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A MASSIVE FRESHWATER MUSSEL BED (BIVALVIA: UNIONIDAE) IN A SMALL RIVER IN UKRAINE

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Abstract: During a monitoring survey, a massive mussel bed was found and studied in the Gnily Rig River, Ukraine. The mussel bed was 25 cm thick and multilayered, with one of the greatest densities and biomass (wet weight) recorded so far in natural aggregations: up to 1,801.0 ± 175.4 ind./m² and up to 88.3 ± 20.7 kg/m², respectively. The site was surveyed periodically since 2009, and despite the temporal differences in the density (but not in biomass) the mussel bed was stable and should be considered for protection due to its high ecological and conservational value.

Key words: Unionoida, *Unio tumidus*, *U. pictorum*, *Anodonta anatina,* freshwater mussels, densities, conservation

INTRODUCTION

Freshwater mussels are among the most threatened animal groups on the planet, and in the last decades a growing number of studies have been conducted concerning their ecology and conservation (Lopes-Lima et al. 2014). Assessments of density and biomass of freshwater mussel assemblages are necessary for ecological comparisons and as a reference for the present conservation status of these organisms (Strayer et al. 2004, Régnier et al. 2009). Although descriptive in nature, the characterisation of density, biomass and size structure of mussel beds is extremely useful in order to detect possible temporal changes but also to report extreme values that could be seen as an exception or a reminiscent of earlier conditions with small human disturbance (Strayer 2008, Haag 2012). In this study, we assessed the density and biomass of a massive mussel bed found in the summer of 2009 in the River Gnily Rig (Ukraine).

MATERIALS AND METHODS

The studied site (50°14'45"N, 26°39'54"E) is located in the River Gnily Rig, a left-bank tributary of the Vilia River in the Pripyat basin (Fig. 1). The river has the total length of 28 km and the mean annual discharge of about 0.8 m³/sec. During the first survey a large mussel bed was found near the Bilotyn village (Figs 1, 2), 100 m downstream of a small pond. The surveyed section of the river channel was 12 m wide, and 0.5–0.6 m deep in the summer, the current velocity was low and the sediments were mainly

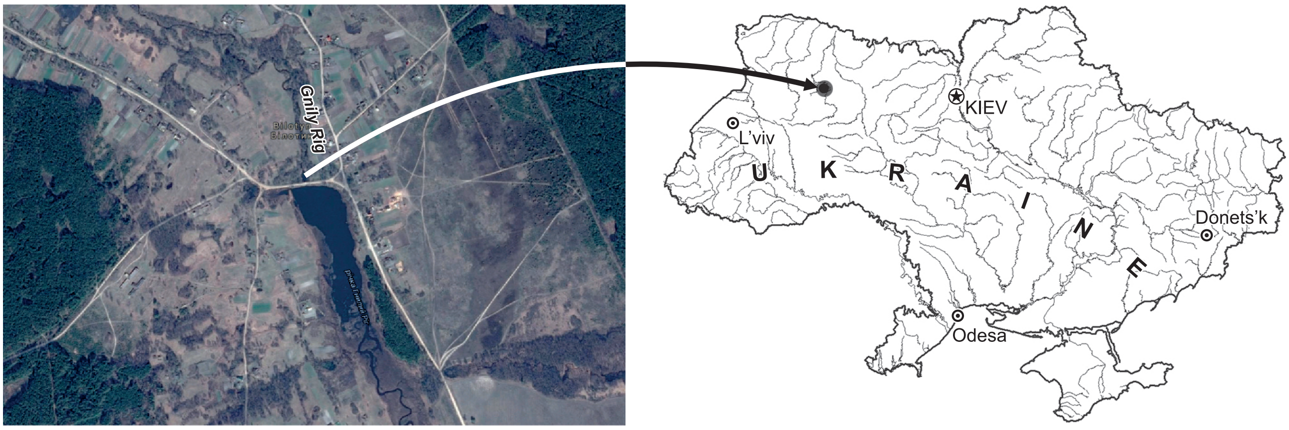

Fig. 1. Sampling site in the Gnily Rig River in Ukraine where the unionid mussel bed was found

constituted by silts and colonised by aquatic vegetation such as *Sagittaria* sp., *Nuphar* sp., and *Carex* sp. Although this stretch was located 5 km upstream of the cooling reservoir of the Khmelnitsky nuclear power plant, it was not under any thermal influence. The large accumulation of freshwater mussels was found in the form of a multilayered colony with the minimum thickness of 25 cm (Fig. 3).

