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Dynamics of colonial settlements of grey heron (*Ardea cinerea* L.) and great egret (*Ardea alba* L.) and stages of great egret expansion on the territory of Ryazan and Yaroslavl regions

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We present detailed data on three colonies of grey herons and great egrets in the Ryazan and Yaroslavl regions. All colonies are located on the banks of water bodies, differing in the amount of water immediately under the nests, the character of vegetation, the number of birds and the ratio of heron species. In the Ryazan oblast, grey heron is seen to increase its abundance in one colony (from 15 nests in 2002 to 69 in 2017), in the other – abundance stays approximately the same throughout 2001–2017 (3–40 nests). Abundance of birds in the mixed heron-egret colony in the Yaroslavl oblast in 201–2017 was stable (60 nests of grey heron and 11 nests of great egret).

In 2000's grey herons were observed to arrive in the Ryazan oblast earlier (mid-, late March) compared to 1950's – 1960's (early to mid-April). Arrival of herons in the coast of Volga's reach of the Rybinsk reservoir is of similar character. Data on various aspects of heron biology are given.

We present information on the expansion of great egret in the Ryazan and Yaroslavl oblasts. Three stages are demonstrated: in the Ryazan oblast – single encounters (1962–1999), sporadic nesting of single pairs (2000–2014), annual stable nesting (from 2014 till present); in the Yaroslavl oblast – single encounters (1997–2008), systematic encounters (2009–2014), nesting (from 2015).

Ключевые слова: great egret, *Ardea alba*, grey heron, *Ardea cinerea*, colony dynamics, nest colonies, expansion stages.

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Introduction

Grey heron *Ardea cinerea* L. one of the most common bird species in the Ryazan and Yaroslavl oblasts, breeds in colonies. Twelve colonies of grey heron are known in the Ryazan oblast territory to date (Ivanchev et al., 2012) while nine colonies of the species are known in the Yaroslavl oblast (Golubev, 2011) with some of them consisting of 4–5 pairs existing for 1–2 years old. Great egret *Ardea alba* L. is an ecologically similar species, although its

encounters were rare for a long time. It was found to nest in the Ryazan oblast only in the last twenty years (Ivanchev, 2015; Lobov, 2004) and only four years ago, its nests were found in Yaroslavl oblast (Petrova and Pavlov, 2016) although great egret encounters are documented since early 2000's.

In Ryazan oblast grey heron colonies are situated in strongly different biotopes: dry pine forests on coastal terrace, in paludified floodplain broad-leaf forest, in broad-leaf forest on gully slopes, on forest vegetation ridges between waterbodies, on waterbody coasts, in old pine forest. Known colonies of grey heron in Yaroslavl oblast are mainly located on the coasts of large waterbodies: Volga River, the Rybinsk reservoir, Lake Nero and Lake Plescheevo in various biotopes – long-boled pine forests, willow forests as well as in coastal vegetation beds (reeds, rush) (Golubev, 2011).

Heron colonies produce a profound influence on the ecosystems they inhabit: birds transfer significant amounts of organic matter (building material for nests and food for juveniles) (Ardamatskaya, 2011; Chuikov, 1981). With time, trees with nests die, decay and eventually fall out from the tree stand (Ardamatskaya, 2011). Multiannual heron nests decay together with fallen trees they were built on. Adults' and fledglings' droppings, dead juveniles and undigested or dropped food fragments (Ardamatskaya, 2011; Chuikov, 1981) provide a considerable impact on the environment. Biogenic compounds of nitrogen and phosphorus actively entering water during the nesting period locally increase the productivity of adjacent parts of waterbodies, causing changes in the quantitative and qualitative composition of links of the food chain (Krylov et al., 2012; Kulakov et al., 2010; Stolbunov et al., 2017). Work on the study of changes taking place due to the activity of these birds is impossible without knowing the biology of birds.

