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NOTES AND NEW DATA ON THE DISTRIBUTION OF A NON-NATIVE OLIGOCHAETE: *BRANCHIURA SOWERBYI* (BEDDARD, 1892) IN CROATIA

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The freshwater oligochaete *Branchiura sowerbyi* is indigenous to southeast Asia, but can be found inhabiting most of Europe. This tubificid was even described for the first time outside of its natural area of occurrence: in the garden of the Royal Botanic Society in London. It has spread over all continents except Antarctica, and in Europe it has been found in 23 countries. The presence of this non-native species may affect other species' relationships in the benthic community and thus have substantial effects on food webs of aquatic ecosystems. Our goal was to present the first comprehensive overview of the distribution of this potentially invasive species in Croatia as a basis for the future monitoring of the species distribution. In Croatia, *B. sowerbyi* was found for the first time in 1954 in Varaždin's thermal stream and the following year in the lake of the Botanical garden, Faculty of Science, University of Zagreb. To date, *B. sowerbyi* individuals were found on 64 different sites in Croatia, mostly occupying the Pannonian Lowland Ecoregion (ER 11) with only two findings in the Dinaric Western Balkan Ecoregion (ER 5).

Key words: invasive species, tubificid distribution, Dinaric Western Balkan Ecoregion, Pannonian Lowland Ecoregion

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Prirodni areal rasprostiranja vrste *Branchiura sowerbyi* je jugoistočna Azija, no ovaj se maločetinaš može pronaći u slatkovodnim ekosustavima diljem Europe. Čak je i prvi opis ove vrste tubificida bio izvan njegovog prirodnog areala rasprostiranja, točnije u botaničkom vrtu „Royal Botanic Society" u Londonu. Ova vrsta danas je prisutna na svim kontinentima osim Antartike, a u Europi je zabilježena u 23 zemlje. Prisustvo ove alohtone vrste može imati još neutvrđene implikacije na zajednice slatkovodnih makroskopskih beskralježnjaka, kao i na funkcioniranje hranidbenih mreža unutar ovih zajednica. Cilj ovog rada bio je izraditi sveobuhvatan pregled distribucije ove vrste na području Hrvatske kao bazu za buduće nadziranje širenja te vrste. U Hrvatskoj je vrsta *B. sowerbyi* nađena prvi put 1954. godine u termalnom potoku u Varaždinu, a već sljedeće godine pronađena je u Botaničkom vrtu Sveučilišta u Zagrebu. Dosad je vrsta zabilježena na 64 različite lokacije na području Hrvatske, većinom u Panonskoj ekoregiji (ER 11), dok je u Dinaridskoj ekoregiji (ER 5) dosad zabilježena na samo dvije lokacije.

Ključne riječi: invazivna vrsta, rasprostranjenost tubificida, Dinaridska ekoregija, Panonska ekoregija

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INTRODUCTION

The majority of freshwater ecosystems in Europe are under some form of anthropogenic impact: water drainage, dam construction, river flow alternation and many others (Ward *et al*., 1999). Alongside all these negative environmental influences, there is also the influence of alien invasive species introduction (Elton, 1958). The transport of people and goods increased in the last century, and so did the transfer of non-indigenous animals, plants and microorganisms (Bryan, 1996). Alien species may change both the taxonomic and functional composition of the community and even become the dominant taxon or functional entity (Vermeij, 1996). Nevertheless, some authors suggest that "*invasive species denialism*" is gaining more followers in the scientific community (Russell & Blackburn, 2017a, b). Regardless of the denialism theory, in practice the invasions truly are most often revealed too late, when they have already grown to a very large scale, and as such, are difficult to suppress.

These, intentionally or unintentionally introduced, species are allochthonous or non–native and they could become invasive species if the conditions are favorable (Gollasch & Nehring, 2006). Alien species who find themselves in a new area often do not have natural predators, so they have the possibility to become great competitors (Pyšek & Pyšek, 1995; MacDougall *et al*., 2009). One of the most important scientific tasks is to predict the outcomes of the introduction of a particular species and the possible impact on ecosystems that are housing or might house the non-native species. This can be done only if comprehensive and detailed data is kept on the distribution and dispersal rates of the alien species.

