AQUATIC MOLLUSCS OF THE ZEMPLÍNSKÁ ŠÍRAVA DAM RESERVOIR (EAST SLOVAKIA)

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ABSTRACT: The mollusc communities of the Zemplínská Šírava dam reservoir were studied in 2019. The reservoir, built in 1961–1965, is situated in the eastern part of Slovakia near the boundary with Ukraine; with its area of 33 km\(^2\) it is the second biggest dam reservoir in Slovakia. Nineteen species (13 gastropods, 6 bivalves) were recorded in the first more detailed inventory of its malacofauna. The mollusc communities in individual sites consisted of 8–14 species. The existence of littoral zone overgrown by macrophytes is important especially for populations of pulmonate snails while unionids were usually found on muddy or sandy bottom. Five non-native species were recorded. The abundant population of non-native \textit{D. polymorpha} probably has a negative impact on unionids because of the shortage of suitable substrata (rocks, stones) for attachment, and as a result \textit{D. polymorpha} uses shells of dead or live unionids.

KEY WORDS: dam reservoir, Zemplínská Šírava, aquatic molluscs

INTRODUCTION

Dams have been altering riverine ecosystems since humans started constructing them. They have a positive effect on civilisation through their various designed purposes, irrigation being the most important. At the same time, they exert an array of adverse effects on humans and they affect ecosystems in a negative way (Hanks 2020). On the other hand, the dams provide appropriate habitats for aquatic molluscs which prefer stagnant waters (e.g. Dvořák & Beran 2004, Beran 2007, Horáčková et al. 2014).

The Zemplínská Šírava dam reservoir, 33 km\(^2\) in area, is the second biggest dam reservoir in Slovakia. Though aquatic molluscs of the country have been studied for a long time, its fauna has not been inventoried yet. Only unpublished records of 10 species from this reservoir, without precise location data, exist from 1978 (leg. J. Šteffek). It was the reason for a more detailed survey done during the 22nd session of the Czech and Slovak malacologists (“MalacoDays 2019”) in Novice. The results are presented here.

MATERIAL AND METHODS

Samples were taken by the author in 2019. In total, 7 sites were studied (Fig. 1, Appendix 1). The main method used was washing vegetation and sediments using a metal sieve (diameter 20 cm, 0.8 mm mesh) combined with hand-collecting from the surface of stones, wood and artificial materials (e.g. plastic bags and bottles). Snorkelling in shallow parts (up to ca. 3 m deep) was also used. The molluscs were identified based on shell characters or genital structure whenever purely conchological identification was impossible. Specimens for dissection were killed in hot water and then fixed in 80% ethanol. Selected shells and alcohol-preserved specimens are deposited in the author’s collection. The classification used follows Horsák et al. (2019).
STUDY AREA

The Zemplínská Šírava dam reservoir is situated in the eastern part of Slovakia near the boundary with Ukraine, at an altitude of 113.7 m a. s. l. The dam was built in 1961–1965, and the reservoir is 33 km² in area. Its average depth is 9.5 m, with the maximum depth 14 m. The reservoir is fed by a canal (Šíravský kanál) of the Laborec River (tributary of the Bodrog River, Danube river basin). The area is primarily used for recreation (it is also called “Slovak sea”).

RESULTS

In total, 19 aquatic molluscs (13 gastropods, 6 bivalves) were found at 7 sites of the Zemplínská Šírava reservoir (Fig. 1). The mollusc communities in individual sites consisted of 8–14 species (for the list of species and estimated population density see Table 1). Physella acuta, Unio pictorum, U. tumidus and Dreissena polymorpha were found in all the sites, Bithynia tentaculata, Valvata piscinalis, Radix auricularia, Anisus spirorbis, Gyraulus cf. parvus and Anodonta anatina were recorded in 4–6 sites while the remaining species were found at only 1–3 sites. R. auricularia, P. acuta, G. cf. parvus and D. polymorpha usually formed abundant populations.

Rich gastropod communities with abundant populations were found within the littoral zone overgrown by macrophytes (sites No. 3, 4, Fig. 2) while sites with sparse macrophyte vegetation were inhabited by fewer species (e.g. sites No. 2, 5, 6, Fig. 3). Live unionids were usually found on muddy or sandy bottom at the depth of 1–3 m and probably occurred also in the deeper parts which were not investigated. Viviparus acerosus and Pseudanodonta complanata are listed as Vulnerable in the Red List of molluscs of Slovakia (ŠTEFFEK & VAVROVÁ 2006) while the other species are common and widespread. P. complanata was recorded in three sites while V. acerosus only in one site (No. 5, only few specimens).