The highest intensity of involvement of the products of grey heron life in ecosystems is observed in the near-water (or surrounded by water) nest locations. Two such colonies are known in the Ryazan region: on the channel of lake Shagara (Klepikovsky district) (N 55°13'47", E 40°5'44") and on the bank of river Pronya (N 54°1'24", E 38°47'33") in the zone of Pronsky reservoir backwaters at the border of Ryazan and Tula regions. In the Yaroslavl region, the largest colony of herons is located in the Volga reach of the Rybinsk Reservoir on Radovskii Island (N 58°3'15", E 38°17'30").

The objectives of this study are to examine the dynamics of the colonial settlements of two species of herons that perform the functions of a key species, with their nesting colonies in biotopes characterized by high water supply, and also provide information on the stages of expansion of the great egret in the Ryazan and Yaroslavl regions.

Material and methods

Material for the present work was obtained during colony surveys: 2001–2017 in the Ryazan region and in 2014–2017 – in Yaroslavl. Colony survey included counting of nests and/or counting of nesting bird pairs, identification of tree species used for nest placement, the height of the nests and the nesting stage of birds were established. Other data on the biology of the species were used as well – the number of chicks in the broods, the timing of their presence in the nests, and so on. The work uses previously published information, data from the scientific funds of the Okskiy Reserve.

Results and discussion

General data of grey heron biology

Within the Ryazan region, the arrival of the grey heron is timed to the appearance of the first ice-holes on rivers, lakes and meliorative ditches. In the 2000s, this occurred in the mid-to-late March, but in the 1950s and 1960s, arrival of herons was noted much later – from the first decade to the middle of April. The deadline for the appearance of the grey heron in the Ryazan Region is 07.03 (in 2016) – 23.04 (in 1965), on average (n = 65) – 01.04±10.1 ($M \pm \sigma$).

Spring arrival and autumn departure of herons occur imperceptibly, having no pronounced character. During observations from the points of birds' spring migrations tracking in the floodplain of the middle reaches of the Oka River (in the protected zone of the Okskiy reserve), usually movements of single birds are recorded, occasionally 3–4 individuals. In total, for 45 days of observations for the spring migration of birds from April 1 to May 15 in 1985–2017, was noted from 2 (in 1985) to 69 (in 2000) birds, usually – 16–40 individuals. After arrival to the nesting area grey herons immediately adhere to the location of the colonies, take nests that have survived the winter, repair them or build them anew.

The arrival of herons on the coast of the Volga reach of the Rybinsk reservoir is of similar nature. Herons, which arrived first, are found at some distance from the nesting site: on the ice-holes of reservoir tributaries, which are free of ice earlier than the Volga near the colony; on the southern slopes of the fields, as well as in the area of discharge of warmed-up sewage in Borok village. The frame of the heron's nest is made of large willow branches about 2 cm in diameter, and the tray is laid out with thin fresh willow branches. Dimensions of the nests of grey herons on the lake Shagara: the diameter of the nests is 55–65 cm, the diameter of the tray is 30–32 cm, the depth of the tray is 12–14 cm and the height is 19–26 cm. The height of the old nests is up to 47 cm (Kotyukov, 2003). Egg laying, apparently, begins at the end of the first and beginning of the second decade of April. Nestlings in the nests are noted until the end of July

and mid-August. The last registration of grey heron in the Ryazan region takes place in mid-September and late October (14.09 in 1984, 27.10 in 1971 and 1974).

As in the case of the arrival terms, egg laying, as well as hatching of chicks in the colony on the island of the Rybinsk Reservoir, takes place one and a half to two weeks later compared to those in the Ryazan Region. It is interesting that during the autumn drainage of the water level of the Rybinsk reservoir, extensive littorals are exposed, and herons gather near the colony forming clusters of a considerable number – up to 60 individuals.