One of the potentially invasive species is a widespread tubificid oligochaete *Branchiura sowerbyi* (Beddard, 1892) native to Southeast Asia (Mills *et al*., 1993). *B. sowerbyi* can be typically found in warmer freshwaters that are rich in organic matter and with flow rates of less than 0.5 ms^{-1} (Paunovic *et al*., 2005). With high distributional spreading rates and high breeding rates, *B. sowerbyi* has a great invasive potential which could be triggered by various anthropogenic instabilities in freshwater ecosystems such as temperature, elevation or habitat degradation (Carrol & Dorris, 1972; Nehring 2002). The tubificid was described for the first time by Beddard (1892) in the garden of the Royal Botanic Society in London. In Southeast Asia, it was first identified by Brinkhurst in 1969. It is spread over all continents except Antarctica. In Europe, it has been found in 23 countries (www.fauna-eu.org/). It is assumed that *B. sowerbyi* has been spread by ornamental aquatic plant transport and by importing fish for aquacultural purposes (Paunovic *et al*., 2005). *B. sowerbyi* can reproduce both sexually and asexually (by fragmentation) and at temperatures between 21 and 29 °C they exhibit great reproductive potential, ascending at 25 °C (Aston *et al*., 1982). Their growth and reproduction are influenced by the amount of organic matter present in freshwater substrates (Georgieva *et al*., 2012). Because of its great reproduction rates and size (it can grow to 185 mm) *B. sowerbyi* is frequently used as food in fish farming facilities. On the other hand, recent research has shown that *B. sowerbyi* can serve as a host for a microscopic cluster of Myxozoa, which causes various diseases in fish used in aquaculture (Zhao *et al*., 2016) leading to both ecologic and economic damage (Hedrick, 1998).

The presence of this species may affect other species' relationships in the benthic community and thus have a substantial effect on food webs of aquatic ecosystems (Paunovic *et al*., 2005). Due to its size and easy handling, this species is also used in ecotoxicological research to estimate the level of contamination of river and lake sediments with various pollutants (Casellato *et al*., 1992).

In Croatia, *B. sowerbyi* was found for the first time in 1954 in Varaždin's thermal stream (Matoničkin, 1957) and the following year in the lake of the Botanical garden, Faculty of Science, University of Zagreb (Devide, 1956). *B. sowerbyi* was later found in the artificial lake Jarun near Zagreb (Kerovec *et al*. 1989), the lower course of the Krapina River north of Zagreb and in the hydroelectric power plant reservoir on the Drava River near Varaždin (Mihaljević *et al*., 2007; Kerovec *et al*., 2016). Since the beginning of 21st century, intensive monitoring and freshwater research according EU Water framework directive requirements were conducted on all types of water bodies in Croatia, yielding new data and evidence on the growing distribution of this species. Our goal was to present the first comprehensive overview of the distribution of this potentially invasive species in Croatia.

MATERIAL AND METHODS

Study area

The territory of Croatia spreads across two ecoregions: the Dinaric Western Balkan Ecoregion (ER 5) and the Pannonian Lowland Ecoregion (ER 11) (Illies, 1978). The ER 5 is characterized by a range of different climates: temperate-humid to humid-boreal climate, with warm summers in the mountainous eastern part of ER 5, whereas the western (Mediterranean) part is in most part characterized by Mediterranean climate but in some areas has a temperate humid climate, both with dry hot summers. ER 11 is in most part characterized by temperate-humid climate (Šegota & Filipčić, 2003). Research in both Ecoregions has been evenly conducted within the investigated period.

Data collection

This paper represents a comprehensive overview of the presence of *B. sowerbyi* in Croatia, incorporating literary data with unpublished research data. All new records are the result of multiannual (1987 – 2018) research and monitoring projects of the Department of Biology, Division of Zoology, Faculty of Science, University of Zagreb, Croatia. All collected oligochaete specimens are deposited in this institution.