P. acuta, G. parvus, Ferrissia californica, Sinanodonta woodiana and D. polymorpha are non-native invasive species. In the case of G. parvus the identification is only preliminary due to its similarity to G. laevis (Alder, 1838) so this taxon is mentioned only as G. cf. parvus in this study (see Discussion).
Table 1. List of aquatic molluscs recorded from the Zemplínská Šírava reservoir

| Species/Site No.                   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Σ |
|-----------------------------------|---|---|---|---|---|---|---|---|
| Viviparus acerosus (Bourguignat, 1862) |   | × |   |   |   |   |   | 1 |
| Bithynia tentaculata (Linnaeus, 1758) | × |   | × | × |   |   |   | 4 |
| Valvata piscinalis (O. F. Müller, 1774) |   | × | × | × |   |   |   | 4 |
| Galba truncatula (O. F. Müller, 1774) |   |   | × |   |   |   |   | 1 |
| Radix auricularia (Linnaeus, 1758) | ××× | ×× | × | × | × | × | ×× | 6 |
| Lymnaea stagnalis (Linnaeus, 1758) | × |   | × |   |   |   |   | 2 |
| Physella acuta (Draparnaud, 1805) | ××× | ××× | × | × | ×× | ×× | ××× | 7 |
| Anisus spirorbis (Linnaeus, 1758) | ×× | × | ×× |   |   |   |   | 4 |
| Gyraulus albus (O. F. Müller, 1774) | × |   |   |   |   |   |   | 2 |
| Gyraulus crista (Linnaeus, 1758) |   |   |   |   |   |   |   | 1 |
| Gyraulus cf. parvus (Say, 1817) | ××× | ××× | ××× | ××× | ××× | ××× | ××× | 5 |
| Hippeutis complanatus (Linnaeus, 1758) | ×× |   |   |   |   |   |   | 1 |
| Ferrisia californica (Rowell, 1863) |   |   |   |   |   |   |   | 1 |
| Unio pictorum (Linnaeus, 1758) | ×× | × | × | × | × | × | ×× | 7 |
| Unio tumidus Philipsson, 1788 | × | ×× | x | × | × | × |   | 7 |
| Anodonta anatina (Linnaeus, 1758) | × | ×× |   | × | × |   |   | 5 |
| Pseudanodonta complanata (Rosssmässler, 1835) |   | × | × |   |   |   |   | 3 |
| Sinanodonta woodiana (Lea, 1834) | ×× | ×× |   | × |   |   |   | 3 |
| Dreissena polymorpha (Pallas, 1771) | ××× | ××× | ×× | ×× | ×× | ×× | ×× | 7 |
| Number of species                | 11 | 8 | 12 | 14 | 9 | 8 | 9 |   |

× – few specimens, ×× – scattered occurrence, ××× – abundant occurrence.

Fig. 2. Bank with overgrown bight (site No. 4); littoral zone overgrown by macrophytes. Photo: LUBOŠ BERAN
DISCUSSION

This survey is the first more detailed inventory of aquatic molluscs of this extensive reservoir built more than 50 years ago, therefore it is impossible to compare its results with any previous research. Only records of 10 species from the reservoir exist, albeit with no precise location data. J. Šteffek (unpublished) made the records in 1978. He mentioned the occurrence of Borysthenia naticina (Menke, 1845), V. piscinalis, G. truncatula, R. auricularia, R. labiata (Rossiasmässler, 1835), G. albus, G. crista, G. laevis, U. pictorum and A. anatina. All species except B. naticina, R. labiata and G. laevis were found during the present survey. Previously, B. naticina was known in Slovakia only from the Danube River and its floodplain (Ložek 1956, Lisický 1991, Horsák et al. 2019) and its occurrence in the dam reservoir is doubtful; the record probably resulted from misidentification of V. piscinalis. R. labiata is common and widespread, it inhabits especially nutrient-poor habitats and its occurrence in the reservoir 10–15 years after its filling is possible. The abundant occurrence of G. cf. parvus was documented during this survey instead of G. laevis mentioned by J. Šteffek in 1978. Both species (G. laevis, G. parvus) are very similar and the difference between them is hardly perceptible, so it is not certain which species occurred in the reservoir on the previous occasion. The status of the two forms is still uncertain, hence material was collected for genetic analysis.

