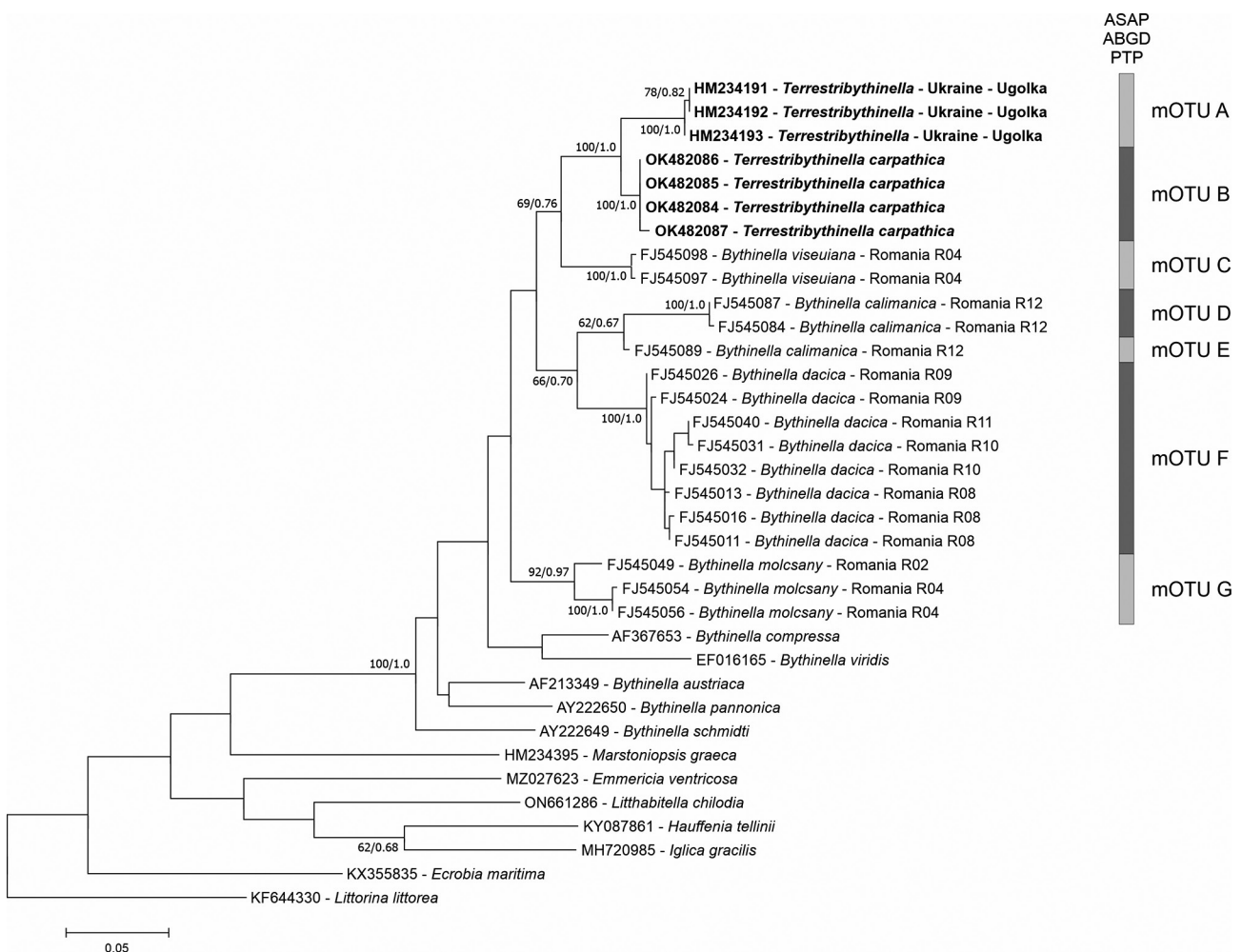


Fig. 1. Maximum likelihood tree based on the COI for *Terrestribythinella* and related taxa, bootstrap supports (>60%) and Bayesian posterior probabilities are given. The HKY+I+G model were used for ML and BI analysis. Results of species delimitation are also shown. The GenBank numbers are given with the taxon, the sequences after WILKE et al. 2000, 2001, SZAROWSKA & WILKE 2004, BICHAIN et al. 2007a, FALNIOWSKI et al. 2009a, BENKE et al. 2011, ANISTRATENKO et al. 2021 (unpublished) and present paper