B. sowerbyi individuals were identified using Brinkhurst (1986) and Timm (2009).

RESULTS AND DISCUSSION

To date, *B. sowerbyi* individuals with their distinctive finger-like posterior gills (Fig. 1) were found on 64 different sites in Croatia (Tab. 1). Although all research did not evaluate abundance, it is important to note that *B. sowerbyi* abundance ratios were found to be very high in some artificial or anthropogenicaly altered freshwater

habitats. A study conducted on reservoirs in 2016 showed that *B. sowerbyi* abundances might make up as much as half of the total macroinvertebrate abundance in these lentic habitats. This was the case in Gravel pit Novo Čiče (site 46) where 51% of all macroinvertebrate individuals were *B. sowerbyi*. A study conducted on channels and channelized lotic habitats in 2018 showed abundance percentages of *B. sowerbyi* reaching up to 42% in Sutla River (Donje Brezno) (site 62).

Fig. 1. Finger-like gills on posterior end of a *B. sowerbyi* specimen found in Bednja River (Site 43).

Tab. 1. General information on sites of *B. sowerbyi* findings in Croatia.

Sampling site number	Study area	Ecoregion	Findings	Year of finding	Coordinates
1	Zagreb - pond in the Botanical Garden (published research)	Pannonian	Devide, 1956	1955	45.80502, 15.97241
2	Thermal stream - Varaždinske toplice (published research)	Pannonian	Matoničkin, 1957	1954	46.21165, 16.42606 (aprox)
3	Zagreb - Gravel pit Jarun	Pannonian	Kerovec *et al.*, 1989	1984, 1985, 2016	45.78065, 15.91705
4	Drava River- Reservoir HEPP Varaždin	Pannonian	Kiš-Novak, 2007.	1999, 2003, 2016	46.38090, 16.18191
5	Drava River- Reservoir HEPP Čakovec	Pannonian	Kiš-Novak, 2007.	1999, 2003, 2016	46.31494, 16.40811
6	Drava River- Reservoir HEPP Dubrava	Pannonian	Kiš-Novak, 2007	1999, 2003, 2016	46.31309, 16.65558
7	Krapina River - Gubaševo	Pannonian	Molak, 2009	2008	46.02035, 15.85589
8	Krapina River - Zaprešić	Pannonian	Molak, 2009	2008	45.83965, 15.82306
9	Šumetlica Stream - Prvča	Pannonian	Kerovec *et a*l., 2016	2009	45.22788, 17.34116
10	Česma River - Narta	Pannonian	Kerovec *et al.*, 2016	2009	45.83756, 16.82253
11	Česma River - Čazma	Pannonian	Kerovec *et al.*, 2016	2006	45.75246, 16.60939
12	Artificial channels Nova Lonja	Pannonian	Kerovec *et a*l., 2016	2003	45.17395, 17.22616
13	Plitvica River, Selnik	Pannonian	Kerovec *et a*l., 2016	2009	46.27376, 16.51512
14	Sutla River - Zelenjak	Pannonian	Kerovec *et al.*, 2016	2009	46.05887, 15.70778
15	Trnava River	Pannonian	Kerovec *et al.*, 2016	2008	46.43101, 16.59124
16	Murščak Stream	Pannonian	Kerovec *et al.*, 2016	2008	46.44154, 16.61545
17	Šenkovec Reservoir	Pannonian	Kerovec *et al.*, 2016	2008	46.4252, 16.42335
18	Selnica Reservoir	Pannonian	Kerovec *et al.*, 2016	2008	46.50113, 16.39946
19	Trakošćan Reservoir	Pannonian	Kerovec *et al.*, 2016	2006, 2007	46.26187, 15.93628
20	Čemernica Stream -Trakošćan	Pannonian	Kerovec *et al.*, 2016	2007	46.26707, 15.94735
21	Kopačevo Lake - dam	Pannonian	Kerovec *et a*l., 2016	1988	45.60847, 18.79885