The malacofauna of the Zemplínská Šírava reservoir includes only 13 species of freshwater snails out of the 52 aquatic snail species known in Slovakia (Horsák et al. 2019). Similarly, few gastropod species were found in other dam reservoirs in Slovakia, e.g. in the Oravská Priehrada reservoir (13–14 species; Šteffek & Nagel 2004), in the Věstonice reservoir (14 species; Beran 2013) and in small dam reservoirs in the Slovak Carpathians – a maximum of 12 species (Čejka 2011). Similar numbers of freshwater snail species were found in most of dam reservoirs in Poland in Upper Silesia (Strzelec 2005, Strzelec et al. 2005) while 21 gastropods were recorded in the Slapy reservoir built on the Vltava River in the Czech Republic (Beran 2007).

There was a positive dependence between the presence of macrophytes on the one hand, and the abundance and species richness of pulmonate snails...
on the other. A similar dependence was observed by Jurkiewicz-Karnkowska (2002) who studied mollusc communities of the Sulejów dam reservoir in Poland.

Dam reservoirs provide favourable habitats for abundant populations of unionids preferring standing waters (e.g. Dvořák & Beran 2004, Steffek & Nagel 2004, Beran 2007, Golab et al. 2010, Horáčková et al. 2014). On the other hand, human-induced transformation of running into standing waters favours common unionids, and dramatically reduces habitat for species which inhabit mostly streams and rivers (Burlakova et al. 2011). Five unionid species (U. pictorum, U. tumidus, A. anatina, P. complanata, S. woodiana) out of the seven species known from Slovakia were recorded from the Zemplínská Šírava reservoir. Only U. crassus Philipsson, 1788, a typical inhabitant of running waters (e.g. Beran 2019) was missing, as was A. cygnea (Linnaeus, 1758), which on the other hand prefers standing waters including dam reservoirs. P. complanata, declining in most European countries and listed in the IUCN Red List of Threatened Species as Vulnerable (Van Damme 2011) was found in the Zemplinská Šírava. The species is a typical inhabitant of rivers (e.g. Beran 2002, Killeen et al. 2004, Beran 2019) but it is also known to occur in lakes (e.g. Van Damme 2011, Piechocki & Wawrzyniak-Wydrowska 2016) and dam reservoirs (Horáčková et al. 2014). This unionid usually occurs in low densities and belongs to the rarest native unionids (e.g. Zettler 1998, 1999, Killeen et al. 2004, Beran 2019); also in the Zemplínská Šírava it is rare and only 1–3 specimens per site were found. The species is rare in Slovakia and is known mostly from lowland rivers along the Danube (Podunajská nižina) and in the south-eastern part of Slovakia (Východoslovenská nižina) (Lisický 1991, Čejka et al. 2015, Horsák et al. 2019).

Dam reservoirs, especially those used for recreation, are often a place of mass occurrence of alien invasive molluscs which often dominate in such habitats (Strzelec 2005, Strzelec et al. 2005), for example P. acuta in the Věstonice dam reservoir (Beran 2013). This also applies to Zemplínská Šírava, where the dominants are P. acuta, G. cf. parvus and D. polymorpha. The abundant population of D. polymorpha probably has a negative impact on the unionid populations including the vulnerable P. complanata, because of the deficit of suitable attachment substrata (rocks, stones) and as a result D. polymorpha uses valves of dead or live unionids (Fig. 4). The populations of native unionids can also be negatively affected by the invasive Chinese giant mussel S. woodiana. This bivalve can compete with native unionids for food, increase resistance to glochidia in potential host fishes and serve as a vector for introduction of new parasites and diseases (Lopes-Lima et al. 2017,

Fig. 4. Live Unio tumidus (left) and Pseudanodonta complanata (right) with sessile specimens of Dreissena polymorpha. Photo: Luboš Beran
DONROVICH et al. 2017, DOUDA & ČADKOVÁ 2018). An abundant occurrence of G. cf. parvus was observed in most of the sites but without any obvious effect on the native species; the same was true of P. acuta and F. californica.

REFERENCES

BERAN L. 2002. Vodní měkkýši České republiky – rozšíření a jeho změny, stanovitě, šíření, ohrožení a ochrana, červený seznam. Sborník přírodovědného klubu v Uh. Hradišti, Supplementum 10: 1–258.