History of the development of investigated heron colonies

Colony of grey herons on the channel of the lake Shagara

It was first discovered in 2001 (Ivanchev et al., 2003; Kotyukov, 2003) and there were 35 nests in it. According to polling data the colony was established in the late 1980s, apparently. This colony was also visited in 2005, 2010, 2016 and 2017. A noticeable increase in the number of nests in it has not been noted, although it must be recognized that due to its location in hard-to-reach places it is difficult to calculate them accurately at the height of nesting period without the use of special technical means (aerial photography). Nevertheless, the total number of nesting birds in the colony was estimated at 40 pairs in 2017.

The colony is diffuse; the nests were located over 120 m of willow thicks by arranged in groups of 7–9 nests. Nests are places on willow trunks at an altitude of about 1–1.2 m from the water. Nesting biotope – flooded undergrowths of almond willow, growing in patches among reed and cattail beds. In 2016 three pairs of great egret, *Ardea alba* were found to nest in this colony and two pairs were seen in 2017. The nests of the great egret were located on the side of the grey herons colony and, judging by the flight of nesting birds, were built in reed beds.

Colony of grey herons on the bank of the river Pronya

The presence of this colony was revealed in 2002. It was found to be inhabited by 15 pairs of grey heron (Lobov, 2004). A brood of 6 great egrets (apparently, a pair of adults with nestlings fledged from the nest) was seen in the vicinity of the colony. However, that year, it was not possible to locate their nests. Colony was surveyed for the second time in 2003: the number of breeding birds did not change, nesting of great egrets was not observed. In 2014, 50 live nests of grey herons were observed, and 69 in 2017. Nests were located on large willows (white willow) at an altitude of 6–10 m from the ground, mostly 8 m. There were 1–10 nests on trees, 4.9 nests on a tree on average. A total of 14 trees were used.

When visiting this colony on July 8, 2014, three great egrets were found in its vicinity. They hunted in the shallow water of Pronsky reservoir on the channels between cattail and reed beds, and at night they settled on a tree standing alone on the shore of the reservoir. Birds did not show any attachment to the colonial settlement of grey herons and if they nested in this area this year, it is most likely that the nest(s) were located in the reed beds apart from grey herons.

Colony of grey herons on the bank of the river Pronya is characterized by very high protection from terrestrial predators. It has a peninsular wedge-shaped location: the channel of river Pronya is located on one side, and shallow water of Pronsky reservoir with reed thickets on the other. In the first half of the nesting period, trees with nests stood in water, 15–50 cm deep.

Colony of grey herons on the Radovskii Island of the Rybinsk Reservoir

According to polling data, the colony has existed since the 80s of the XX century (Golubev, 2011). In the early 1990s, it consisted of 20 nests of grey herons, located on deciduous trees. At the time of the nest description of this colony, made in 2010, there were 82 live nests of the grey heron (Kulakov, 2015). At the end of July 2015 there were about 60 inhabited nests in this colony. Nests were located on poplars, birches and pines, at an altitude of 5–10 m above the ground. On one tree there could be up to five nests, on average – two or three. The colony is located next to Rybinsk reservoir shallows rich in fish and other forage objects. In view of the fact that the level of the Rybinsk reservoir is subject to considerable fluctuations, the trees with nests located on the colony's margins can be at a distance of 100 m from the water's edge one year (2015) and immediately in the water two years after (2017), which has a strong impact on the amounts of biogenic compounds entering water. During the period of active feeding of chicks, hunting adult birds are met at a small distance from the nesting settlement (50 m – 5 km).

In 2015, eleven inhabited nests of great egret were also found here, with adult birds and grown-up chicks sitting in them. Nests were located on the edges of the colony in two groups, with four live nests in one group and seven in the other. In some cases, the nests of the great egrets and grey herons were located on one tree. In total, 45 great egrets were found in the colony (Petrova and Pavlov, 2016). It is interesting that great egrets were observed at a smaller distance from the colony than grey herons. Thus, the number of adult great egrets at the time of nesting was estimated at 10 pairs by the results of a survey of adjacent shallow waters (maximum distance from the colony is 1.8 km), and a survey of the colony from the land showed 11 pairs. However, great egrets are much easier to spot than grey herons.

