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COMPOSITION AND DIVERSITY OF PASSERINE BIRD ASSEMBLAGES IN THE FLOODPLAIN DECIDUOUS FORESTS DURING THE BREEDING SEASON (BELARUS)

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Key words: *breeding passerine bird assemblage, floodplain black alder and oak forests, species richness, overall density.*

Видовой состав и разнообразие сообществ воробьинообразных птиц во время гнездового сезона в пойменных лиственных лесах Беларуси. - В. Сахвон. Музей зоологии, Беларусский государственный университет

Исследования видового состава и плотности населения птиц проводились в 1999-2007 гг. Для количественного учета птиц использовался маршрутный метод с некоторыми элементами метода картирования гнездовых территорий на учетных площадках. Три типа пойменных лесов Беларуси были охвачены учетами: дубравы, «южные» черноольховые леса и черноольшаники с примесью в древостое и подросте ели («северные»). В общем 48 видов воробьинообразных птиц было зарегистрировано на гнездовании в пойменных лесах, для 37 из них получены значения плотности на учетных площадках. MDS-анализ показал, что структура сообществ птиц была детерминирована структурным разнообразием лесов. Общая плотность гнездования и в целом видовое богатство возрастали от «северных» черноольховых лесов к черноольшаникам Полесья. Структура сообществ птиц «южных» черноольшаников оказалась более схожа с сообществами птиц дубрав, чем черноольховых лесов с примесью ели («северных»). По результатам BEST анализа Phylloscopus trochilus, Troglodytes troglodytes, Turdus philomelos, Aegithalos caudatus и Sturnus vulgaris определили распределение сообществ птиц по группам на основании степени их сходства. Общая плотность гнездования птиц в пойменных лесах была высокой главным образом из-за значительной плотности широкораспространенных видов, характеризующихся высокой степенью пластичности в выборе мест для гнездования. Всего 18 видов (48%) гнездилось, хотя бы раз за все годы исследований, с плотностью равной либо выше 0.5 пар/га. Группа доминантов представлена 17 видами и в среднем 11-13 видов доминировали на отдельной площадке. Участие доминантных видов в сообществе птиц на отдельной площадке было высоким и составляло от 57.6% до 75.7%. Доля видов птиц, гнездящихся открыто на деревьях либо в подлеске составляла 31.2-51.4%, видов-дуплогнездников - 25.4-40.9% и наземногнездящихся видов - 13.6-31.4%.

Ключевые слова: *сообщества гнездящихся воробьинообразных, пойменные черноольховые леса и дубравы, видовое богатство, общая плотность.*

Видовий склад та різноманіття угруповань горобцеподібних птахів під час гніздового сезону в заплавних листяних лісах Білорусі. - В.Сахвон. Музей зоології, Білоруський державний університет.

Дослідження видового складу та щільності населення птахів проводилися в 1999-2007 рр. Для кількісного обліку птахів використовувався маршрутний метод з деякими елементами методу картування гніздових територій на облікових ділянках. Три типи заплавних лісів Білорусі були охоплені обліками: діброви, «південні» чорновільхові ліси і чорновільшаники з домішкою у деревостої і підрості ялини («північні»). Загалом 48 видів горобціподібних птахів було зареєстровано на гніздуванні в заплавних лісах, для 37 з них отримані значення щільності на облікових ділянках. MDS-аналіз показав, що структура угруповань птахів була детермінована структурним різноманіттям лісів. Загальна щільність гніздування і в цілому видове багатство зростали від «північних» чорновільхових лісів до чорновільшаників Полісся. Структура угруповань птахів «південних» чорновільшаників виявилася більш схожа з угрупованнями птахів дібров, ніж чорновільхових лісів з домішкою ялини («північних»). За результатами аналізу BEST Phylloscopus trochilus, Troglodytes troglodytes, Turdus philomelos, Aegithalos caudatus і Sturnus vulgaris визначено розподіл угруповань птахів по групах на основі ступеня їх схожості. Загальна щільність гніздування птахів у заплавних лісах була високою головним чином через значну щільність широкорозповсюджених видів, що характеризуються високим ступенем пластичності у виборі місць для гніздування. Загалом 18 видів (48%) гніздилось хоча б раз за всі роки досліджень, з щільністю рівною або вище 0.5 пар/га. Група домінантів представлена 17 видами, і в середньому 11-13 видів домінували на окремій ділянці. Участь домінантних видів в угрупованні птахів на окремій ділянці була високою і становила від 57.6% до 75.7%. Частка видів птахів, що гніздяться відкрито на деревах або у підліску становила 31.2-51.4%, видів, що гніздяться в дуплах - 25.4-40.9%, і видів, що гніздяться наземно - 13.6-31.4%.