22	Old River Drava - Osijek	Pannonian	Kerovec *et al*., 2016	1988.	45.54945, 18.75563
23	Drava River - Osijek (Bilje)	Pannonian	Kerovec *et al*., 2016	1988	45.591257, 18.734397
24	Drava River - D. Miholjac	Pannonian	Kerovec *et al*., 2016	2009	45.77507, 18.17291
25	Drava River - Botovo	Pannonian	Kerovec *et al*., 2016	2009	46.23362, 16.94265
26	Drava River - Old river channel HEPP Dubrava	Pannonian	Kiš-Novak, 2007; Mihaljević *et al*., 2007	2002	46.31736, 16.74408
27	Drava River - Old river channel HEPP Čakovec	Pannonian	Kerovec *et al*., 2016	2010, 2011, 2012	46.30759, 16.52381
28	Drava River - Old river channel HEPP Varaždin	Pannonian	Kerovec *et al*., 2016	2002, 2004, 2006, 2008, 2012	46.37636, 16.19298
29	Sava River - Račinovci	Pannonian	Kerovec & Kerovec, 2014	2009.	44.85092, 18.96052
30	Sava River - Gunja	Pannonian	Kerovec & Kerovec, 2014	2004, 2007	44.88089, 18.81477
31	Sava River - Stara Gradiška	Pannonian	Kerovec & Kerovec, 2014	2004, 2007	45.14844, 17.24841
32	Crna Mlaka - Fish Pond	Pannonian	Kerovec *et al*., 2016	1987	45.61595, 15.73151
33	Kraljevec Stream - Zagreb	Pannonian	Kerovec *et al*., 2016	2003	45.88000, 15.94111
34	Maksimir Lake II - Zagreb	Pannonian	Kerovec *et al*., 2016	2003	45.82289, 16.02131
35	Maksimir Lake III - Zagreb	Pannonian	Kerovec *et al*., 2016	2003	45.82541, 16.01830
36	Maksimir Lake V - Zagreb	Pannonian	Kerovec *et al*., 2016	2003	45.83280 16.02453
37	Bliznec Stream - Zagreb (Maksimir)	Pannonian	Kerovec *et al*., 2016	2003	45.83585, 16.02702
38	Radonja River - Vojnić	Pannonian	Kerovec *et al*., 2016	2006	45.32731, 15.69702
39	Turpinjska River - Grabovac Krnjacki	Pannonian	Kerovec *et al*., 2016	2006	45.34193, 15.61417
40	Mrežnica River - Karlovac	Pannonian	Kerovec *et al*., 2016	2006	45.46533, 15.53788
41	Botonega reservoir (Istria)	Dinaric	Kerovec *et al*., 2016	2012	45.32562, 13.92199
42	Dobra River - Jarče Polje	Dinaric	New record	2006	45.45629, 15.41299
43	Bednja River-Lepoglava	Pannonian	New record	2015	46.20722, 16.04055
44	Bednja River-Ludbreg	Pannonian	New record	2015	46.25694, 16.63583
45	Gravel pit Rakitje	Pannonian	New record	2016	45.78965, 15.84373
46	Gravel pit Novo Čiče	Pannonian	New record	2016	45.71184, 16.10331
47	Borovik reservoir	Pannonian	New record	2016	45.39164, 18.18720
48	Jošava reservoir	Pannonian	New record	2016	45.32278, 18.45258
49	Lapovac II reservoir	Pannonian	New record	2016	45.48027, 18.11297
50	Pakra reservoir	Pannonian	New record	2016	45.43810, 16.89887
51	Popovac reservoir	Pannonian	New record	2016	45.63776, 16.87407
52	Sakadaš Lake	Pannonian	New record	2016	45.60828, 18.80041
53	Grabova reservoir	Pannonian	New record	2016	45.27137, 19.07371
54	Gravel pit Koprivnica	Pannonian	New record	2016	46.23605, 16.90363
55	Glogovnica-Donji Lipovčani	Pannonian	New record	2018	45.75602, 16.53428
56	Pakra-Janja Lipa	Pannonian	New record	2018	45.44702, 17.01271
57	Ilova-Veliki Zdenci	Pannonian	New record	2018	45.66638, 17.12173
58	Drava Ledine Molvanske	Pannonian	New record	2018	46.12931, 17.06687
59	Drava-Storgač	Pannonian	New record	2018	46.05062, 17.25237
60	Drava-Gat, Petrovo selo	Pannonian	New record	2018	45.72774, 18.31975
61	Črnomerec, Srednjaci	Pannonian	New record	2018	45.79151, 15.93752
62	Sutla River-Donje Brezno	Pannonian	New record	2018	46.18220, 15.63790
63	Kapinci channel, near Drava	Pannonian	New record	2018	45.80835, 17.70868
64	Sava River- Slavonski Brod	Pannonian	New record	2018	45.15221, 18.00074

