DISTRIBUTION OF NON-INDIGENOUS TUBIFICID WORM *BRANCHIURA SOWERBYI* (BEDDARD, 1892) IN SERBIA

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ABSTRACT

Recently, dispersion of invasive species became an important theme, since the man-aided outspread of the organisms was recognized as one of the major threats to the biodiversity. Aquatic biotopes are, due to its unique features, among the most disposed ecosystems to this kind of disturbance. Non-indigenous species of different origin were found among plants, vertebrates and invertebrates. Aquatic worm Branchiura sowerbyi (Beddard 1892) is obvious example of human induced dispersal of invertebrates. The aim of the study was to contribute to the cognition of the current distribution of this invasive species and to point up, once again, the risk of devastation of aquatic ecosystems caused by distribution of alien species. B. sowerbyi was for the first time observed in Serbia in 1972 in fish pond in Vojvodina. Since that time the worm spread its areal and now it could be found in a lot of ponds, channels, reservoirs and lowland rivers in Serbia. According to our results B. sowerbyi has been well adapted in artificial and modified water bodies in Serbia.

Introduction

During the last century, there is increasing cognizance in relation to the human-aided dispersal of species beyond their natural range of distribution. Alien plants and animals became one of the major threats to the aquatic ecosystems (1). Ballast water of ships, plant cultivation and fish farms were pointed as prospective agents of dispersal of aquatic organisms (2, 3, 4, 5), as well as unprofessional fish stocking for recreational fishery.

The establishment and consequences of introduced species has been object of a discussion in a lot of studies (6), but we are still not able to predict outcome of the introduction of particular species, as well as the impact of invasions in general to specific ecosystem. Therefore, every finding of non-indigenous species and effort to understand the way of transport, introduction, establishment and spread of species, or a group of species of the same origin, is valuable in the process of defining of predictable models, as well as an attempt to warn to the problem of endangerment of native biodiversity caused by invaders. In that regard, the aim of this paper is to present current distribution of *Branchiura sowerbyi* (Beddard 1892) in Serbian waters, to point up to its the progressive dispersal, and to try to contribute to the recognition of vectors of introduction and ways dispersal, as well as cause of successful adaptation.

B. sowerbyi originates from tropics (7).

The worm lives with its heads buried in the sediment, whilst the tails wave actively in water layer above the bottom. It is conveyor-belt feeder that mixes sediments (8). Potentially, it can have a large impact on the recipient environment since it is characterized by high adaptability to local conditions (9). *B. sowerbyi* is a thermal water species, with huge ability of adaptation. It is typical for waters with current velocity under 0.5 ms^{-1} (10).

Recently, the growing colonization of allochthonous organisms in the Serbian waters was observed. Non-indigenous species were found among plants (11), vertebrates (12, 13, 14, 15) and invertebrates (16, 17, 10, 18, 19, 5). The invasive species of different origin were detected. Thus, five fish (13) and one Decapoda species (*Eriocheir sinensis* – 5) that originate from East Asia were observed in the Danube River. Further, five invasive fish taxa introduced from North America were found in ichthiofauna of Serbia (13). Ponto-Caspian invaders represent particular threat to aquatic ecosystems in Serbia - five Ponto-Caspian gobiids (Gobiidae) were found in the Serbian stretch of the Danube River (12, 13). *Hypania invalida* (Polychaeta) is also a Ponto-Caspian invaders that was frequently observed in the Danube River after damming the river (17, 19). Among invertebrates, aquatic worm *Branchiura sowerbyi* (Beddard) is obvious example of anthropogenic introduction and progressive dispersal. This worm was recorded for the first time in Europe, in botanical garden in London, 1892 and it seems that this introduction could be connected with transport of plants from one part of the world to another. Later, *B. sowerbyi* was found in other parts of the Europe. It was recorded (literature review 20) in Germany, France, Ireland, Belgium, Italy, Switzerland, Czech Republic and Rumania. This invasive species was also found in Slovakia, in three water bodies belonging to the Tisza river basin (21), as well as in the River Struma in Bulgaria (22).