and close to the other *Bythinella* species (mOTUs D–G) from Romania, whose localities were not far from the Ukraine. Such close relationships rather definitely deny the possibility of such substantial anatomical differences as the ones listed above, described by SITNIKOVA et al. (1992). *Terrestribythinella* clearly belongs to the genus *Bythinella*, and it cannot be accepted as a genus without creating a paraphyletic status of *Bythinella*. Thus, the only solution is to consider *Terrestribythinella* a junior subjective synonym of *Bythinella* Moquin-Tandon, 1856. Phylogenetic analyses using all available *Bythinella* sequences also support this thesis (BENKE et al. 2011, JASZCZYŃSKA in press).

Another genus reported in the Bythinellidae in WORMS (2024) is *Strandzhia* Georgiev et Glöer, 2013,

with its type species *S. bythinellopenia* Georgiev et Glöer, 2013. Its placement within the Bythinellidae remains enigmatic, since it was described as a member of the Hydrobiidae (GEORGIEV & GLÖER 2013). Our sequences of COI deposited in GenBank (PP752094-PP752096), as well as the one published by DELICADO et al. (2024: OP096318) undoubtedly classify *S. bythinellopenia* as belonging to the genus *Grossuana* Radoman, 1983, since in our tree *Strandzhia bythinellopenia* clusters within the mOTU A (Fig. 2), together with *Grossuana derventica* Georgiev et Glöer, 2013, *G. falniowskii* Georgiev, Glöer, Dedov et Irikov, 2015, and *G. thracica* Glöer et Georgiev 2009. The p-distance within this group does not exceed 0.001, and between this group (mOTU A) and other species of *Grossuana* (FALNIOWSKI et al. 2016)

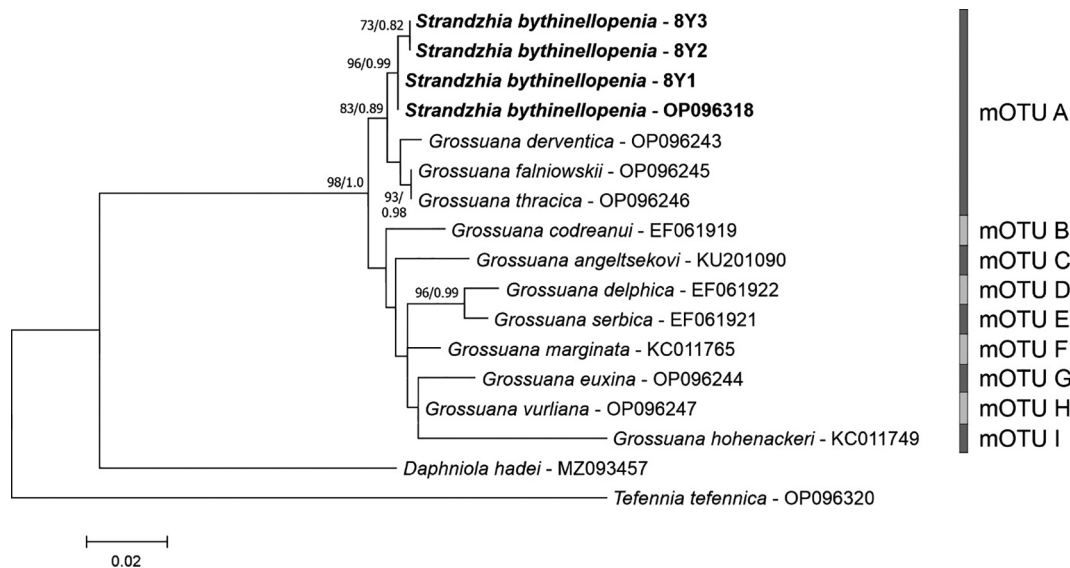


Fig. 2. Maximum likelihood tree based on the COI for *Strandzhia* and related taxa, bootstrap supports (>60%) and Bayesian posterior probabilities are given. The HKY+G model were used for ML and BI analysis. Results of species delimitation are also shown. The GenBank numbers are given with the taxon name, the sequences after SZAROWSKA et al. 2007, FALNIOWSKI et al. 2012, FALNIOWSKI et al. 2016, HOFMAN et al. 2021, DELICADO et al. 2024 and present paper