In general, *B. sowerbyi* did not extend to the area of the Dinaric Ecoregion (ER 5, Fig. 2), with the exception of a reservoir located in Istria (Butoniga, site 41) which is part of Adriatic basin and a river located near the border of the two ecoregions (Dobra River, site 42) which is part of Black sea basin. ER 5 has some parts that are of similar climate to ER 11 (temperate-humid climate) and even parts that have warmer Mediterranean climate that would be more suitable for the southeast-Asian species. Nevertheless, populations of *B. sowerbyi* were not noted in this warmer Mediterranean climate. Most rivers and lakes of the ER 5 are located on karstic terrain and rich in calcium carbonate (in both sediment and dissolved in water). The Botonega reservoir is an exception: in the upper part of its basin geological layers have flysch and alluvial deposits prone to erosion, which is more characteristic for reservoirs of ER 11 rather than ER 5 (Žic *et al.*, 2010). Further research is needed to assess species' preferences to specific environmental characteristics of each ecoregion.

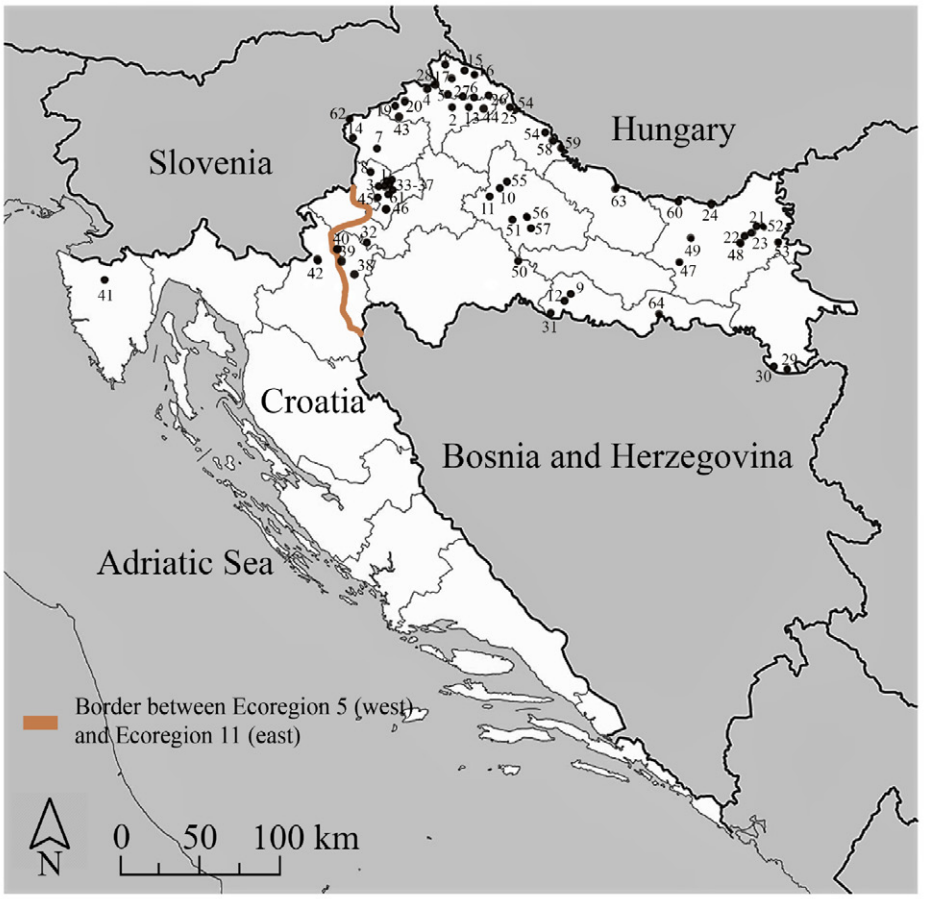

Fig. 2. Distribution of *Branchiura sowerbyi* in Croatia. Location numbers are presented in Tab. 1.