Materials and Methods

The study is based on long-time investigations of Oligochaeta fauna in Serbia, from 1982 up to now. Database on Aquatic Ecosystem Diversity in Serbia (23), developed on Faculty of Science, University of Kragujevac, Serbia and Montenegro, has been used to obtain relevant data, thus covering whole territory of Serbia (**Fig. 1**). The most intensive investigations was performed in period 1995-2004, covering the Danube, the Tisza, the Sava, the Kolubara, the Velika Morava, the Juzna Morava the Zapadna Morava the Ibar, the Nisava, the Mlava and the Timok catchments areas (Fig. 1). The study comprehends samples from 311 sampling sites. The investigation was performed at main watercourses, as well as at tributaries and Reservoirs in the region, mostly in periods of high (April-July) and low water conditions (September and November). A total of 380 findings of *B. sowerbyi* in Serbian waters were taken into the consideration with the aim to observe distribution of this aquatic worm. In addition, data from two international expeditions on the Danube River that are stored in database of International Commission for the Protection of the Danube River, Vienna (24) were used in order to maintain the distribution *B. sowerbyi* along Serbian stretch of the Danube River.

Results presented in this study have been based on material collected by Hydraulic Polyp Grab, FBA hand net (mesh size 950 and 500 µm), benthological dredga (mesh size 250 µm), Ekman-type grab (225 cm^2) and Van Veen grab (270 cm^2).

Results and Discussion

Current distribution of *B. sowerbyi* in Serbia is presented at Fig. 1.

B. sowerbyi was for the first time observed in Serbia in 1972 (16) in fish pound near Futog (Fig. 1, site 1). Since that time, the worm rapidly spreads it's areal, and