Ключові слова: *угруповання горобцеподібних птахів, що гніздяться, заплавні чорновільхові ліси й діброви, видове багатство, загальна щільність.*

Introduction

There are many works concerning study of bird assemblages of deciduous forests in the European temperate zone (Nilsson, Liberg 1984; Waliczky 1991, 1992; Hansson 2001; Kralj, Radović 2005; Leito et al. 2006). But the majority of researched forests situates in uplands, e.g. they are dry and transformed by human activity. Some of long-term researches are carried out in never-managed, «climax» old-growth forests (including swampy stands) of Białowieża National Park (Poland) (Tomiałojć, Wesołowski 1996, 2004; Wesołowski, Tomiałojć 1997; Tomiałojć et al. 1984; Wesołowski et al. 2002, 2006).

The floodplain forests in Belarus consist of oak, alder and very rare ash stands. They occupy floodplains of rivers and are flooded during the spring high water. These forests are mostly distributed in the territory of Polesye lowland along the Pripyat River (Yurkevich et al., 1977). In the recent past the floodplain forests were intensively cut down, that led to significant reduction of the areas and age of these types of forests. Now most of them are taken under protection.

The floodplain forests bear the minimum of anthropogenic influence due to their difficult position to traverse and the spring high water level, which lasts a significant part of year (late March to mid May and sometimes even later). That is why they can be considered as stable ecosystems important for conservation of bird diversity in Belarus, including some rare species.

The structure of bird communities is determined by processes operating at local scales, such as the floristic structure of habitats (spatial configuration, productivity and diversity of vegetation) (Wiens 1989). The character of spring high water (duration, altitude, frequency) is an important factor influencing bird assemblages in the floodplain forests, especially ground nesting species besides the effect of vegetation structure.

The aim of this research was to determine the composition and structure of the passerine bird assemblages of the floodplain deciduous forests during the breeding season and explore the main habitat characteristics that affect the given parameters.

Study area

The Republic of Belarus is situated in the geographical center of Europe. In general the relief is represented with lowlands; the highest point is 346 meters above sea level. The climate is moderately continental with frequent cyclones. Physical and climatic conditions provide the domination of forest (mainly coniferous) and wetland ecosystems in the territory. The average annual rainfall is 600-700 mm, the average temperature is 7.4 ºC in the southwest and 4.4 ºC in the northeast. The average temperature in January is between - 8 and - 4.5 ºC and in July is between 17-18.8 ºC. Snow cover lies for 75-125 days. In the territory of Belarus two geobotanical regions meet: European broad-leaved and Eurasian coniferous forests (Podolyako 2000; Loginov 2002). The total area of forests in Belarus is 35.5% of the whole territory. They are represented by boreal coniferous – 50.4 % of the forests territory, sub-boreal broad-leaved coniferous – 13.1 %, oak-leaved and broad-leaved – 3.8 % with their participation continuing to descend, small-leaved forests – the rest. There are main types of floodplain forests – oak *Quercetum fluvialis* (only 7% from all the quantity of oak forests) and alder *Alnetum fluvialis* forests (about 11 % from all forests) (Yurkevich et al. 1977).