B. sowerbyi is seemingly not the dominant oligochaete species present in Croatian water bodies in general, although its abundances appear to proliferate in artificial or heavily modified water bodies of ER 11. This shift in dominance within oligochaete assemblages may prove to occur with hydromorphological alternations or even as a result of climate change. Continuous research and monitoring are needed to determine how this species affects biodiversity and freshwater invertebrate community dynamics and if its presence can indicate ecological degradation in the ecosystems.

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REFERENCES

Aston, A. R. J., Sadler, K. & Milner, A. G. P., 1982: The effects of temperature on the culture *Branchiura sowerbyi* (Oligochaeta, Tubificidae) on activated sludge. Aquaculture **29** (1–2), 137-145.

Beddard, F. E., 1892: A new branchiate Oligochate (*Branchiura sowerbyi*). Quarterly Journal of Microscopical Science **33**, 325 - 341.

Brinkhurst, R. O., 1969: Aquactic Oligochaeta of the Azores and Madeira. Boletim do Museu Municipal do Funchal **23**, 46 - 48.

Brinkhurst, R.O., 1986. Guide to the freshwater aquatic microdrile oligochaetes of North America. Department of Fisheries and Oceans, Ottawa, 1 – 529.

Bryan, R. T., 1996: Alien species and emerging infectious diseases: Past lessons and future applications. In: Sandlund G. T., Schel P. J., Viken A., (eds.), Proceedings of the Norway UN Conference on Alien Species. Norwegian Institute for Nature Research, Trondheim, Norway. p. 74-80.

Carroll, J. H. & Dorris, T. C., 1972: The life history of *Branchiura sowerbyi*. American Midland Naturalist **87**, 413–422.

Casellato, S., Aiello, R., Negrisolo, P. A. & Seno M., 1992: Long-term experiment on *Branchiura sowerbyi* Beddard (Oligochaeta, Tubificidae) using sediment treated with LAS (Linear Alkylbenzene Sulphonate). Hydrobiologia **232**, 169-173.

Devide, Z., 1956: *Branchiura sowerbyi* u jezeru botaničke bašte u Zagrebu. Biol. Vestnik **5**, 76-78.

Elton, C. S., 1958: The ecology of invasions by animals and plants. Methuen, London. p. 159.

Georgieva, G., Varadinova E. & Uzunov Y., 2012: Distribution of non indigenous tubificid worm *Branchiura sowerbyi* (Beddard, 1892) in Bulgaria. Journal of Bioscience and Biotechnology, SE/ ONLINE: 105-113.

Gollasch, S. & Nehring, S., 2006: National checklist for aquatic alien species in Germany. Aquatic Invasions **1**, 245-269.

Hedrick, R. P., 1998: Relationships of the host, pathogen and environment: Implications for diseases of cultured and wild fish populations. Journal of Aquatic Animal Health **10**, 107–111.

Illies, J., 1978: Limnofauna Europaea. A Checklist of the Animals Inhabiting European Inland Waters, with an Account of their Distribution and Ecology. 2nd Edition. Gustav Fischer Verlag, Stuttgart. p. 552.

Kerovec, M., Tavčar, V. & Meštrov, M., 1989: Macrozoobenthos as an indicator of the level of the trophy and saprobity of lake Jarun. Acta Hydrochimica et Hydrobiologica **17** (1), 37-45.

Kerovec, M. & Kerovec, M., 2014: Oligochaeta and Polychaeta fauna of the Croatian part of the Sava River. Natura Croatica, **23**, 335–348.

Kerovec, M., Kerovec, M. & Brigić, A., 2016: Croatian freshwater oligochaetes: species diversity, distribution and relationship to surrounding countries. Zootaxa, **4193** (1): 073-101.

Kiš-Novak, D., 2007: Makrozoobentos kao pokazatelj kakvoće vode akumulacija na rijeci Dravi. Magistarski rad, Sveučilište u Zagrebu. Masters thesis, University of Zagreb, Faculty of Science. In Croatian.

