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Distribution of Rotifer *Kellicottia bostoniensis* (Rousselet, 1908) (Rotifera: Brachionidae) in Water Bodies and Watercourses of Nizhny Novgorod Oblast

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Abstract—In view of frequent findings of the alien North American rotifer *Kellicottia bostoniensis* (Rousselet, 1908) in water bodies and watercourses of Russia, the generalization of information about its locations and ecological requirements in particular regions has become an urgent task. The rotifer *K. bostoniensis* was recorded in 32 water objects (19 watercourses, 13 water bodies) of Nizhny Novgorod oblast from 55° to 56° N and from 42° to 43° E. In most water bodies, we recorded *K. bostoniensis* for the first time. The invader is widespread in water bodies and watercourses with different morphometry, current velocity, transparency, water color, pH, conductivity, trophic status, and level of anthropogenic pollution. *K. bostoniensis* dwells in a wide range of water pollution: from quality classes II to VI (clean to extremely polluted) of water. The highest frequency of occurrence and density of the rotifer are mainly recorded in July in ponds of eutrophic streams with slow current, high concentrations of nutrients, and well-developed higher aquatic vegetation. In some water bodies, the invader frequently co-occurred with the aboriginal species *Kellicottia longispina* (Kellicott, 1879). Only *K. bostoniensis* was recorded in small streams within the precincts of the city of Nizhny Novgorod. A wide distribution of *K. bostoniensis* in Nizhny Novgorod oblast and the ability to live in water bodies with different complex of natural factors and degree of anthropogenic impact may indicate high ecological plasticity of the species and the possibility of its further expansion.

Keywords: zooplankton, invader, *Kellicottia bostoniensis*, distribution, water bodies, watercourses, Nizhny Novgorod oblast

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INTRODUCTION

Over the first 15 years of the 21st century, in view of the increasing number of findings of the North America rotifer *K. bostoniensis* (Rousselet, 1908) in water bodies and watercourses of Russia, its distribution and ecological requirements remain key points of interest of researchers. A great bulk of the data on the distribution and possible ways of dispersion of *K. bostoniensis* in water bodies and watercourses has been obtained on a vast territory of Russia (Ivanova and Telesh, 2004), in Lake Onega and water bodies of its basin, in Lake Ladoga (Lobunicheva et al., 2011; Makartseva and Rodionova, 2011; Aleshina et al., 2014; Fomina and Syarki, 2015), in lakes and rivers of the Upper and Middle Volga basins (Zhdanova and Dobrynin, 2011; Lobynicheva et al., 2011; Bayanov, 2014), and in reservoirs of the Upper Volga basin: Ivankovo, Uglich, and Sheksna (Lazareva and Zhdanova, 2014). By 2015, *K. bostoniensis* had spread in the Volga River basin southward to 55° N (lakes in the basins of the

Oka and Pra rivers) and eastward almost to 45° E (the Kerzhenets River, the basin of the Cheboksary Reservoir) (Zhdanova et al., 2016). The rotifer was detected in more than 40 water bodies and watercourses in Vologda, Leningrad, Novgorod, Tver, Vladimir, Nizhny Novgorod, and Ryazan oblasts. *K. bostoniensis* was recorded in Lakes Elovoe, Roy, Rodionovo, Svyato, Svyatoe Dedovskoe, Bolshoe, and Komsomolskoe and in the Kerzhenets River in Nizhny Novgorod oblast (Bayanov, 2014; Il'in et al., 2014, 2016; Shurganova et al., 2015a). The information about particular findings of the rotifer in rivers, lakes, and reservoirs in the oblast was reported in a number of publications (Makeev and Gavrilko, 2013; Il'in et al., 2015; Shurganova et al., 2015a, 2015b; Zolotareva et al., 2016; etc.).

The aim of this work is to generalize the information about locations of *K. bostoniensis* in water bodies and watercourses of Nizhny Novgorod oblast and to analyze its ecological requirements.