In 2016, the number of grey herons and great egrets in this colony increased insignificantly – 62 live

nests of grey heron and 12 live nests of the great egret. The nests of great egret were now located diffusely, but closer to the core (center) of the colony. The last pair of great egrets with a chick left the area of the colony in mid-August, following a strong hurricane.

In 2017, the number of adult birds of both species remained unchanged. Due to an earlier spring, birds in the colony nested a week earlier than in the previous two years, and the grey heron fledglings began to leave the colony *en masse* in mid-July. As in the previous two years, great egrets arrived 10–14 days later than grey herons and left the colony in the first decade of August.

It is interesting that, unlike of grey herons' pairs, pairs of great egrets every year nest in freshly built nests, never occupying last year's nests. This can be caused both by later terms of arrival, and by the peculiarities of the biology of this species. Also noteworthy is the fact that during the entire period of the study of this colony, we never great egret chicks' corpses on the ground under the nest, while chicks of the grey herons fall out of the nests in large numbers (up to 10 chicks per night, during which a strong wind blew).

It should be noted that the time of arrival, egg laying and hatching of chicks great egrets are shifted forward in comparison with the grey herons. Grey herons fly off their nests *en masse* at the end of July, while all great egret nestlings are still in their nests. However, grey herons tend to remain in the colony's vicinity for a long time, up to the point of departure. Great egrets, in contrast, disappear from the nesting area almost simultaneously, and in all three years of observations (2015–2017) this occurred before the beginning of September.

Stages of Great Egret Expansion

The first registrations of great egrets in the Ryazan Region have been known since 1962 (Priklonsky et al., 1992). In the following years (until 1999 inclusive), single individuals and groups of 1–2 birds were encountered in the vicinity of the Okskiy Reserve almost throughout the entire summer-autumn period in 1980–1982, 1984, 1990, 1991, 1993. In 1976 and 1994 great egrets were noted in the Shylovsky District (Goryunov and Nazarov, 1998). A greater number of encounters – 6 out of 16 – falls on May, but birds were also observed in other months. The earliest encounter was in 19 May (1991), the latest – 16 September (1993). In terms of territory, encounters are confined to the Oka River floodplain to a greater extent (the protection zone of the Oksky Reserve – Ageyeva Gora, Krasny Kholm, Lopata, Shilishche, etc.), but birds were also noted on the river Pra (Zheltyi brod ford, Chertova borozda). Grey herons were sometimes seen along with great egrets, but more often great egrets kept solitary. A flock of four great egrets was encountered on river Pra in 25 May 1982 but judging by the registration terms, they were all adults. In the early 1980's few birds stayed at lake Velikoye in the Klepikovsky District (N 55°13'30", E 40°9'58") at the end of August and beginning of September (Kontorschikov, 2001). Thus, from 1962 to 1999, great egret was registered at least 17 times in the territory of the Ryazan region. This period of expansion of the species – flights into the newly developed territory – lasted 38 years.

During the next period – 2000–2014 – great egrets were met in 2001, 2003, 2008, 2009, 2011, 2014 – in total 22 cases of species registration. Usually these were solitary birds, sometimes groups of 2. In July 2003, one bird was found in the Shatsky District (Cheltsov and Cheltsov, 2003), and in July and August 2012 – in the vicinity of the villages of Fomino (N 55°6'33", E 40°0'30") and Makeevo (N 55°6'48", E 39°58'45") Klepikovsky district (Fionina et al., 2015). According to polling data, this species was also noted in 2007–2010 in Klepikovsky district on lakes Chebukino (N 55°9'2", E 40°0'23"), Lebedinoe (N 55°7'10", E 39°57'59"), Shagara, Velikoe (N 55°13'30", E 40°9'58") and on the Ivnya mire (N 55°9'37", E 39°56'57") (Fionina et al., 2016).