Description of the census areas

Our researches in floodplain forests were based on dominant plant species of a forest stand, a young-tree layer and a character of a bush layer. Three types of the floodplain forests were covered: the floodplain oak *Quercus robur* forests, the «southern» and the «northern» floodplain black alder *Alnus glutinosa* forests. «Northern» black alder forests are characterized by presence in the young-tree layer and in the forest stand of Norway spruce *Picea abies* in comparison with the «southern» stands. We tried to choose the most typical, homogeneous and as big as possible internal sites of the forest, avoiding the influence of various factors (glades, open areas (meadows, bogs) etc.). Only the main features of each plot are presented. The age of these forests is approximate because of contradictions in the botanical literature concerning the definition of the age of floodplain tree stands. All studied forests were old. In total 8 census areas have been placed (fig. 1). These areas are Important Bird Areas and are taken under protection in Belarus.

«Southern» floodplain black alder forests:

1. Plot AZs - 52°46’ N 26°00’ E. The transect (census plot) length is 1500 m. It is located in the floodplain of the Shchara River. It is characterized by the significant water level (up to 0.6m during some seasons). The upper canopy is composed of black alders (40-50 cm tree diameter at breast-height, aged 70-90). The well-developed bush layer is composed of *Padus racemosa,*

Fig. 1. *Distribution of study areas in Belarus*

Notes: 1 – Plots APs, FF-1, FF-2, FF-3; 2 – AZs and ATs; 3 – ABn; 4 – ASn (for explanations look through the text)

Рис. 1. *Распределение территорий исследования в Беларуси*

Примечания: 1 – Площадки APs, FF-1, FF-2, FF-3; 2 – AZs и ATs; 3 – ABn; 4 – ASn (объяснение см. в тексте).

Frangula alnus, and some species of willow *Salix sp., Rubus idaeus, R. caesius* and *Ribes sp*. A dry oak belt with hornbeam *Carpinus betulus* in the young-tree layer presents a plot that is typical for the floodplain alder forests. The herb layer (height is more than 1 m at the end of spring): *Carex sp.*, ferns, nettle *Urtica dioica* and other water-resistant plants - is well-developed. There are many fallen trunks (logs) and uprooted trees. The hop *Humulus lupulus* densely braids trees that are preferred for nesting by many birds.

2. Plot ATs – 52°12’ N 27°30’ E. The transect length is 1000 m. It is also located in the floodplain of the Shchara River and within 10 km from the previous one. In comparison with the previous plot this one consists of a younger tree stand (30-40 cm in diameter, 60-80 years old). The water level usually does not exceed a depth of 30 cm and water can dries up in summer. The bush layer is less developed. There are many uprooted trees.

3. Plot APs - 52°09’ N 27°40’ E. The transect length is 500 m. The forest we are interested in lies in the floodplain of the Pripyat River. It is 70-90 years old. In early spring the water level can exceed 70 cm in depth and the plot remains swampy at some places throughout a year. The upper canopy is composed of black alder with a small number of birches *Betula sp*. and some large oaks. The young trees practically are absent, as well as uprooted trees. The bush layer is represented as separate willow bushes and *Frangula alnus*.

«Northern» floodplain black alder forests:

1. Plot ASn - 54°12’ N 28°06’ E. This plot is situated in the floodplain of the Gaina River. The transect length is 1000 m. Old alder stands (25-40 cm in diameter, 80 years and more) with some inclusions of *Picea abies* dominate and form the upper canopy. In the lower canopy spruce dominates. The young tree layer is also represented almost exclusively by spruces (height 2-7 m). The forest is about 300 m in width and spreads along the Gaina River on the one side and borders on a spruce forest on the other side. Birch becomes dominant with alder at the swampiest sites of forest. Some places are presented with solitary aspens *Populus tremula*. The well-developed bush layer is composed of willow and *Frangula alnus*. The high herb layer (1-1.3 m high) is represented as nettle, ferns, *Carex sp*. and other marsh plants. This is the swampiest plot. The water level can be 20-30 cm in summer and up to 50 cm in early spring. There are many uprooted trees.