MATERIALS AND METHODS

The work is based on hydrobiological studies which were carried out in large reservoirs of the Volga River: Cheboksary and Gorky; in rivers, the tributaries of the first order of the Cheboksary Reservoir: Oka, Kudma, and Kerzhenets; small rivers, the tributaries of the Kerzhenets River (Vishnya, Chernaya, Pugai, Rustaichik, Makarikha, Bolshaya Chernaya, Malaya Chernaya, Ukhmantei, Chernushka, and Bugrovka) located in the Kerzhensky State Nature Biosphere Reserve (further SNBR, Kerzhensky Nature Reserve). The Serezha River; Lakes Velikoe, Glubokoe, Parovoe, Dolgoe, Svyato, and Protoka (a channel between Lakes Velikoe and Svyato) within the Pustynsky State Nature Reserve and in adjacent areas; and the Chara River and Lake Charskoe within the nature sanctuary of regional importance Lake Charskoe and Adjacent Forest Massif were studied. In addition, we used the materials collected in small watercourses flowing through the city of Nizhny Novgorod: Chernaya, Levinka, Parasha, Rzhavka, Viyunitsa, Gnilichka, Starka, Kova, and Rakhma rivers and Shuvalovsky channel. The samples were collected over the years of the study (2013–2016) mainly in summer (July). The studies were conducted from May to September in some water objects (the Serezha River and lakes in the Pustynsky Reserve, small urban streams, Cheboksary Reservoir with its tributaries, Oka and Kudma rivers).

Samples of zooplankton were collected with a Juday net (a nylon sieve with a mesh size of 70 μm) from the bottom to the surface or by filtering of 200 L of water through an Apstein net (a nylon sieve with a mesh size of 70 μm) in the medial zone of the rivers and in pelagic zones of lakes and reservoirs. The samples were fixed in 40% formaldehyde (the final concentration of 4%) and stored in hydrobiological glasses. The material was processed according generally accepted hydrobiological methods (*Metodicheskie rekomendatsii*..., 1982). The species *K. bostoniensis* was identified according to the published information (De Paggi, 2002; Zhdanova and Dobrynin, 2011; Lazareva and Zhdanova, 2014).

RESULTS

Location of the species. The analysis of the available data (Fig. 1) and published data (Bayanov, 2014) has demonstrated that *K. bostoniensis* inhabits 32 water objects (19 watercourses and 13 water bodies) in Nizhny Novgorod oblast from 55° to 56° N and from 42° to 43° E.

In some lakes of Nizhny Novgorod oblast (Elovoe, Roy, Rodionovo, Svyatoe Dedovskoe, Komsomolskoe, and Bolshoe), *K. bostoniensis* was detected by Bayanov (2014). In all surveyed water objects, we recorded *K. bostoniensis* for the first time. The exception is Lake Svyato, where the invader was first detected by Bayanov (2014). All water objects in Nizhny Novgorod oblast belong to the Middle Volga basin.

The area of the Cheboksary Reservoir watershed within Nizhny Novgorod oblast includes landscapes of the forest Trans-Volga (Zavolzhye) and forest-steppe right-bank area which differ considerably in the geological structure, relief, climate, and soil and vegetative cover, as well as in hydrography and the degree of economic use. Differences and features of the watershed of left- and right-bank tributaries of the reservoir determine, to a greater degree, the differences in their hydrological and hydrochemical regimes, etc. (Kharitonychev, 1978; *Geografiya*..., 1991; Shurganova, 2007; etc.). In respect to ecological zoning of Nizhny Novgorod oblast (Bragazin et al., 2014), the surveyed water bodies and watercourses are located in regions with different anthropogenic load.

The surveyed water bodies and watercourses differ in their origin, morphometry, transparency, water pH, conductivity, and trophic status (Table 1). The Cheboksary Reservoir has a high water flow (the water exchange coefficient of 20.9) and average depth of 4.2 m. The reservoir is formed by two different water flows from the Gorky Reservoir and the Oka River, which differ in the complex of hydrophysical and hydrochemical parameters (Shurganova, 2007). The mouth part of the Oka River is subjected to the impact of industrial and municipal wastewaters of the cities of Nizhny Novgorod and Dzerzhinsk (Krivdina and Loginov, 2015). Thus, the polluted river causes a strong nutrient load on the middle riverine part of the Cheboksary Reservoir (Bikbulatov et al., 2002).

All studied lakes are small (<1 km^2) and are of a karstic genesis; the trophic status of the lakes ranges from oligotrophic-mesotrophic to mesotrophic-eutrophic. In most lakes, water pH ranges from neutral to weakly alkaline, except for Lake Charskoe with humic water and acid pH (Table 1).