In 2000's birds were repeatedly noted in groups, presumably broods. Geography of nesting is wide enough. There are cases of meetings of young birds and broods in the Mikhailovsky District in the upper reaches of the Pronsky Reservoir (2002 and 2014) (Ivanchev, 2015; Lobov, 2004), in the Sarayevsky District near the village of Zerkalnye Prudy (2008) (Ivanchev et al., 2013), in the Spassky District, near the village Panino (2009). In these years, the nesting of great egret in any area was of an accidental nature and had no recurrence for the following year. Thus, the expansion of the great egret in the Ryazan region from the stage of single encounters passed to the next – the nesting of individual pairs. The duration of this period was about 15 years. In the next three years, the expansion of great egret in the territory of the Ryazan region was explosive. In 2015, in the northern part of the Ryazan Region, it was met in five places in the Klepikovsky District: in the vicinity of villages Fomino, Makeevo, Chebukino, Ershovo (N 55°6'41", E 40°5'4") and on lake Shagara (Fionina et al., 2015). In 2016, great egrets were met both at the registration sites in 2015 and at lake Martynovo (N 5°7'11", E 40°3'28") in an amount from 1 to 30 individuals (Fionina et al., 2016). In 2016 and 2017 great egrets nested on lake Shagara (own data by V.P. Ivanchev; Fionina et al., 2016). A huge flock of great egrets estimated by different observers to be 300–500 birds was observed in mid-September 2016 on lake Shagara (Fionina et al., 2016; Isaev D.V., pers. comm.).

Nesting of great egrets in these years occurred in other areas of the Ryazan region. In 2016, from 20 August to 23 September almost in the same area on

the River Oka from the lake Shilische (N 54°41'22", E 40°59'9") to the Izhevskoye pier (N 54°40'51", E 40°59'53") (Spassky District) a group of great egrets, numbering from 5 to 9 individuals was met. Most likely, they were birds from one or two broods.

Finally, A.A. Zakoldaeva (2017) examined a mixed colony, consisting of 22 nests of a great egrets and several nests of grey herons in 2017, in the vicinity of village of Makeevo, Klepikovsky district. It was arranged in reed beds.

In the Ryazan Region habitats are favorable for nesting of the great egrets in many areas: on the territory of fish farms in the Sarayevskiy, Ryazhskiy and Miloslavsky districts, in the upper reaches of the Pronsky Reservoir, at the Novomichurinsk Reservoir, in the Izhevskoye Oka River floodplain extension, in the Klepikovsky lakeland. Therefore, it can be assumed that nesting of great egret will be regular, and the nesting sites will be stationary. Permanent nesting in the same place in a row for two years on lake Shagara (possibly three – since 2015), the discovery of mass nesting in the village Makeevo, a sharp increase in the number of species in the post-nesting period indicates a further development of the species expansion and its transition to the next level.

In the Yaroslavl region great egret is considered a single nesting, regularly encountered species. A single bird was noted in 1997 at the Kostroma reservoir, on the border of the Yaroslavl and Kostroma regions. Since 2009, the meetings of the great egrets have become systematic. A single egret was observed on 13.08.09 on Volga River in the Nekouz District (D.V. Kulakov, pers. comm.). In June – July 2010, two adult birds were constantly encountered at the Volga reach of the reservoir (D.V. Kulakov, pers. comm.). Two birds in a flock of grey herons were photographed in 21.07.11 in the same location (D.V. Kulakov, pers. comm.). In the 20th of June 2013 a solitary bird was encountered at the mouth of the river Sutka Nekouz district (Simonov, 2014). Since 2015, encounters of great egret in the area of the colony on the Radovsky island are regular and its abundance there is high. The number of nesting pairs stays on the same level within eight to ten. Currently, this great egret colony is the northernmost in Europe (Stolbunov et al., 2017).