2. Plot ABn - 53°21’ N 28°51’ E. The study plot is located in the floodplain of the Berezina River. The transect length is 700 m. An old black alder forest (30-45 cm diameter, 80 years and more) occupies the lowest places of the floodplain and is surrounded by older dry oak-spruce stands. Solitary aspens and oaks are presented in some sites. The well-developed young tree layer is represented only by spruces (2-5 m height). The bush layer is composed of bird cherries and willows. The water level is insignificant and does not exceed 30-40 cm in spring and dries up in summer. The high herb layer is typical for swampy forests.

Floodplain oak forests:

This territory (52°12’ N 27°32’ E) of old oak forests (over 100 year-old) is situated in the floodplain of the Slutch River and is included in the republic protected site «Middle Pripyat

Floodplain». Three census plots have been chosen in 15 km^2 territory. The floodplain oak forest is not uniform. There are spots with the old pine *Pinus silvestris*; lowest places consist of alder stands. Much more rarely hornbeams are found on uplands. It is quite typical for the floodplain forests of Polesye Region. In all plots the average diameter of oak trees at breast-height is 40-55 cm, some trees reach more than 70 cm.

1. Plot FF-1 – The transect length is 500 m. The relief is plain and the plot is the swampiest (the water level can exceed 40 cm in spring) in comparison with other oak plots. Water dries up only in summer. More alders are found farther from the river, so the oak forest is replaced by swampy alder stands. The oak stands with some inclusions of ash *Fraxinus excelsior* and aspens dominate and form the upper canopy. The well-developed bush layer is represented mainly by *Corylus avellana* (5-7 m height) and *Frangula alnus* and willows in damp places. The high herb layer is mainly composed of *Urtica dioica, Carex sp., Aegopobium podagraria* etc. and is formed on the gaps, but under *Corylus avellana* – is almost not present. This plot is characterized by abundance of gaps in comparison with the other study oak stands. The well-pronounced young tree layer is formed by maples *Acer sp*., birches etc.

2. Plot FF-2 – The length of transect is 600 m. The relief is undulate**.** The oak uplands which are not filled up with water in spring alternate with lowlands filled up with water that never dries up. These lowlands are frequently covered with willows. The oak stands dominate and with some quantity of ashes and aspens in lowlands form the upper canopy. There are many dead trees, especially oaks and aspens. The well-developed bush layer is formed by *Corylus avellana, Euonymus europaea* and *Rubus* species. When trees are covered with foliage it becomes dark in the forest. The herb layer is oppressed.

3. Plot FF-3 – The length of transect is 500 m. The main characteristics are similar to the previous plot. The upper canopy layer is very open due to separate old oak stands and the herb layer is well-developed (more than 1 m high in summer). The young tree layer and the bush layer are well identified and represented by maples, *Malus silvestris, Pyrus comminis, Sorbus aucuparia, Rubus species, Corylus avellana* and *Frangula alnus*.

The water level in all oak plots can exceed more than 60 cm in spring and can be more than 1.5 m in lowlands.

Methods

Bird census. The data were collected using the Finnish line transect method (Järvinen, Väisänen 1976) with some elements (additional) of the territory mapping technique (Wesołowski et al. 2002; Tomiałojć, Wesołowski 2004). For census of birds we chose a constant transect of the certain length and counted all birds in a certain belt (afterwards this area was considered as a census plot and was used for the calculation of the species density). We used only three main belts to count birds (120, 150 and 200 m). We used 60 m in both sides for *Pyrrhula pyrrhula, Carpodacus erythrinus, Coccothraustes coccothraustes, Certhia familiaris, Aegithalos caudatus* and for all of *Parus* tits, except for *Parus major*. We used 100 m in both sides for *Anthus trivialis, Troglodytes troglodytes, Locustella fluviatilis, Sturnus vulgaris, Sitta europaea, Oriolus oriolus, Garrulus glandarius* and for all species of *Turdidae*, except for *Erithacus rubecula*. 150 m (75m to both sides) wide belt was used to count all other species. We used 200 m to both sides for census of *Corvus corax*.