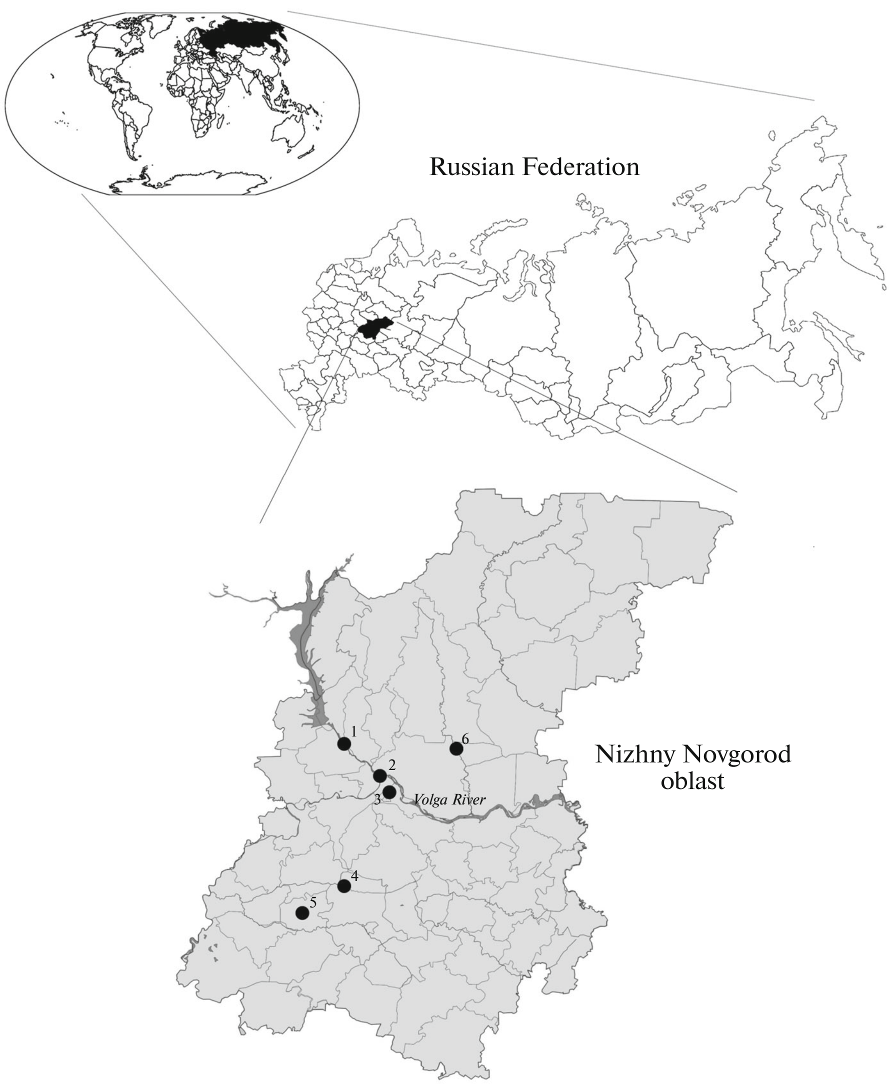

Fig. 1. Map of locations of findings of *K. bostoniensis* in Nizhny Novgorod oblast. (1) Upper riverine part of the Cheboksary Reservoir; (2) watercourses within the city of Nizhny Novgorod; (3) Kudma River; (4) water objects in the Pustynsky Nature Reserve; (5) water objects in the nature sanctuary Lake Charskoe and Adjacent Forest Massif; (6) watercourses in the Kerzhensky SNBR.

Watercourses in the Trans-Volga region in the city of Nizhny Novgorod are characterized by high current velocities, high humification (93–410° Pt-Co scale), neutral and weakly acid pH (5.5–7.6), and low conductivity (69.0–269.0 μS/cm), and they are oligo-mesotrophic according to the reports of algologists (Vodeneeva et al., 2014). In contrast to them, rivers in the Cis-Volga region of Nizhny Novgorod (Serezha River, Kudma River) are characterized by slow current, low degree of humification (10.2–143.0° Pt-Co scale), higher conductivity (55.0–1913.5 μS/cm), neutral and weakly alkaline pH (6.1–8.9), higher concentrations of nutrients and their higher availability, and mesotrophic-oligotrophic water (Vodeneeva et al., 2014).