MacDougall, A. S., Gilbert, B. & Levine, J., 2009: Plant invasions and the niche. – Journal of Ecology., **97**: 609–615.

Matoničkin, I., 1957: Ekološka istraživanja faune termalnih voda Hrvatskog Zagorja. Jugoslavenska Akademija znanosti i umjetnosti RAD **312**, 139-206. [Ecological research of thermal waters in Croatian Zagorje] In Croatian.

Mihaljević, Z., Kerovec, M. & Ternjej, I., 2007: Maločetinaši (Oligochaeta) kao pokazatelji trofije akumulacija na rijeci Dravi. In: Gereš, D. (Ed.), Zbornik radova 4. Hrvatska konferencija o vodama: Hrvatske vode i Europska unija—izazovi i mogućnosti. Sveučilišna tiskara, Zagreb, pp. 163–169. In Croatian.

Mills, E. L., Leach, J. H., Carlton, J. T. & Secor, C. L., 1993: Exotic species in the Great Lakes: a history of biotic crises and anthropogenic introductions. Journal of Great Lakes Research **19** (1), 1-54.

Molak, Z., 2009: Makrozoobentos kao pokazatelj sezonskih i prostornih razlika u kakvoći vode rječica Krapine i Krapinice. Magistarski rad. Prirodoslovno–matematički fakultet, Sveučilište u Zagrebu. Masters thesis, University of Zagreb, Faculty of Science. In Croatian.

Nehring, S., 2002: Biological invasions into German waters: an evaluation of the importance of different human-mediated vectors for nonindigenous macrozoobenthic species. In: Leppäkoski, E., Gollasch, S., Olenin, S. (Eds.) Invasive aquatic species of Europe: Distribution, impacts and management. Kluwer Academic: Dordrecht.

Paunovic, M., Miljanovic, B., Simic, V., Cakic, P., Djikanovic, V., Jakovcev-Todorovic, D., Stojanovic, B. & Veljkovic, A., 2005: Distribution of non-indigenous tubificid worm *Branchiura sowerbyi* (Beddard, 1892) in Serbia. Biotechnology & Biotechnological Equipment **3**, 91-97.

Pyšek, P. & Pyšek, A., 1995: Invasion by *Heracleum mantegazzianum* in different habitats in the Czech Republic. Journal of Vegetation Science **6**, 711–718.

Russell, J. C. & Blackburn, T. M., 2017a: The Rise of Invasive Species Denialism. Trends in Ecology Evolution **32**, 3-6.

Russell, J. C. & Blackburn, T. M., 2017b: Invasive Alien Species: Denialism, Disagreement, Definitions, and Dialogue. Trends in Ecology & Evolution **32**, 312-314.

Šegota, T. & Filipčić, A., 2003: Köppenova podjela klima i hrvatsko nazivlje. Geoadria **8** (1), 17–37 (In Croatian).

Timm, T., 2009: A Guide to the Freshwater Oligochaeta and Polychaeta of Northern and Central Europe. Lauterbornia **66**, 1–235.

Vermeij, G. J., 1996: An agenda for invasion biology. Biological Conservation **78**, 3–9.

Ward, J. V., Tockner, K. & Schiemer, F., 1999: Biodiversity of floodplain river ecosystems: Ecotones and connectivity. River Research and Applications **15**, 125–139.

www.https://fauna-eu.org (Accessed on October 1 2019).

Zhao, D., Borkhanuddin, M. H., Wang, W., Liu, Y., Cech, G., Zhai, Y., & Székely, C., 2016: The life cycle of *Thelohanellus kitauei* (Myxozoa: Myxosporea) infecting common carp (*Cyprinus carpio*) involves aurantiactinomyxon in *Branchiura sowerbyi*. Parasitology Research **115** (11), 4317–4325.

Žic, E., Ožanić, N. & Vranješ M., 2010: Function of the Drainage-Retaining Botonega Channel in the Integrated Management of the Botonega Accumulation. Conference paper: Balowis 2010 At: Ohrid, Republic of Macedonia; DOI: 10.13140/2.1.1795.9682.