The counts were carried out during breeding seasons of 2000 and 2007. The counts (from 3 up to 10 during a breeding season) were made between the end of March and the middle of June. Counting was conducted early in the morning during the period of maximum bird activity. To increase the accuracy of results the counts were made with long stops. Some visits were performed in the evening for the dusk active bird's registration. In addition we carried

out detailed inspection of the census area within the limits of transects to search for nests (or mapping of territories) of some not numerous species, species with large breeding territories and «problematic» for counts species (*Sitta europaea, Locustella fluviatilis* and all species of *Turdidae*, except for *Erithacus rubecula*) (Tomiałojć, Lontkowski 1989). At the end of the breeding season the general map of the breeding territories for each species was made. It was used for the calculation of the overall density.

Data analysis. Besides counts of birds on the census plots we revealed composition of bird species in a breeding season using repeated inspection of studied territories of floodplain forests. Some species of floodplain forests are not registered on the studied plots during the counting. *Parus cristatus, Turdus pilaris, Phoenicurus phoenicurus, Sylvia curruca, Acrocephalus palustris* and *Passer montanus* were found breeding once. *Motacilla alba, Ficedula parva, Parus cyanus, Emberiza citrinella* and *Lanius excubitor* are distributed sporadically and are rare everywhere in the floodplain forests. These species were not used for the statistical analysis.

The calculation of density without any corrections was carried out as a number of pairs/ha. A territorial male, inhabited nest or birds with attributes of breeding were accepted for a pair. The territories of bigamists or bachelor males were treated as equivalent to those of monogamists. The number of species was considered as a basic measure of species richness. Species components over 5% of assemblage were considered as dominants. For analyses of bird assemblage we distinguished among nesting birds the following groups: ground nesters, openly nesting on trees and shrubs, hole-nesters. *Erithacus rubecula* and *Certhia familiaris* was considered as hole-nesters.

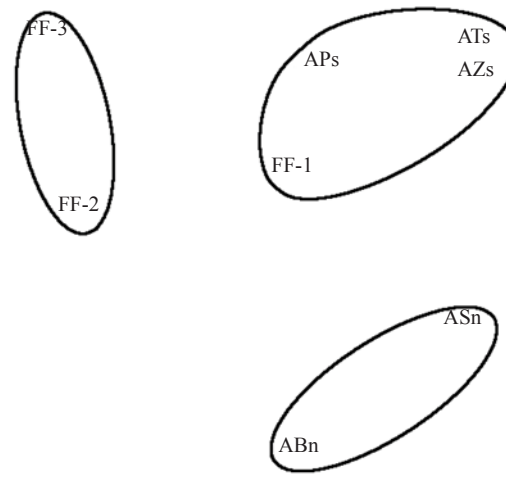

Fig. 2. *Results of multidimensional scaling of the surveyed bird assemblages in different types of floodplain forests*

Note: The bird assemblages are represented by abbreviations of researched types of forests (see descriptions of census plots).

Рис. 2. *Результаты многомерного шкалирования исследованных сообществ птиц в разных типах пойменных лесов.*

Примечание: сообщества птиц обозначены буквенными индексами исследованных типов лесов (см описание учетных площадок).