Watercourses within the city of Nizhny Novgorod flow through two landscape zones, Balakhna Lowlands (a part of the city over the river) and Cis-Oka-Volga right-bank area (upland part of the city) (Kharitonychev, 1974), and are subjected to a strong multifaceted anthropogenic impact. According to the water quality assessment on the basis of hydrochemical parameters, the watercourses are classified as polluted to extremely polluted (Kudrin, 2016). Most watercourses in the city area over the river are eutrophic (Table 1).

K. bostoniensis was not found in the lacustrine part of the Gorky Reservoir (from the town of Yurievets to the dam of the Nizhny Novgorod Hydroelectric Power Plant) (2015–2016) or in the upper, middle, and lower

Table 1. Characteristics of water bodies where *Kellicottia bostoniensis* was detected

No.	Water body/coordinates	Parameters*					
		1	2	3	4	5	6
1	Cheboksary Reservoir (upper riverine part)	–	6.0	2.2	7.07–8.46	135.3–487.0	Eutrophic
2	Oka River 56°19′ N 43°58′ E	–	9.0	0.9	8.05–8.78	409.0–524.0	Eutrophic
3	Kudma River 56°9′ N 43°54′ E	144.0	8.0	2.1	–	–	Mesotrophic-eutrophic
Watercourses in Kerzhensky SNBR							
4	Kerzhenets River 56°30′ N 44°48′ E	290.0	14.8	1.3	6.60–7.70	66.8–100.9	Oligotrophic-mesotrophic
5	Rustaichik River 56°30′ N 44°47′ E	8.5	0.5	0.5	5.50	64.0–82.0	Oligotrophic-mesotrophic
6	Chernaya River 56°26′ N 44°52′ E	16.6	1.5	0.9	5.80	78.0–90.0	Oligotrophic-mesotrophic
7	Pugai River 56°24′ N 44°57′ E	23.0	0.8	0.5	6.30	55.0–78.0	Oligotrophic-mesotrophic
Water objects within the nature sanctuary Lake Charskoe and Adjacent Forest Massif							
8	Chara River 55°31′ N 43°10′ E	34.0	1.0	1.0	6.20	93.0	Oligotrophic-mesotrophic
9	Lake Charskoe 55°31′ N 43°11′ E	0.31	16.0	1.3	6.10	55.0	Oligotrophic-mesotrophic
Water objects in Pustynsky Nature Reserve and adjacent territories							
10	Serezha River 55°39′ N 43°36′ E	196.0	15.0	1.8	7.46–8.80	221.0	Mesotrophic-eutrophic
11	Lake Velikoe 55°39′ N 43°35′ E	0.91	11.0	1.1	8.89–7.65	219.0	Mesotrophic-eutrophic
12	Channel between Lakes Velikoe and Svyato 55°40′ N 43°34′E	1.7	3.5	1.6	7.10	159.0	Mesotrophic-eutrophic
13	Lake Svyato 55°43′ N 43°09′ E	0.27	14.5	1.6	7.10	69.0	Ologotrophic-mesotrophic
14	Lake Glubokoe 55°40′ N 43°33′ E	0.61	10.9	0.9	8.7	220.0	Mesotrophic

Table 1. (Contd.)

No.	Water body/coordinates	Parameters*					
		1	2	3	4	5	6
15	Lake Parovoe 55°40′ N 43°32′ E	0.41	5.2	1.0	7.87–8.45	211.0	Mesotrophic
16	Lake Dolgoe 55°40′ N 43°30′ E	0.47	4.0	0.9	8.17–8.84	269.0	Mesotrophic
Watercourses within the city of Nizhny Novgorod							
17	Shuvalovsky channel 56°18′ N 43°55′ E	6.65	7.0	2.3	6.70–7.70	542.0–659.0	Eutrophic
18	Viyunitsa River 56°13′ N 43°43′ E	10.9	3.0	1.0	–	–	Eutrophic
19	Rzhavka River 56°18′ N 43°57′ E	3.5	0.4	0.3	6.65–7.36	–	–
20	Parasha River 56°20′ N 43°50′ E	9.0	2.0	0.8	6.54–7.23	267.0–552.0	Eutrophic
21	Levinka River 56°20′ N 43°52′ E	6.1	2.5	1.0	6.83–7.33	171.0–606.0	Eutrophic
22	Gnilichka River 56°13′ N 43°44′ E	5.6	11.7	1.4	7.35–7.91	–	Eutrophic
23	Chernaya River 56°23′ N 43°50′ E	19.0	2.0	1.2	6.69–7.30	396.0	–
24	Rakhma River 56°14′ N 44°5′ E	18.0	1.5	1.5	8.21–8.45	–	–
25	Kova River 56°18′ N 44°3′ E	11.0	1.5	1.0	7.72–8.27	–	–
26	Starka River 56°18′ N 44°2′ E	4.6	0.5	0.5	7.76–8.42	–	–