BERAN L. 2007. Vodní měkkýši přehradní nádrže Slapy (Česká republika). Malacologica Bohemoslovaca 6: 11–16. Online serial at <http://mollusca.sav.sk>

BERAN L. 2013. Freshwater mussels of the Dyje (Thaya) river and its tributaries – the role of these water bodies in expansion of alien species and as a refuge for endangered gastropods and bivalves. Folia Malacologica 21: 143–160. https://doi.org/10.12657/folmal.021.018

BERAN L. 2019. Distribution and recent status of fresh-water mussels of family Unionidae (Bivalvia) in the Czech Republic. Knowledge and Management of Aquatic Ecosystems 420: 45. https://doi.org/10.1051/kmae/2019038

BURLAKOVA L. E., KARATAYEV A. Y., KARATAYEV V. A., MAY M. E., BENNET D. L., COOK M. J. 2011. Endemic species: contribution to community uniqueness, effect of habitat alteration, and conservation priorities. Biological Conservation 144: 155–165. https://doi.org/10.1016/j.biocon.2010.08.010

ČEJKA T. 2011. Diversity patterns and freshwater mussel communities in small water reservoirs. Malacologica Bohemoslovaca 10: 5–9.

ČEJKA T., ČACANÝ J., HORSÁK M., JUŘIČKOVÁ L., BUĎOVÁ J., DUDA M., HOLUBOVÁ A., HORSÁKOVÁ V., JANŠOVÁ M., KOCURKOVÁ A., KORÁBEK O., MANÁŠ M., ŘIHOVÁ D., ŠIZLING A. L. 2015. Vodné měkkýše ochranársky významných lokalít na Podunajskej nížine. Malacologica Bohemoslovaca 14: 5–16. Online serial at <http://mollusca.sav.sk> 21-April-2015.

DONROVICH S. W., DOUDA K., PLECHINGEROVÁ V., RYĽKOVÁ K., HORKY P., SLAVÍK O., LIU H. Z., REICHARD M., LOPES-LIMA M., SOUSA R. 2017. Invasive Chinese pond mussel Sinanodonta woodiana threatens native mussel reproduction by inducing cross-resistance of host fish. Aquatic Conservation Marine and Freshwater Ecosystems 27: 1325–1333. https://doi.org/10.1002/aqc.2759

DOUDA K., ČADKOVÁ Z. 2018. Water clearance efficiency indicates potential filter-feeding interactions between invasive Sinanodonta woodiana and native freshwater mussels. Biological Invasions 20: 1093–1098. https://doi.org/10.1007/s10530-017-1615-x

DVOŘÁK L., BERAN L. 2004. Remarkable records of aquatic molluscs in the Lipno Reservoir and its environs. Silva Gabreta 10: 97–106.

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GOLAB M. J., LIPINSKA A. M., ČMIEL A. M. 2010. The consequences of water release from a dam reservoir for freshwater mussel survival: recommendations for improved management. Ekołgia (Bratislava) 29: 454–459. https://doi.org/10.4149/ekol_2010_04_454

HANKS D. R. 2020. Dams. In: GOLDSTEIN M. I., DELLASALA D. A. (eds) Encyclopedia of the World’s Biomes. Elsevier, Amsterdam.

HORÁČKOVÁ J., LOŽEK V., BERAN L., JUŘIČKOVÁ L., PODROUŽKOVÁ Š., PETERKA J., ČECH M. 2014. Měkkýší údolí Vltavy (Čechy). Malacologica Bohemoslovaca 13: 12–105. Online serial at <http://mollusca.sav.sk> 22-Apr-2014.

HORSÁK M., ČEJKA T., JUŘIČKOVÁ L., BERAN L., HORÁČKOVÁ J., HLAVÁČ J. Č., DVOŘÁK L., HAJEK O., DIVIŠEK J., MANÁŠ M., LOŽEK V. 2019. Check-list and distribution maps of the molluscs of the Czech and Slovak Republics. Online at <http://mollusca.sav.sk/malacology/checklist.htm>. Checklist updated at 8-October-2019, maps updated at 2-October-2019.

JURKIEWICZ-KARNKOWSKA E. 2002. Occurrence of molluscs communities in a lowland dam reservoir colonized by Dreissena polymorpha (Pallas) (Sulejów reservoir, Central Poland). Polish Journal of Ecology 50: 5–16.

KILLEEN I., ALDRIDGE D., OLIVER G. 2004. Freshwater bivalves of Britain and Ireland. Field Studies Council & National Museum of Wales, Shrewsbury.

LISICKY M. J. 1991. Mollusca Slovenska. Veda, Bratislava.