To test whether bird assemblages form natural assemblages in accordance with the type of forest, we used MDS-analysis of square-root transformed density data (Bray-Curtis coefficient of similarity; 50 restarts; minimum stress 0.001). The statistical significance of difference between the bird assemblages was then tested with ANOSIM procedure. To find a subset of species that best "explain" the results of MDS-analysis, we used the BEST procedure. All tests were performed using PRIMER 6.0 software (Clarke, Gorley 2006).

Results

Overall, 37 species were registered breeding within all the census plots that make 77.1% from 48 passerine species breeding in the floodplain forests (Table 1-3). The number of species in plots varied from 15 (plot FF-2) to 28 (plots AZs and ATs) in a single breeding season (Table

1, 2). The highest number of species was found in the floodplain black alder forests of Polesye region – 33 species (Table 2). According to results of cluster analysis at a level of similarity about 70 % it is possible to allocate three basic assemblages of birds of: 1) floodplain oak forests; 2) «southern» floodplain black alder forests; and 3) floodplain alder forests with presence of spruce at a forest stand and young-tree layer («northern»). The difference between bird assemblages was statistically significant (P=0.004, ANOSIM) (Fig. 2). The presence of bird assemblage of the oak plot FF-1 in group «southern» black alder forests was explained by habitat structure (impurity of alders in a tree stand and high swamp). The following 5 species: *Phylloscopus trochilus, Troglodytes troglodytes, Turdus philomelos, Aegithalos caudatus* and *Sturnus vulgaris* were found to best explain the grouping of the bird assemblages of different types of forests studied (r = 0.926, BEST procedure).

Table 1. *The breeding passerine bird assemblages of the floodplain oak forests*

Таблица 1. *Сообщества гнездящихся воробьинообразных птиц в пойменных дубравах.*

Species Вид	FF-1, length 500 m длина 500 м				FF-2, length 600 m длина 600 м			FF-3, length 500 m длина 500 м		
	Pairs / Пары		Mean / Среднее		2003			2002		
	2004	2005	p/ha пар/га	%	pairs пары	p/ha пар/га	%	pairs пары	p/ha пар/га	%
Fringilla coelebs	**15**	**14**	1.93	**14.5**	21	2.33	**19.3**	14	1.87	**14.3**
Sylvia atricapilla	**10**	**6**	1.07	**8**	8	0.89	**7.4**	-	-	-
Phylloscopus collybita	**10**	**6**	1.07	**8**	7	0.78	**6.4**	8	1.07	**8.2**
Phylloscopus sibilatrix	**8**	**8**	1.07	**8**	12	1.33	**11**	11	1.47	**11.3**
Parus major	**6**	**7**	0.87	**6.5**	8	0.89	**7.4**	5	0.67	**5.1**
Turdus philomelos	**8**	**7**	0.75	**5.6**	6	0.5	4.1	3	0.3	2.3
Phylloscopus trochilus	**6**	5	0.73	**5.5**	-	-	-	-	-	-
Erithacus rubecula	4	**6**	0.67	**5**	13	1.44	**12**	10	1.33	**10.2**
Parus caeruleus	3	**5**	0.67	**5**	5	0.69	**5.7**	3	0.5	3.8
Turdus merula	**7**	6	0.65	4.9	7	0.58	4.8	7	0.7	**5.4**
Certhia familiaris	2	4	0.5	3.8	-	-	-	-	-	-
Luscinia luscinia	4	6	0.5	3.8	-	-	-	4	0.4	3.1
Sylvia borin	-	-	-	-	-	-	-	3	0.4	3.1
Muscicapa striata	1	4	0.33	2.5	-	-	-	-	-	-
Ficedula albicollis	3	2	0.33	2.5	5	0.56	4.6	-	-	-
Ficedula hypoleuca	2	3	0.33	2.5	7	0.78	**6.4**	13	1.73	**13.3**
Troglodytes troglodytes	3	3	0.3	2.3	2	0.17	1.4	1	0.1	0.8
Sturnus vulgaris	3	3	0.3	2.3	4	0.33	2.8	7	0.7	**5.4**
Anthus trivialis	-	-	-	-	-	-	-	3	0.3	2.3
Hippolais icterina	1	2	0.2	1.5	-	-	-	-	-	-
Locustella fluviatilis	2	2	0.2	1.5	-	-	-	-	-	-
Sitta europaea	2	2	0.2	1.5	3	0.25	2.1	4	0.4	3.1
Luscinia svecica	2	2	0.2	1.5	-	-	-	4	0.4	3.1
Coccothraustes coccothraustes	1	1	0.17	1.3	4	0.56	4.6	3	0.5	3.8
Spinus spinus	-	2	0.13	1	-	-	-	-	-	-
Oriolus oriolus	1	1	0.1	0.8	-	-	-	-	-	-
Garrulus glandarius	1	-	0.05	0.4	-	-	-	2	0.2	1.5
Total (27 species) Всего (27 видов)	105	107	13.32	100	112	12.08	100	105	13.03	100