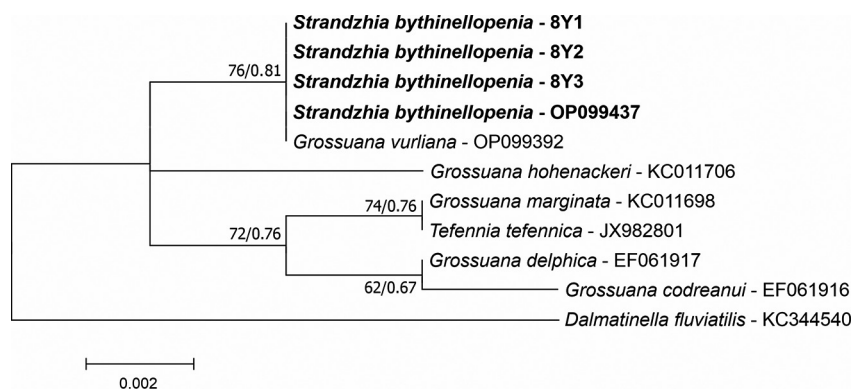


Fig. 3. Maximum likelihood tree based on the 18S for *Strandzhia* and related taxa, bootstrap supports (>60%) and Bayesian posterior probabilities are given. The HKY+G model were used for ML and BI analysis. The GenBank numbers are given with the taxon name, the sequences after SZAROWSKA et al. 2007, ÇAĞLAN et al. 2012, FALNIOWSKI et al. 2012, FALNIOWSKI & SZAROWSKA 2013, DELICADO et al. 2024 and present paper



varied from 0.013 to 0.064 (mOTUs B-I). The distance 0.001 is much below the threshold value generally accepted between congeneric species (e.g. PRIÉ & BICHAIN 2009, PRIÉ & CUCHERAT 2021). Also, 18S sequence (GenBank PP752097-PP752099) confirmed the assignment of *Strandzhia bythinellopenia* to the genus *Grossuana* (Fig. 3). Our dissection of paratypes of this species showed the simple penis typical of *Grossuana*. This, coupled with careful examination

of the photograph published by GEORGIEV & GLÖER (2013) clearly show that the region where the simple penis is bent typically for *Grossuana*, was erroneously interpreted as the base of bi-armed penis, and the base was misrecognised as the tip of the second arm. To conclude, *Strandzhia* Georgiev et Glöer, 2013 becomes a junior objective synonym of *Grossuana* Radoman, 1983.