Surveys were conducted during the summers of 2009, 2012, 2013 and 2014 using 0.1 m^2 frames randomly located in the mussel bed. Three replicates were collected each year in order to minimise disturbance. From each frame, the individuals were collected, identified to the species level, counted, measured and the biomass (wet weight) was determined. All the specimens were carefully returned to the river in their original position. Possible differences in density and biomass over the years were tested using ANOVA.

Fig. 2. Study area with the mussel bed

Fig. 3. Massive accumulation of unionid mussels

RESULTS

In 2009, the total mean (± standard deviation) density and biomass were 1,801.0 ± 175.4 ind./m² and 86.6 ± 9.0 kg/m², respectively (Figs 4, 5). The mussel bed was dominated by *Unio tumidus* Philipsson, 1788 with 86% of the total density and 91% of the total biomass. Other mussel species were also present, namely *Anodonta anatina* (Linnaeus, 1758) and *Unio pictorum* (Linnaeus, 1758), but with much smaller density and biomass. The bed was mainly dominated by large mussels with the mean length of 75.5 mm for *U. tumidus*, 65.2 mm for *U. pictorum* and 74.9 mm for *A. anatina* (Table 1). Further assessments were performed in 2012, 2013 and 2014, in order to monitor the main characteristics of the mussel bed. In the

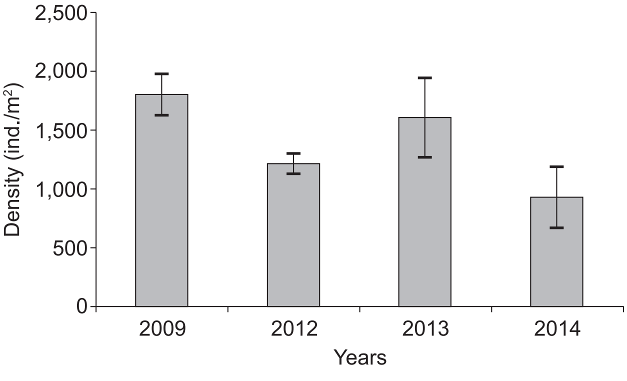

Fig. 4. Total mean (± standard deviation) density of unionid mussels collected over the years

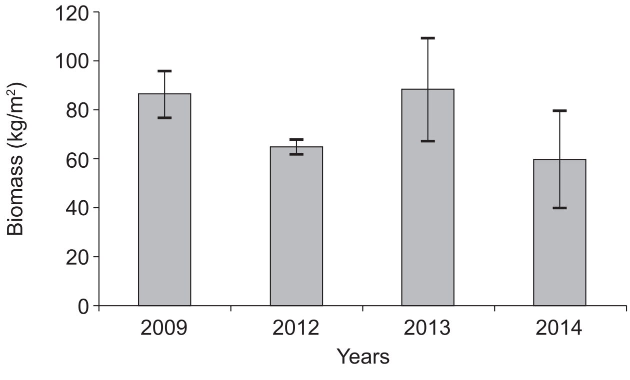

Fig. 5. Total mean (± standard deviation) biomass (wet weight) of unionid mussels collected over the years

Table 1. Mean shell length (mm) of unionid mussels collected in the sampling site in the Gnily Rig River

Year	*U. tumidus*	*U. pictorum*	*A. anatina*
2009	75.5 ± 7.1	65.2 ± 11.2	74.9 ± 3.7
2012	77.7 ± 9.0	69.5 ± 3.3	76.9 ± 12.9
2013	77.4 ± 8.5	63.0 ± 13.1	81.0 ± 11.0
2014	79.6 ± 8.9	78.8 ± 4.2	72.5 ± 11.7