* (1) area of water bodies, km^2/length of rivers, km; (2) depth, m; (3) transparency, m; (4) pH; (5) conductivity, μS/cm; (6) trophic status; (–) data are absent.

reaches of the tributaries of the Kerzhenets River, Vishnya, Makarikha, Bolshaya Chernaya, Malaya Chernaya, Ukhmantei, Chernushka, and Bugrovka rivers, running through the territory of the Kerzhensky Nature Reserve (2013–2015). The frequency of occurrence of the species in the region is 80%.

Species abundance. The following results were obtained in the course of seasonal surveys (from May to September). The rotifer was recorded in June, July, and September in the Cheboksary Reservoir, in June and September in different years in the mouth part of the Oka River (Table 2), and in July in the Kudma River.

K. bostoniensis was recorded in water objects of Pustynsky Nature Reserve in May, July, and September in different years. The rotifer was found in watercourses within the city of Nizhny Novgorod in May, June, July, August, and September in different years (Table 2). In watercourses of the Kerzhensky Nature Reserve (the Kerzhenets River, mouth parts of Rustaichik, Chernaya, and Pugay rivers) and in the Chara River and Lake Charskoe, *K. bostoniensis* was recorded in July in different years. The most frequent findings of the rotifer *K. bostoniensis* in the majority of water objects were recorded in the summer period, mainly in July (Table 2).

The density of rotifers in different surveyed water objects varied considerably (Table 2). The abundance of the rotifer was mainly low (not more than 18200 ind./m^3) in the Cheboksary Reservoir, Kerzhenets River and its tributaries, Lake Charskoe, and the Chara River. The contribution of the abundance of *K. bostoniensis* to the total abundance of zooplankton did not exceed 45.6% in the Kudma River and 18.2% in Lake Charskoe (Table 2).

The proportion of the alien rotifer in the total abundance of zooplankton reached 60.7% (September 2014) and 63.9% (July 2013) in the Serezha River (Pustynsky Nature Reserve) in some periods. In Lake Velikoe, the contribution of the rotifer *K. bostoniensis* to the total abundance of zooplankton was much lower (Table 2). The proportion of the rotifer *K. bostoniensis* in the total abundance of zooplankton reached 45.5–47.9% in lakes of the Pustynsky Reserve and the channel between Lakes Velikoe and Svyato. The highest density of rotifers was recorded in the eutrophic Protoka between Lakes Velikoe and Svyato, in the oligo-mesotrophic Lake Svyato, and in mesotrophic Lake Parovoe.

Watercourses within the city of Nizhny Novgorod were mainly characterized by low values of the density of *K. bostoniensis* (Table 2). A pond expansion in the Levinka River (July 2013) and the Gnilichka River (July 2014) were exceptions. The total abundance of rotifer was 17.7% of the total abundance of zooplankton in the Gnilichka River and reached 97.9% of the total abundance of zooplankton and 98.8% of the abundance of rotifer in the Levinka River.

In general, *K. bostoniensis* entered the composition of dominant species (>10% of the total abundance of zooplankton) in 14 different water objects surveyed in Nizhny Novgorod oblast during different periods under study (Table 2).

DISCUSSION

K. bostoniensis was recorded in different water bodies and watercourses in Nizhny Novgorod oblast located in territories with different geological structure, relief, climate, soil and vegetative cover, hydrography, and degree of anthropogenic load. Water objects where the invader was recorded differ in their genesis, morphometry, current velocity, transparency, water pH, conductivity, trophic status, and degree of pollution.