LOPES-LIMA M., SOUSA R., GEIST J., ALDRIDGE D. C., ARAUJO R., BERGEMREN J., BESPALAYA Y., BÓDIS E., BURLAKOVA L., VAN DAMME D., DOUDA K., FROUFE E., GEORGYEV D., GUMPINGER C., KARATAYEV A., KEBAPCI Ü., KILLEEN I., LAJTNER J., LARSEN B. M., LAUCERI R., LEGAKIS A., LOIS S., LUNDBERG S., MOORKENS E., MOTTE G., NAGEL K.-O., ONDINA P., OUTEIRO A., PAUNOVIC M., PRIÉ V., VON PROSCHWITZ T., RICCARDI N., RUDZTÉ M., RUDZITIS M., SCHEIDER C., SEDDON M., ŠEREFLIȘAN H., SIMIĆ V., SOKOLOVA S., STOECKL K., TASKINEN J., TEIXEIRA A., THIELEN F., TRICHKOVÁ T., VARANDAS S., VICENTINI H., ZAJAC K., ZAIJAC T., ZOGARIS S. 2017. Conservation status of freshwater mussels in Europe: state of the art and future challenges. Biological Reviews 92: 572–607. https://doi.org/10.1111/brv.12244

LOZEK V. 1956. Klíč československých měkkýšů. Slovenská akadémie věd, Bratislava.

PIECHOCA A., WAWRYNIAK-WYDRZOSKA B. 2016. Guide to freshwater and marine Mollusca of Poland. Bogucki Wydawnictwo Naukowe, Poznań.
STRZELEC M. 2005. The settlement of anthropogenic water-bodies of Silesia by Ferrissia clessiniana (Jickeli). Malacologia Bohemoslovaca 4: 5–9. http://mollusca.sav.sk/4.htm

STRZELEC M., SPYRA A., KRODKIEWSKA M., SERAFINSKI W. 2005. The long-term transformations of gastropod communities in dam-reservoirs of Upper Silesia (Southern Poland). Malacologia Bohemoslovaca 4: 41–47. http://mollusca.sav.sk/4.htm

ŠTÉFEK J., NAGEL K.O. 2004. Vodné mákkýše regiónu Orava. Zborník Oravského múzea (Dolný Kubín) 21: 185–193.

ŠTÉFEK J., VAVROVÁ L. 2006. Current ecosozological status of molluscs (Mollusca) of Slovakia in accordance with categories and criterion of IUCN – version 3.1. (2001). In: KRYCHUK G. Y. (ed.). Molluscs: perspective of development and investigation, 27–29th September 2006, Zytomyr, Ukraine: pp. 266–276.

VAN DAMME D. 2011. Pseudanodonta complanata. The IUCN Red List of Threatened Species 2011: e. T18446A8279278. https://doi.org/10.2305/IUCN. UK.2011-2.RLTS.T18446A8279278.en. (accessed 12 November 2019).

ZEITLER M. L. 1998. Zur Verbreitung und Morphologie von Pseudanodonta complanata (Rossmassler, 1835) in Mecklenburg-Vorpommern (Bivalvia: Unionidae). Malakologische Abhandlungen des staatlichen Museums für Tierkunde, Dresden 15: 139–149.

ZEITLER M. L. 1999. Zur Verbreitung und Ökologie der Groß-, Dreikant- und Kugelmuscheln in Fließgewassern Mecklenburg-Vorpommerns (Bivalvia: Unionidae, Dreissenidae und Sphaeriidae). Heldia 4: 21–32.

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APPENDIX 1

List of sampling sites, data as follows: site number, geographical co-ordinates, name of the nearest settlement, site description, date of sampling.

1. 48°47'19.6"N, 21°56'47.5"E, Vinné, Zemplínská Šírava dam reservoir at the inflow of the Šíranský kanál canal, 25.06.2019;
2. 48°47'55.6"N, 22°00'02.8"E, Kaluža, north-western edge of Zemplínská Šírava reservoir, 27.06.2019;
3. 48°48'29.6"N, 22°01'45.5"E, Klokočov, northern edge of Zemplínská Šírava reservoir by the church, 25.06.2019;
4. 48°48'31"N, 22°02'19.7"E, Klokočov, overgrown bight of Zemplínská Šírava reservoir (Fig. 2), 24.06.2019;
5. 48°46'37.8"N, 22°02'24.7"E, Lúčky, south-eastern edge of Zemplínská Šírava reservoir, 26.06.2019;
6. 48°46'00.1"N, 21°59'35.8"E, Malé Zalužice, southern edge of Zemplínská Šírava reservoir, 26.06.2019;
7. 48°46'40.1"N, 21°57'14.3"E, Michalovce, western edge of Zemplínská Šírava reservoir, 25.06.2019.