summer of 2012 there was a significant decrease in the water level due to low river flow (the river water level dropped by about 50 cm leaving the mussel bed at the total depth of not more than 20–30 cm). The 2012 survey showed that the mussel populations had strongly declined when compared to 2009, probably due to the low water level. The mean density and biomass were 1,217.7 ± 82.3 ind./m^2 and 64.7 ± 2.6 kg/m^2, respectively (Figs 4, 5). The dominant species was still *U. tumidus* with 71% of the total number of individuals and 86% of the total biomass. The bed again was mainly composed of large mussels of a size similar to that found in 2009 (Table 1). The surveys during 2013 showed an increase in the density and biomass with the mean values of 1,604.8 ± 336.8 ind./m^2 and 88.3 ± 20.7 kg/m^2, respectively (Figs 4, 5). The dominant species was again *U. tumidus* with 88% of the total number of individuals and 91% of the total biomass. Finally, the surveys conducted in the summer of 2014 showed that the density and biomass of the mussel bed had declined again. The mean density and biomass were 926.0 ± 259.9 ind./m^2 and 59.5 ± 19.7 kg/m^2, respectively (Figs 4, 5). The assemblage was again dominated by *U. tumidus* (94% of the total density and 96% of the total biomass), and only a few specimens of *A. anatina* and *U. pictorum* were found. Overall, we detected significant year-to-year differences in the density ($F=6.85$; $p=0.017$) but not in the biomass ($F=2.45$; $p=0.148$). The bed was dominated by large mussels during the whole period of studies; the mean shell length fluctuated slightly (Table 1).

DISCUSSION

Despite the temporal oscillations in the density and biomass observed during the five years, the values reported in this study are quite exceptional. The mussel bed occupied the total area of approximately 13 m^2, and so the total number of mussels in the surveyed years always exceeded 12,000 and the weight was more than 700 kg. Mussel beds are known to occur at sites where shear stresses are small and sediments are stable during flooding (Strayer et al. 2004). However, due to their complex life history traits which include long life span, parental care and parasitic larval stage on specific hosts (usually fish), the requirements of all life stages must be met. Specific factors such as food quality and quantity, availability of hosts during the season of larval discharge, well-oxygenated substrates for juvenile survival and growth, and refuge from predators may also be important in structuring mussel beds. Therefore, future studies should assess the importance of abiotic and biotic factors structuring this mussel bed and, if possible, to estimate its functional importance (e.g. water filtration, bioturbation, nutrient cycling).

In the literature, some reports of high density and biomass of unionoids exist and they usually deal with highly disturbed areas such as thermal ponds of power plants, or with highly pristine sites with almost no human disturbance. In fact, Afanasjev et al. (1996) reported massive beds of large mussels at the Konin lakes (Poland) within the cooling system of two thermal power plants, where the invasive freshwater mussel *Sinanodonta woodiana* (Lea, 1834) occupied most of the heated areas (discharge canals) reaching a high density (more than 200 ind./m^2) and biomass (50 kg/m^2). Similar density and biomass values were also reported for the River Danube under the influence of the Paks nuclear power plant (Hungary) in a bivalve assemblage also dominated by *S. woodiana* (Bódis et al. 2014). On the other hand, according to Coker et al. (1921) densities of 30–180 ind./m^2 were reported for some American rivers, before human influence (Strayer 2014). More recently, and already subjected to higher human disturbance, the density in some sites in the River Hudson reached more than 200 ind./m^2 (Strayer et al. 1994). In Europe, Ziuganov et al. (1994) estimated the mean density of *Margaritifera margaritifera* (Linneaus, 1758) in undisturbed rivers as 15 ind./m^2. However, more recently, Popov & Ostrovsky (2014) reported high densities (up to 1,000 ind./m^2) of this mussel species in an undisturbed pristine site on the River Peypia (Russia).

The Unionidae are among the most threatened taxa in the world and there has been an overall decline in Europe, including Ukraine, both in terms of the number of populations and the density (Yanovich & Pampura 2011, Lopes-Lima et al. 2014). Freshwater mussels are beginning to be recognised for their exceptional roles in ecosystem functioning (reviewed in Vaughn et al. 2008) although the exact true nature of their importance in pristine sites with high densities is still incompletely understood. Therefore, this unique mussel bed with its exceptionally large density and biomass is of extreme importance for future ecological studies on freshwater bivalves, and the site should be targeted for protection.

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