The rotifer is widespread both in lakes with depths to 14.5 m (Lake Svyato) and in shallow small rivers where the depths do not exceed 0.5 m (Rzhavka and Starka rivers).

Water pH in water objects in Nizhny Novgorod oblast inhabited by *K. bostoniensis* ranges from acid (pH 5.5) (the Rustaichik River, a tributary of the Kerzhenets River within the Kerzhensky Nature Reserve) to neutral and weakly alkaline (pH 8.89) (karst Lake Velikoe within the Pustynsky Nature Reserve). In water bodies of Sweden affected by effluents of the pulp and paper industry (Arnemo et al., 1968), the invader was distributed in a wide range of ecological conditions (pH 4.8–8.5). In European Russia, *K. bostoniensis* inhabits water bodies with a wide range of water pH from 4.5 (Lake Trestino) to 9.5 (Lake Ladoga) (Zhdanova et al., 2016).

We recorded the invader under conditions of a high degree of humification (93–410° Pt-Co scale) and low values of conductivity (66.8–101.0 μS/cm) (the Kerzhenets River) and low color of water (10.2–143.0° Pt-Co scale) and higher conductivity of water (up to 659 μS/cm) (Shuvalovsky channel). In Russia, *K. bostoniensis* occurs in the range of water color from 30 to 680° Pt-Co scale (Zhdanova et al., 2016). The results obtained in Nizhny Novgorod are in this range.

The studies demonstrated that *K. bostoniensis* was recorded in some water objects from May to September in different years of surveys. The highest frequency of occurrence of the rotifer was mainly recorded in July in all surveyed water objects (Table 2). The maximum densities of *K. bostoniensis* were also recorded in July (Table 2). It should be noted that maximum values of density (566200 ind./m^3) were recorded in July 2013 at rather high water temperature (24–25°C) in a pond expansion of the eutrophic Levinka River (Table 2), where the proportion of *K. bostoniensis* reached 97.9% of the total abundance of zooplankton.

The maximum values of the density of the invader were recorded in karst lakes in the Pustynsky lake-river system (oligotrophic-mesotrophic polyhumic Lake Svyato with neutral pH; up to 45.5% of the total abundance of zooplankton) and in the medial part of mesohumic weakly alkaline watercourses with slow current and well-developed higher aquatic vegetation, the Serezha and Protoka connecting Lakes Velikoe and Svyato (Table 2). It should be emphasized that the abundance of *K. bostoniensis* reached 63.9 and 60.7% of the total abundance of zooplankton in the Serezha River in July and September, respectively, and 45.5 and 47.9% of the total abundance of zooplankton in Lake Svyato and Protoka.

In general, the values of density of *K. bostoniensis* in water objects in Nizhny Novgorod were low and did

Table 2. Abundance (thousand ind./m^3) *Kellicottia bostoniensis* in the surveyed water objects