Conclusion

Thus, two grey heron colonies were surveyed in the Ryazan region in almost the same periods of time. Bird numbers in one colony were seen to increase substantially and stayed stable in the other. Mixed colony of grey heron and great egret in the Yaroslavl region is stable in the last three years, there is only a slight increase in the number of both species in the colony. Different dynamics of species in the two heron settlements in the Ryazan Region may be determined by anthropogenic impact, since heron colony on Pronsky reservoir is located near fish farms. Grey heron is actively hunted by man in fish farms, there are known cases of nests being ruined in colonies located close to fish farms. Birds move in search of more favorable nesting sites, which can determine the increase in the number of nests in this colony.

The expansion of great egret in the Ryazan Region was relatively slow, including three stages. In the first, from 1962 to 1999 only a few adult birds were seen on the territory of the region. In the second, from 2000 to 2014 birds were observed with about the same frequency, but were already found in groups, including broods, which indicated sporadic nesting of individual pairs. In the third, from 2014 to present time, the expansion is explosive, there are flocks of great egrets of up to 300–500 individuals and numerous nesting facts are noted.

In the Yaroslavl region, the expansion of the great egret takes place in a similar way. Solitary individuals were encountered from 1997. Then, since 2009, encounters have become systematic, and already in 2015 great egret was found nesting. At present, its numbers have stabilized and remain at approximately the same level for the past three years. No competitive interactions between two closely related species – grey herons and great egrets in the territory of the Ryazan and Yaroslavl regions have been observed to date.

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References

Ardamatskaya, T.B., 2011. Seraya tsaplya *Ardea cinerea* Linnaeus, 1758 [Grey heron *Ardea cinerea* Linnaeus, 1758]. In: Priklonskiy, S.G., Zubakin, V.A., Koblik E.A. (eds.), *Ptitsy Rossii i sopredel'nykh regionov: Pelikanoobraznyye, Aistoobraznyye, Flamingooobraznyye* [*Birds of Russia and adjacent regions: Pelicaniformes, Ciconiformes, Phoenicopteriformes*]. KMK, Moscow, Russia, 334–355. (In Russian).

Chel'tsov, S.N., Chel'tsov, N.V., 2003. Vstrecha bol'shoy beloy tsapli v Ryazanskoy oblasti [Great egret encounters in the Ryazan region]. *Ekologiya i evolyutsiya zhivotnykh. Sbornik nauchnykh trudov kafedry zoolodii RGPU [Ecology and evolution of animals. Collection of scientific proceedings of zoology chair of RSPU]*, 100–101. (In Russian).

Chuykov, Yu.S., 1981. Izucheniye sredoobrazuyushchey roli kolonial'no gnezdyashchikhsya ptits [The study of environmental-forming role of colonially nesting birds]. *Nauchnyye osnovy obsledovaniya kolonial'nykh gnezdoviy okolovodnykh ptits [Scientific foundations of studies of colonial nestings of hydrophilous birds].* Nauka, Moscow, Russia, 118–120. (In Russian).

Fionina, Ye.A., Valova, Ye.V., Zakoldayeva, A.A., Lobov, I.V., 2016. O sovremennom statuse bol'shoy beloy tsapli *Ardea alba* u severnykh granits Ryazanskoy oblasti (natsional'nyy park ''Meshchera'') v 2015–2016 godakh [On the modern status of great egret *Ardea alba* on the northern borders of the Ryazan region (national park ''Meschera'') in 2015-2016]. *Russkiy ornitologicheskiy zhurnal [Russian ornithological journal]* **25** (1370), 4593–4600. (In Russian).

Fionina, Ye.A., Zakoldayeva, A.A., Lobov, I.V., 2015. Zalety bol'shoy beloy tsapli *Ardea alba* v natsional'nyy park ''Meshcherskiy'' [Great egret *Ardea alba* visits in the national park Meschera]. *Russkiy ornitologicheskiy zhurnal [Russian ornithological journal]* **24** (1214), 4124–4127. (In Russian).