REFERENCES

- ANISTRATENKO V. V. 1995. A new species of the genus *Terrestribythinella* (Mollusca Gastropoda Pectinibranchia) from Transcarpathia. *Vestnik Zoologii* 4: 66–68. [in Russian]
- ANISTRATENKO V. V., PERETOLCHINA T. E., ANISTRATENKO O. Y., DEGTYARENKO E. V., FURYK Y. I., SHERBAKOV D. Y., SITNIKOVA T. Y. 2021. Spring snails *Bythinella* in Ukrainian Carpathians (Caenogastropoda: Bythinellidae): variability, diversity and phylogenetic relationships. Unpublished, cited after GenBank.
- BENKE M., BRÄNDLE M., ALBRECHT C., WILKE T. 2009. Pleistocene phylogeography and phylogenetic concordance in cold-adapted spring snails (*Bythinella* spp.). *Molecular Ecology* 18: 890–903. <https://doi.org/10.1111/j.1365-294X.2008.04073.x>
- BENKE M., BRÄNDLE M., ALBRECHT C., WILKE T. 2011. Patterns of freshwater biodiversity in Europe: lessons from the spring snail genus *Bythinella*. *Journal of Biogeography* 38: 2021–2032. <https://doi.org/10.1111/j.1365-2699.2011.02527.x>
- BERNASCONI R. 1990. *Falniowskia* n. gen. for *Bythiospeum neglectissimum* Falniowski et Šteffek, 1989 (Mollusca: Prosobranchia: Hydrobiidae). *Folia Malacologica* 4: 47–51. <https://doi.org/10.12657/folmal.004.004>
- BICHAIN J. M., BOISSELIER-DUBAYLE M. C., BOUCHET P., SAMADI S. 2007a. Species delimitation in the genus *Bythinella* (Mollusca: Caenogastropoda: Rissooidea): a first attempt combining molecular and morphometrical data. *Malacologia* 49: 293–311. <https://doi.org/10.4002/0076-2997-49.2.293>
- BICHAIN J. M., GAUBERT P., SAMADI S., BOISSELIER-DUBAYLE M. C. 2007b. A gleam in the dark: Phylogenetic species delimitation in the confusing spring-snail genus *Bythinella* Moquin-Tandon, 1856 (Gastropoda: Rissooidea: Amnicolidae). *Molecular Phylogenetics and Evolution* 45: 927–941. <https://doi.org/10.1016/j.ympev.2007.07.018>
- ÇAĞLAND. C., YILDIRIM Z. M., SZAROWSKA M., FALNIOWSKI A. 2012. Phylogenetic position of *Tefennia* Schutt et Yildirim, 2003 (Caenogastropoda: Rissooidea). *Folia Malacologica* 20: 271–277. <https://doi.org/10.2478/v10125-012-0024-0>
- DAVIS G. M. 1967. The systematic relationship of *Pomatiopsis lapidaria* and *Oncomelania hupensis formosana* (Prosobranchia: Hydrobiidae). *Malacologia* 6: 1–143.
- DELICADO D., HAUFFE T., WILKE T. 2024. Fifth mass extinction event triggered the diversification of the largest family of freshwater gastropods (Caenogastropoda: Truncatelloidea: Hydrobiidae). *Cladistics* 40: 82–96. <https://doi.org/10.1111/cla.12558>
- FALNIOWSKI A. 1987. Hydrobioidea of Poland (Prosobranchia: Gastropoda). *Folia Malacologica* 1: 11–122. <https://doi.org/10.12657/folmal.001.001>
- FALNIOWSKI A. 2018. Species distinction and speciation in hydrobioid Gastropods (Mollusca: Caenogastropoda: Truncatelloidea). *Archives of Zoological Studies* 1: 003. <https://doi.org/10.24966/AZS-7779/100003>
- FALNIOWSKI A., GEORGIEV D., OSIKOWSKI A., HOFMAN S. 2016. Radiation of *Grossuana* Radoman, 1973 (Caenogastropoda: Truncatelloidea) in the Balkans. *Journal of Molluscan Studies* 82: 305–313. <https://doi.org/10.1093/mollus/eyv062>
- FALNIOWSKI A., JASZCZYŃSKA A., HOFMAN S. 2023. A new species of *Bythinella* (Truncatelloidea: Bythinellidae) from Bosnia and Herzegovina. *Journal of Conchology* 44: 551–561. <https://doi.org/10.61733/JConCh44603>
- FALNIOWSKI A., ŠTEFFEK J. 1989. A new species of *Bythiospeum* (Prosobranchia: Hydrobioidea: Moitessieriidae) from Southern Poland. *Folia Malacologica* 3: 95–101. <https://doi.org/10.12657/folmal.003.006>
- FALNIOWSKI A., SZAROWSKA M. 2011. Radiation and phylogeography in a spring snail *Bythinella* (Mollusca: Gastropoda: Rissooidea) in continental Greece. *Annales Zoologici Fennici* 48: 67–90. <https://doi.org/10.5735/086.048.0201>
- FALNIOWSKI A., SZAROWSKA M. 2013. Phylogenetic relationships of *Dalmanella fluviatilis* Radoman, 1973 (Caenogastropoda: Rissooidea). *Folia Malacologica* 21: 1–7. <https://doi.org/10.12657/folmal.021.001>
- FALNIOWSKI A., SZAROWSKA M., GLÖER P., PEŠIĆ V. 2012. Molecules vs morphology in the taxonomy of the *Radomaniola/Grossuana* group of Balkan Rissooidea (Mollusca: Caenogastropoda). *Journal of Conchology* 41: 19–36.
- FALNIOWSKI A., SZAROWSKA M., SIRBU I. 2009a. *Bythinella* Moquin-Tandon, 1856 (Gastropoda: Rissooidea:



- Bythinellidae) in Romania: species richness in a glacial refugium. *Journal of Natural History* 43: 2955–2973.
<https://doi.org/10.1080/00222930903359636>
- FALNIOWSKI A., SZAROWSKA M., SIRBU I. 2009b. *Bythinella* Moquin-Tandon, 1856 (Gastropoda: Rissooidea: Bythinellidae) in Romania: its morphology with description of four new species. *Folia Malacologica* 17: 21–36.
<https://doi.org/10.2478/v10125-009-0003-2>
- GEORGIEV D., GLÖER P. 2013. Identification key of the Rissooidea (Mollusca: Gastropoda) from Bulgaria with a description of six new species and one new genus. *North-Western Journal of Zoology* 9: 103–112.
- GEORGIEV D., GLÖER P., DEDOV I., IRIKOV A. 2015. Review of the genus *Grossuana* Radoman, 1973 (Gastropoda: Truncatelloidea) from Bulgaria, with a description of a new species. *Acta Zoologica Bulgarica* 67: 159–166.
- GIUSTI F., PEZZOLI E. 1977. Primo contributo alla revisione del genere *Bythinella* in Italia. *Natura Bresciana Annales Musei Civici di Storia Naturale Brescia* 14: 3–80.
- GLÖER P., GEORGIEV D. 2009. New Rissooidea from Bulgaria (Gastropoda: Rissooidea). *Mollusca* 27: 123–136.
- HAASE M., WILKE T., MILDNER P. 2007. Identifying species of *Bythinella* (Caenogastropoda: Rissooidea): a plea for an integrative approach. *Zootaxa* 1563: 1–16.
<https://doi.org/10.11646/zootaxa.1563.1.1>
- HERSHLER R., PONDER W. F. 1998. A review of morphological characters of hydrobioid snails. *Smithsonian Contribution to Zoology* 600: 1–55.
- HOFMAN S., GREGO J., FEHÉR Z., ERŐSS Z. P., RYSIEWSKA A., OSIKOWSKI A., FALNIOWSKI A. 2021. New data on the valvatiform-shelled Hydrobiidae (Caenogastropoda, Truncatelloidea) from southern Greece. *ZooKeys* 1062: 31–47.
<https://doi.org/10.3897/zookeys.1062.64746>
- JASZCZYŃSKA A. in press. Phylogeography and species distinction in *Bythinella* (Caenogastropoda: Truncatelloidea: Bythinellidae) in the Central Europe and the Balkans. *Folia Malacologica*.
- LOCARDA. 1893. *Conchyliologie française*. [I]. Les coquilles des eaux douces et saumâtres de France. Description des familles, genres et espèces. J.-B. Baillière, Paris.
<https://www.biodiversitylibrary.org/page/12977684>
- MAZAN K. 2000. Morphological and allozymic variation within and between populations of *Bythinella* Moquin-Tandon, 1855 (Gastropoda: Prosobranchia). I. Morphological characters. *Folia Malacologica* 8: 107–139.
<https://doi.org/10.12657/folmal.008.007>
- MOQUIN-TANDON A. 1855–1856. *Histoire naturelle des mollusques terrestres et fluviatiles de France*, Tome premier (1): i–viii, 1–14 + Atlas: 1–16, pl. 1–9 (12 April 1855); (2): 145–256 + Atlas: 17–32, pl. 10–18 (4 May 1855); (3): 257–416 + Atlas: 33–48, pl. 19–27 (1 August 1855). Tome second (4): i–iii, 1–176 + Atlas: 49–64, pl. 28–36 (10 September 1855); (5): 177–368 + Atlas: 65–80, pl. 37–45 (2 January 1856); (6): 369–646 + Atlas: i–iii, 81–92, pl. 46–54 (9 April 1856). J.-B. Baillière, Paris.
<https://biodiversitylibrary.org/page/32068638>
- POIRET J. L. M. 1801. *Coquilles fluviatiles et terrestres observées dans le Département de l’Aisne et aux environs de Paris: prodrome*. Barrois et Soissons, Paris.
<https://www.biodiversitylibrary.org/item/81286#page/9/mode/1up>
- PRIÉ V., BICHAIN J.-M. 2009. Phylogenetic relationships and description of a new stygobite species of *Bythinella* (Mollusca, Gastropoda, Caenogastropoda, Amnicolidae) from southern France. *Zoosystema* 31: 987–1000.
<https://doi.org/10.5252/z2009n4a12>
- PRIÉ V., CUCHERAT X. 2021. Additional molecular data on the protected springsnail species *Bythinella viridis* (Poiret, 1801) (Gastropoda: Bythinellidae) suggest synonymy of related taxa. *Knowledge and Management of Aquatic Ecosystems* 422: 36.
<https://doi.org/10.1051/kmae/2021035>
- RADOMAN P. 1983. Hydrobioidea a superfamily of Prosobranchia (Gastropoda). I. Systematics. *Serbian Academy of Sciences and Arts, Monographs* 547, Department of Sciences 57: 1–256.
- SITNIKOVA T. YA., STAROBOGATOV YA. I., ANISTRATENKO V. V. 1992. Anatomy and systematic position of some small Pectinibranch molluscs (Mollusca, Gastropoda) of the European fauna. *Vestnik Zoologii* 26: 3–12. [in Russian]
- SZAROWSKA M. 2006. Molecular phylogeny, systematics and morphological character evolution in the Balkan Rissooidea (Caenogastropoda). *Folia Malacologica* 14: 99–168.
<https://doi.org/10.12657/folmal.014.014>
- SZAROWSKA M., GRZMIL P., FALNIOWSKI A., SIRBU I. 2007. *Grossuana codreanui* (Grossu, 1946) and the phylogenetic relationships of the East Balkan genus *Grossuana* (Radoman, 1973) (Gastropoda: Rissooidea). *Hydrobiologia* 579: 379–391.
<https://doi.org/10.1007/s10750-006-0530-4>
- SZAROWSKA M., OSIKOWSKI A., HOFMAN S., FALNIOWSKI A. 2016. Do diversity patterns of the spring-inhabiting snail *Bythinella* (Gastropoda, Bythinellidae) on the Aegean Islands reflect geological history? *Hydrobiologia* 765: 225–243.
<https://doi.org/10.1007/s10750-015-2415-x>
- SZAROWSKA M., WILKE T. 2004. *Sadleriana pannonica* (Frauenfeld, 1865): a lithoglyphid, hydrobiid or amnicolid taxon? *Journal of Molluscan Studies* 70: 49–57.
<https://doi.org/10.1093/mollus/70.1.49>
- TRYON G. W. 1863. Notes on American fresh water shells, with descriptions of two new species. *Proceedings of the Academy of Natural Sciences of Philadelphia* 14: 451–452.
<https://www.biodiversitylibrary.org/page/1951923>
- WILKE T., BENKE M., BRÄNDLE M., ALBRECHT C., BICHAIN J.-M. 2010. The neglected side of the coin: Non-adaptive radiations in spring snails (*Bythinella* spp.). In: GLAUBRECHT M. (ed.). *Evolution in Action*. Springer-Verlag, Berlin Heidelberg, pp. 551–578.