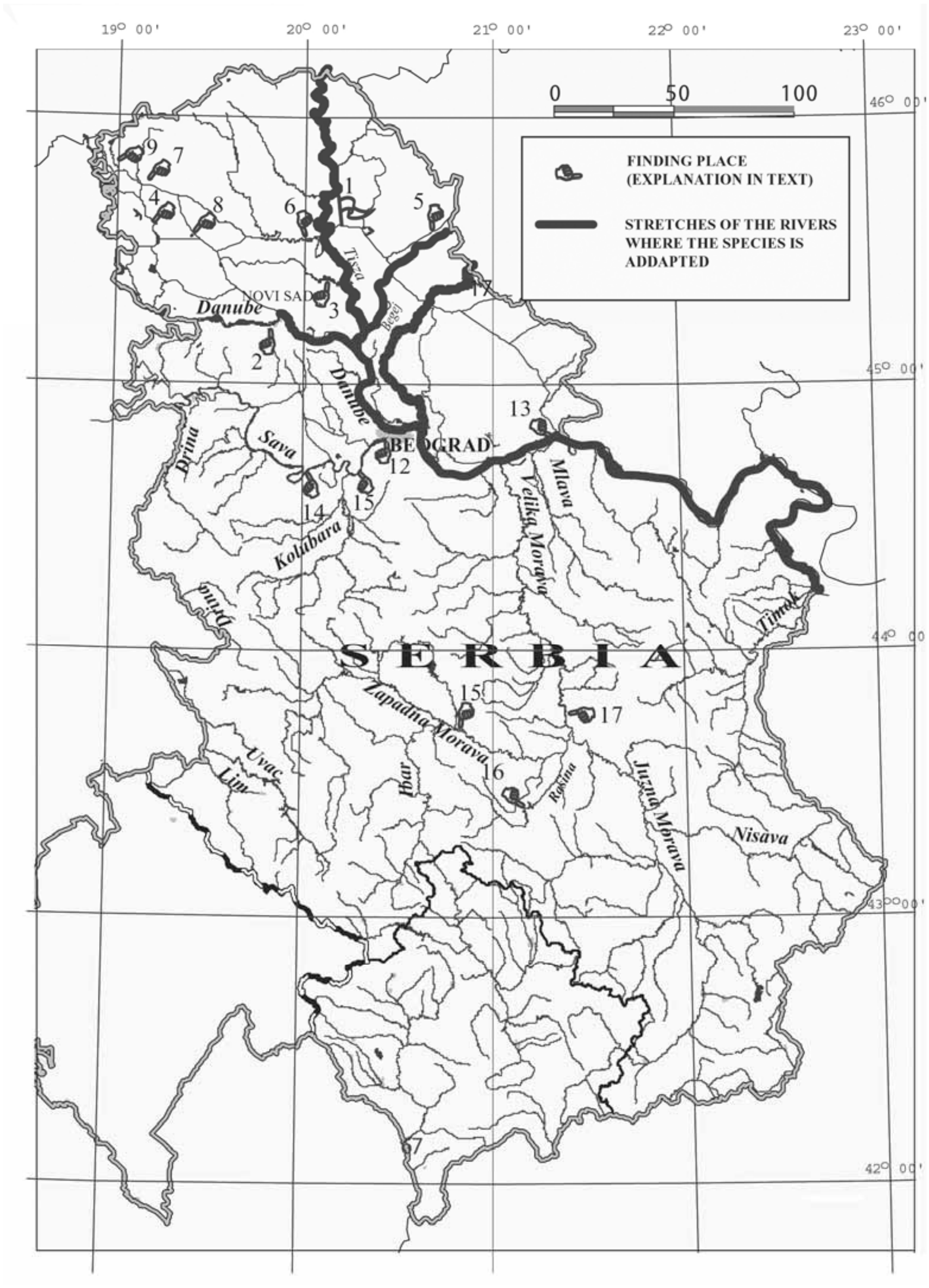

Fig. 1. Distribution of *Branchiura sowerbyi* in Serbia.

now it could be found in a lot of ponds, channels, reservoirs and some potamon-type rivers in Serbia (Fig. 1). Initial introduction of this worm could be connected with import of fish for fish farming.

The dispersal of *B. sowerbyi*, after initial introduction and population establishment, has been rapid. The worm has been found in period 1972-1977 in fish ponds Becej (4.6-22.0% of total density of Oligochaeta) and Jegricka, (9.3-14.2% of total density of Oligochaeta) Vojvodina (Fig. 1, sites 2, 3) (25). Soon after the first finding, in period 1977-1981, dense populations of *B. sowerbyi* were observed in a several artificial, slow-running, channels in Vojvodina (up to 52.2% of total density of Oligochaeta), which are the part of artificial, multipurpose channel system Danube-Tisza-Danube (DTD). (Fig. 1, sites 4, 5, 6, 7, 8, 9) (10). During eighties *B. sowerbyi* spread its areal and became frequent and abundant inhabitant of soft-bottom habitats in some large lowland rivers in Serbia. It has been found along entire Serbian sector of the Tisza River (up to 7.26% of total macrozoobenthos and up to 36.00% of Oligochaeta community) and Tamis River - Fig. 1 bold line (23). *B. sowerbyi* was observed in the Sava River (Fig. 1, sites 10, 11) (26), as well as in the artificial Lake Sava (Fig. 1, site 12) (27), ex side arm of the Sava River that was isolated from the main course by the dam, and nowadays it is used as bathing water.

B. sowerbyi was also found in the Velika Morava Basin (23) (Fig. 1, sites 15, 16 and 17), but with lower population density (up to 5 % of population).

According to the way of dispersal of *B. sowerbyi* in Serbian waters, fast spreading is enabled by the presence of artificial channel network DTD.

B. sowerbyi was for the first time recorded 1979 in Serbian sector of Danube River (Fig. 1, site 13) near Banatska Palanka (28). Up to know, this aquatic worm has been observed in the main channel of the Danube River within the sector from Novi Sad, (1255 km) to Radujevac/Srbovo (849 km) (Fig 1, bold line; up to 56.00 % of the total macrozoobenthos community and up to 76.00 % of Oligochaeta community).

B. sowerbyi was not found in the main channel of the Danube River upstream Novi Sad (23, 24), although its presence is expected due to the fact that is has been observed in upstream tributaries of the Hungarian stretch of the Danube River, near to the mouth into the Danube - the Sio River, empties into the Danube at 1497 and the Tas River that tribute into the Danube at 1568 km (24). *B. sowerbyi* has not been observed (24) during AquaTerra Danube Survey (Danube key study within the AquaTerra project - EU 6th Framework Program, No. N°505428) that was performed at the stretch between Vienna (1942 km) and Calafat (795 km).

B. sowerbyi has been found mainly within artificial and modified waters in Serbia. Thus, the worm has been observed in the main channel of the Danube River in the sector of altered hydrological regime. Due to the dam construction on the Danube near Sip (943 km), 1973, a large Reservoir Djerdap (Iron Gate), was formed. Reservoir is 100 km in length, extends from the dam to Golubac (1040 km). After damming of the Danube, flow rate is slowed far upstream, up to Slankamen (1215 km). The area where back-water effect has been observed is correlated with dispersion and adaptation of *B. sowerbyi* in the main channel of the Danube River. Further, Serbian part of the Tisza River, is influenced by the dam near Novi Becej – 63 km of the watercourse (Fig. 1). The Tamis and the Begej Rivers are also heavily modified water bodies with changed hydrological conditions (29).