Golubev, S.V., 2011. Ptitsy Yaroslavskogo Povolzh'ya i sopredel'nykh regionov: istoriya, sovremennoye sostoyaniye. [Birds of Yaroslavl Volga region and adjacent regions: history, modern state] Volume I. Nevorob'inyye (Non-Passeriformes). Kanzler, Yaroslavl, Russia, 684 p. (In Russian).

Goryunov, Ye.A., Nazarov, I.P., 1998. Nekotoryye svedeniya o redkikh ptitsakh Ryazanskoy oblasti [Some data on rare birds of the Ryazan region]. In: But'ev, V.T. (ed.), Redkiye vidy ptits Nechernozemnogo tsentra Rossii [Rare bird species of the Non-Chernozem center of Russia], Moscow, Russia, 71–73. (In Russian).

Ivanchev, V.P., 2015. Vstrechi redkikh, malochislennykh i maloizuchennykh vidov ptits Nechernozomnogo tsentra Rossii na territorii Ryazanskoy oblasti [Encounters of rare, scarce and weakly studied species of birds from the Non-Chernozem center of Russia on the terrotiry of Ryazan region]. *Trydy Okskogo zapovednika [Proceedings of Okskiy reserve]* **33**, 92–105. (In Russian).

Ivanchev, V.P., Fionina, Ye.A., Nikolayev, N.N., Zakoldayeva, A.A., Nazarov, I.P., Denis, L.S., Lobov, I.V., 2013. Materialy po novym, redkim i malochislennym vidam ptits Ryazanskoy oblasti (po rezul'tatam ekspeditsionnykh i statsionarnykh issledovaniy v 2008–2009 gg.) [Materials on new, rare and scarce species of birds of the Ryazan region (results of expeditionary and stationary studies in 2008–2009)]. Fauna i ekologiya ptits. *Trudy programmy "Ptitsy Moskvy i Podmoskov'y'a" [Fauna and ecology of birds. Procedings of "Birds of Moscow and Moscow region" program]* **9**, 34–42. (In Russian).

Ivanchev, V.P., Kotyukov, Yu.V., Nikolayev, N.N., 2003. Migratsii ptits vesnoy 2001 goda v rayone Klepikovskikh ozor (Ryazanskaya Meshchera) [Bird migrations in the spring of 2001 in the region of Klepiki Lakes (Ryazanskaya Meshchera)] *Trydy Okskogo zapovednika [Proceedings of Okskiy reserve]* **22**, 232–252. (In Russian).

Ivanchev, V.P., Kotyukov, Yu.V., Nikolayev, N.N., 2012. Kadastr kolonial'nykh poseleniy seroy tsapli *Ardea cinerea* v Ryazanskoy oblasti [Cadastre of colonial settlements of grey heron *Ardea cinerea* in the Ryzan region]. *Trydy Okskogo zapovednika [Proceedings of Okskiy reserve]* **27**, 63–69. (In Russian).

Kontorshchikov, V.V., 2001. Vstrechi nekotorykh zalotnykh i redkikh prolotnykh vidov ptits v Moskovskoy i Ryazanskoy oblastyakh [Encounters of some visiting and rare migrating species of birds in the Moscow and Ryazan regions]. *Ornitologiya [Ornithology]* **29**, 297–298. (In Russian).

Kotyukov, Yu.V., 2003. Koloniya seroy tsapli *Ardea cinerea* na oz. Shagara [Grey heron *Ardea cinerea* colony in Lake Shagara]. *Trydy Okskogo zapovednika [Proceedings of Okskiy reserve]* **22**, 649–650. (In Russian).

Krylov, A.V., Kulakov, D.V., Chalova, I.V., Papchenkov, V.G., 2012. Zooplankton presnykh vodoemov v usloviyakh vliyaniia gidrofil`nykh ptitc [Zooplankton of freshwater waterbodies in conditions of hydrophilous birds' influence]. Permyakov S.A. Publishers, Izhevsk, Russia, 204 p. (In Russian).