- WILKE T., DAVIS G. M., FALNIOWSKI A., GIUSTI F., BODON M., SZAROWSKA M. 2001. Molecular systematics of Hydrobiidae (Mollusca: Gastropoda: Rissooidea): testing monophyly and phylogenetic relationships. *Proceedings of the Academy of Natural Sciences of Philadelphia* 151: 1–21.
[https://doi.org/10.1635/0097-3157\(2001\)151\[0001:-MSOHMG\]2.0.CO;2](https://doi.org/10.1635/0097-3157(2001)151[0001:-MSOHMG]2.0.CO;2)
- WILKE T., DAVIS G. M., GONG X., LIU H. X. 2000. *Erhaia* (Gastropoda: Rissooidea): phylogenetic relationships and the question of *Paragonimus* coevolution in Asia. *American Journal of Tropical Medicine and Hygiene* 62: 453–459.
<https://doi.org/10.4269/ajtmh.2000.62.453>
- WILKE T., HAASE M., HERSHLER R., LIU H. P., MISOF B., PONDER W. F. 2013. Pushing short DNA fragments to the limit: Phylogenetic relationships of ‘hydrobioid’ gastropods (Caenogastropoda: Rissooidea). *Molecular Phylogenetics and Evolution* 66: 715–736.
<https://doi.org/10.1016/j.ympev.2012.10.025>
- WORMS (EDITORIAL BOARD) 2024. World Register of Marine Species. Available online at <https://www.marinespecies.org> at VLIZ (accessed 2 January 2024).
<https://doi.org/10.14284/170>
- Received: January 5th, 2024*
Revised: March 5th, 2024
Accepted: March 12th, 2024
Published on-line: May 21st, 2024