Water body/watercourse	Period of surveys	N, thousand ind./m^3	N/N_{tot}, %	N/N_{rot}, %
Cheboksary Reservoir	July 2015	0.02–0.39	0.1–1.0	0.1–1.8
	Sept. 2015	0.02	0.1	0.2
	June 2016	0.02–0.28	0.2–3.1	0.5–4.7
	July 2016	0.01	0.2	1.3
Oka River	Sept. 2015	0.39	0.4	0.4
	June 2016	0.79	15.2	18.7
Kudma River	July 2013	0.07–3.28	1.0–45.6	1.1–49.9
	July 2013	0.01–0.21	0.5–4.5	1.16–4.8
Watercourses in Kerzhensky SNBR				
Kerzhenets River	July 2013	0.005	1.0–9.1	1.1–33.3
	July 2014	0.005–0.067	1.2–3.3	2.0–4.8
	July 2015	0.013–0.026	1.1–2.5	2.2–4.3
Rustaichik River	July 2013	0.01	0.9	1.7
Chernaya River	July 2014	0.025	4.2	7.04
Pugay River	July 2014	0.005	1.5	2.6
Water objects in the nature sanctuary Lake Charskoe and Adjacent Forest Massif				
Chara River	July 2014	0.01–0.33	0.01–0.03	0.02–0.07
Lake Charskoe	July 2014	0.07–18.22	0.1–18.2	0.2–41.6
Water objects in Pustynsky Reserve and adjacent territories				
Serezha River	July 2013	1.9–179.3	0.4–63.9	0.6–81.5
	May 2014	0.26–7.8	0.65–2.6	1.2–3.3
	July 2014	1.0–23.1	0.4–3.2	0.5–4.6
	Sept. 2014	0.04–345.9	0.01–60.7	0.1–66.8
	July 2015	0.39–0.02	0.07–1.1	0.8–7.8
	July 2016	0.4–9.6	0.3–1.1	0.6–1.8
Lake Velikoe	July 2013	3.1–14.3	0.4–4.7	0.7–7.1
	May 2014	0.01–40.9	0.001–3.7	0.001–4.4
	July 2014	1.8–11.8	0.4–3.6	0.6–7.2
	Sept. 2014	0.01–0.6	0.001–0.07	0.002–0.1
	July 2015	0.88	0.23	0.44
Channel between Lake Velikoe and Lake Svyato	July 2013	12.6–305.4	5.6–34.1	7.8–55.4
	July 2014	0.32–10.04	0.03–47.9	0.1–60.6
Lake Svyato	July 2013	46.3–214.6	14.9–45.5	31.8–64.5
	July 2014	18.3–90.7	26.6–40.9	53.9–57.5
	July 2015	0.098–0.39	1.0–4.4	2.1–12.0
Lake Glubokoe	July 2014	4.2–142.1	0.6–18.5	2.4–32.1
Lake Parovoe	July 2014	0.39–286.5	0.1–35.8	0.2–60.8
Lake Dolgoe	July 2014	1.6–80.5	0.2–9.5	0.7–29.8
Watercourses within the city of Nizhny Novgorod				
Shuvalovsky channel	July 2013	0.01–9.36	0.2–82.5	0.45–92.7
	Aug. 2013	0.01–0.20	0.01–3.1	0.02–12.3
	Sept. 2013	0.01	0.005	0.01
	May 2014	0.01–0.16	0.004–0.06	0.005–0.06
	July 2014	0.02–7.13	0.8–1.6	1.8–3.6
	Sept. 2014	0.01–1.77	0.06–1.3	0.09–1.5
	June 2015	0.07–0.01	0.003–0.01	0.004–0.13
	July 2015	0.07	0.02	0.1

Table 2. (Contd.)

Water body/watercourse	Period of surveys	N, thousand ind./m^3	N/N_{tot}, %	N/N_{rot}, %
Viyunitsa River	July 2013	0.89	0.39	10.1
Rzhavka River	July 2014	0.01–0.06	1.2–1.4	1.9–4.7
Parasha River	July 2014	0.01–0.17	1.3–27.4	12.5–49.3
	Aug. 2015	0.09–0.16	0.9–1.8	1.4–3.3
Levinka River	July 2013	7.8–566.2	67.8–97.9	94.9–98.8
	July 2014	0.03–0.82	0.39–4.9	11.6–22.6
	June 2015	0.013–0.09	0.01–0.03	0.3–2.8
	July 2015	0.007–0.013	0.09–0.11	0.3–2.1
	Aug. 2015	0.007–0.02	0.3–0.8	1.0–2.3
Gnilichka River	June 2014	0.003–0.70	0.002–0.33	0.01–0.5
	July 2014	13.1–134.5	12.5–17.7	28.2–38.2
Chernaya River	July 2014	0.3	4.5	8.9
Rakhma River	July 2014	0.007	0.3	0.7
Kova River	July 2014	0.013	7.2	65.0
	May 2015	0.005	14.29	50.0
	Sept. 2015	0.005	5.3–33.3	50.0–100.0
Starka River	May 2015	0.005	7.69–50.0	16.67–50.0

N/N_{tot}, the ratio of the abundance of *K. bostoniensis* to the total abundance of zooplankton; N/N_{rot}, the ratio of the abundance of *K. bostoniensis* to the abundance of rotifers.

not often exceed 100 ind./m^3 (Table 2). The maximum values of density of the rotifer were recorded in July at a water temperature of 24.8°C, mainly in pond expansions of eutrophic watercourses with slow current velocity, high concentrations of nutrients and their higher availability, and well-developed higher aquatic vegetation.