Kulakov, D.V., 2015. Vstrechi bol`shoi` beloi` tcapli *Casmerodius albus* na Ry`binskom vodokhranilishche v Yaroslavskoi oblasti [Encounters of great egret *Casmerodius albus* on the Rybinsk reservoir in the Yaroslavl oblast]. *Rossiyskiy Ornitologicheskiy Zhurnal [Russian Ornithological Journal]* **24** (1109), 609–612. (In Russian).

Kulakov, D.V., Kosolapov, D.B., Krylov, A.V., Korneva, L.G., Malin, M.I., Pavlov, D.D., 2010. Plankton vysokotrofnogo ozera v usloviyakh

vliyaniya produktov zhiznedeyatel'nosti kolonii seroy tsapli (*Ardea cinerea* L.) [Plankton of highly trophic lake affected by the vital activity products of grey heron *Ardea cinerea* colony]. *Povolzhskiy ekologicheskiy zhurnal [Povolzhye ecological journal]* **3**, 274–282. (In Russian).

Lobov, I.V., 2004. Bol'shaya belaya tsaplya v Ryazanskoy oblasti [Great egret in the Ryzan region]. *Ekologiya i evolyutsiya zhivotnykh. Sbornik nauchnykh trudov kafedry zoolodii RGPU [Ecology and evolution of animals. Collection of scientific proceedings of zoology chair of RSPU]*, 35–36. (In Russian).

Petrova, O.R., Pavlov, D.D., 2016. Pervoye obnaruzheniye gnezdoviy bol'shoy beloy tsapli *Casmerodius albus* v Yaroslavskoy oblasti [First finding of nesting great egret *Casmerodius albus* in the Yaroslavl region]. *Rossiyskiy zhurnal biologicheskih invaziy [Russian Journal of Biological Invasions]* **9** (2), 128–133. (In Russian).

Priklonskiy, S.G., Ivanchev, V.P., Sapetina, I.M., 1992. Ptitsy [Birds]. In: Sokolov, V.E. (ed.), *Flora i fauna zapovednikov SSSR. Pozvonochnyye zhivotnyye Okskogo zapovednika (annotirovannyye spiski) [Flora and fauna of the USSR nature reserves. Vertebrates of the Okskiy reserve (annotated lists)]*. IEE RAS, Moscow, Russia, 15–54. (In Russian).

Stolbunov, I.A., Kutuzova, O.R., Krylov, A.V., 2017. Vliyaniye poseleniya tsapel' (*Ardea cinerea* L. i *A. alba* L.) na pribrezhnyye gruppirovki molodi ryb Rybinskogo vodokhranilishcha [The effect of heron-egret (*Ardea cinerea* L. and *A. alba* L.) colony on the coastal groups of fish fry in the Rybinsk reservoir] *Biologiya vnutrennikh vod [Inland water biology]* **4**, 75–85. (In Russian).

Stolbunov, I.A., Kutuzova, O.R., Krylov, A.V., Pavlov, D.D., 2017. Northward range expansion by Great Egret *Ardea alba* and the impact of a mixed heron-egret colony on fish species in the adjacent waters. *Vogelwelt* **137**, 124–128.

Simonov, V.A. (ed.), 2014. Yaroslavskiy ornitologicheskiy sbornik (2010–2013) [Yaroslavl ornithological anthology (2010–2013)]. Indigo, Yaroslavl, Russia, 74 p. (In Russian).

Zakoldayeva, A.A., 2017. Gnezdovaniye bol'shoy beloy tsapli *Ardea alba* v natsional'nom parke ''Meshcherskiy'' (Ryazanskaya oblast) [Nesting of the great egret *Ardea alba* in ''Meshcherskiy'' national park (Ryazan region)]. *Russkiy ornitologicheskiy zhurnal [Russian ornithological journal]* **26** (1544), 5445–5447. (In Russian).