Although the Sava River has been classified as heavily modified water body (30), the hydrological regime has not been such altered in compare with the Danube stretch downstream Novi Sad (Fig. 1), as well as in compare with the Tisza, the Begej and the Tamis Rivers (29). In the case of the Sava River *B. sowerbyi* has been found at two sites (Fig. 1, sites 11, 12), but with lower population density (up to 7 % of the macrozoobenthos community). Scattered distribution of *B. sowerbyi* within the Velika Morava Basin (Fig. 1, sites 15, 16 and 17) could be also explained by existence of stretches with temperate hydrological modification (29) which are not suitable for accommodation of this invasive species.

It could be assumed that, due to the considerable distance in regard to other sites, *B. sowerbyi* spread its areal to Celije Reservoir (Fig. 1, site 16) due to the new introduction related to transplanting of fish for stocking or dissemination by birds by way of excrements.

Nedeljkovic (17) discussed changes in invertebrate community in period 1971-1977, after damming the Danube. He emphasized that changes in hydrological conditions provoked alters in density and biomass of benthic invertebrates, as well as appearance of non-indigenous species *Hypania invalida* (Polychaeta). Further, Martinovic-Vitanovic at al. (31) pointed up changes in benthic community of the Danube River in Belgrade Region (1190-1124 km) in relation to altered hydrological regime.

Our study, as well as prior discussions on response of aquatic fauna to alternation of hydrological conditions (17, 32, 31, 13, 26), indicates that hydrological alternations favour the dispersal of non-indigenous species, as it is the case with *B. sowerbyi. B. sowerbyi* is typical inhabitant of slow waters with intensive sedimentation (10), so conditions that have been created after the regulation of particular rivers in Serbia contribute to the successful adaptation of the worm.

Successful adaptation of *B. sowerbyi* to silt-clay dominated aquatic habitats in Serbia could be connected to its morphological adaptations. Genus *Branchiura* is unique among aquatic worms by dorsal and ventral gill filaments on the segments beyond 30 that provide high adaptability to the environment with low concentration of oxygen (33). According to Caroll and Dorris (9) *B. sowerbyi* is a thermal water species, with huge ability of adaptation to the local environmental conditions.

Further, it should be underlined that *B. sowerbyi* is an alternate host for some fish parasites - *Thelohanellus nikolskii, T. hovorkai* and *Sphaerospora renicola* (34). In this direction, spreading of *B. sowerbyi* could, indirectly, cause reduction of fish abundance and could be reason for damage to the local fisheries.

Conclusions

Aquatic worm *B. sowerbyi* is obvious example of anthropogenic introduction and fast dispersal of invertebrates. Introduction of this worm in Europe could be connected with transport of plants from one part of the world to another. Initial introduction of *B. sowerbyi* in Serbia could be linked with the import of fish for fish farming. Further rapid dispersal and population establishment of this exotic species is connected to artificial water bodies and regulated rivers and it could be found in a lot of ponds, channels, reservoirs and lowland rivers in Serbia. Spreading has been accelerated by presence of artificial canal network DTD. The population establishment is encouraged by alternation of hydrological conditions in potamon-type rivers in Serbia. Spreading of *B. sowerbyi* on some waters that are isolated from other finding sites (Celije Reservoir, Fig. 1, site 16), by distance and existence of river stretches that are not suitable for accommodation of this species, could be explained as new introduction related to transplanting of fish for stocking, or by dissemination of cocoons by bird excrements.

Due to the fast dispersal and success in adaptation that was underlined in our work, *B. sowerbyi* could be characterized as invasive species. According to presented results, further monitoring of distribution, population dynamics and possible effects to aquatic ecosystems is needed. Presence of this species could disturb relations within benthic community and, consequently, could have influence to the aquatic ecosystem food chain. In addition, *B. sowerbyi* is an alternate host for some fish parasites - *Thelohanellus nikolskii, T. hovorkai* and *Sphaerospora renicola* (34). In this direction, spreading of *B. sowerbyi* could, indirectly, cause reduction of fish abundance and could be reason for damage to the local fisheries.

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