In addition to the complex of natural factors which differ in the surveyed water objects in Nizhny Novgorod, they are subjected to a different degree of anthropogenic impact including both the pollution with organic substances and complex pollution with toxic substances. According to ecological zoning of Nizhny Novgorod oblast (Bragazin et al., 2014), the majority of water objects are located in the territories with low and moderate anthropogenic load. Water objects where *K. bostoniensis* was recorded are subject to a wide range of anthropogenic load: from minimum, background load (the Kerzhenets River and its tributaries, rivers running through the territory of the Kerzhensky Nature Reserve) to high load in urban small streams. According to hydrochemical parameters, waters in the Kerzhenets River are of quality class II (clean water), and urban watercourses are of quality class IV–VI (polluted to extremely polluted). It is noteworthy that the density of the rotifer in the clean Kerzhenets River and mouth parts of its tributaries as well as in polluted urban small streams was low (no more than 100 ind./m^3). The density of the rotifer increased significantly in eutrophic watercourses with slow current velocity and well-developed higher aquatic vegetation.

In the surveyed water bodies and watercourses, *K. bostoniensis* occurred separately from the aboriginal species, *K. longispina*, or coexisted with it. Only *K. bostoniensis* was recorded in some water objects (small streams within the city of Nizhny Novgorod: Viyunitsa, Rzhavka, Kova, Starka, and Gnilichka rivers). *K. longispina* inhabited the lacustrine part of the Gorky Reservoir but *K. bostoniensis* was not recorded there. According to the published data (Zhdanova et al., 2016) only *K. longispina* was recorded in most parts in large reservoirs of the Upper Volga. Therefore, the alien species is the most widespread in the Cheboksary Reservoir, which belongs to the Middle Volga reservoirs, compared to the Upper Volga reservoirs.

CONCLUSIONS

By 2017, we and Bayanov (2014) recorded the American rotifer *K. bostoniensis* in 32 water objects (19 watercourses and 13 water bodies) in Nizhny Novgorod oblast, from 55° to 56° N and from 42° to 43° E. The invader *K. bostoniensis* was for the first time recorded in all surveyed watercourses and in the majority of water bodies.

The rotifer inhabits different water bodies and watercourses in Nizhny Novgorod oblast located in the territories with different geological structure, relief, climate, soil and vegetative cover, hydrography, and degree of economic management. The surveyed water bodies and watercourses differ in morphometry, current velocity, transparency and color of water, pH values, and conductivity. The water objects are characterized by different trophic status (from oligotrophic-mesotrophic to eutrophic) and water quality class according to hydrochemical parameters (from II, clean waters, to VI, extremely polluted waters).

K. bostoniensis inhabits water bodies with a wide range of pH: from acid pH of 5.5 (the Rustaichik River, a tributary of the Kerzhenets River within the Kerzhensky Nature Reserve) to neutral and weakly alkaline pH of 8.89 (the karst Lake Velikoe within the Pustynsky Nature Reserve). The rotifer is tolerant to changes in the content of humic substances and conductivity.

In general, the density values of *K. bostoniensis* are low (<100 ind./m^3) in water objects in Nizhny Novgorod oblast. The maximum density (566200 ind./m^3) was recorded in July 2013 in a pond expansion in the Levinka River, where *K. bostoniensis* reached 97.9% of the total abundance of zooplankton. The highest values of density of the invader were recorded in eutrophic watercourses with slow flow and well-developed higher aquatic vegetation at high (up to 25°C) water temperatures.

In water objects of Nizhny Novgorod oblast, *K. bostoniensis* was detected separately from the aboriginal species *K. longispina* as well as together with it. Only *K. bostoniensis* occurred in small watercourses within the city of Nizhny Novgorod (V'yunitsa, Rzhavka, Kova, Starka, and Gnilichka rivers) and only *K. longispina* was detected in the lacustrine part of the Gorky Reservoir.

The results of our studies are similar to the data obtained by a group of researchers who investigated different water bodies in European Russia (Zhdanova et al., 2016) and water bodies of Western Europe with different morphometry and abiotic and biotic environmental conditions (Eloranta, 1988; Balvay, 1994; Jarvinen et al., 1995; etc.).

A wide distribution of *K. bostoniensis* in Nizhny Novgorod oblast and its ability to inhabit water bodies and watercourses with a different complex of natural factors and degree of anthropogenic load may indicate high ecological plasticity of the species and the possibility of its further dispersal.

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