Notes: «-» – species was absent, but in calculation of mean was accepted; The bold – dominants (constituting ≥ 5 % of assemblage).

Примечания: «-» вид отсутствовал, но учитывался при расчетах среднего значения. Жирным шрифтом указаны доминанты (составляющие ≥ 5 % сообщества).

Table 2. *The breeding passerine bird assemblages of the «southern» floodplain black alder forests*

Таблица 2. *Сообщества гнездящихся воробьинообразных птиц в южных пойменных черноольховых лесах.*

Species Вид	AZs, length 1500 m длина 1500 м				ATs, length 1000 m длина 1000 м			APs, length 500 m длина 500 м		
	Pairs / пары		Mean / среднее		2001			2006		
	2000	2001	p/ha пар/га	%	Pairs пар	p/ha пар/га	%	Pairs пар	p/ha пар/га	%
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Fringilla coelebs	**52**	**47**	2.2	**15.9**	19	1.26	**7.9**	13	1.73	**12.6**
Phylloscopus collybita	**35**	**53**	1.95	**14.1**	20	1.33	**8.4**	7	0.93	**6.8**
Erithacus rubecula	**26**	**27**	1.17	**8.5**	20	1.33	**8.4**	4	0.53	3.9
Phylloscopus trochilus	**23**	**28**	1.13	**8.2**	21	1.4	**8.8**	6	0.8	**5.8**
Parus major	**23**	**18**	0.91	**6.6**	6	0.4	2.5	7	0.93	**6.8**
Sylvia atricapilla	**17**	**21**	0.84	**6.1**	18	1.2	**7.6**	8	1.06	**7.7**
Troglodytes troglodytes	17	**24**	0.68	4.9	11	0.55	3.5	5	0.5	3.6
Turdus merula	**25**	14	0.65	4.7	23	1.15	**7.2**	4	0.4	2.9
Phylloscopus sibilatrix	11	**17**	0.62	4.5	20	1.33	**8.4**	8	1.06	**7.7**
Turdus philomelos	11	16	0.45	3.3	14	0.7	4.4	7	0.7	**5.1**
Pyrrhula pyrrhula	8	6	0.38	2.8	2	0.16	1	-	-	-
Hippolais icterina	+	8	0.35	2.5	14	0.93	**5.9**	-	-	-
Parus palustris	6	6	0.33	2.4	4	0.33	2.1	1	0.16	1.2
Aegithalos caudatus	7	4	0.3	2.2	4	0.33	2.1	1	0.16	1.2
Coccothraustes coccothraustes	8	3	0.3	2.2	-	-	-	-	-	-
Sylvia borin	5	6	0.24	1.7	6	0.4	2.5	3	0.4	2.9
Certhia familiaris	4	4	0.22	1.6	3	0.25	1.6	2	0.33	2.4
Carpodacus erythrinus	1	5	0.16	1.2	-	-	-	-	-	-
Sitta europaea	8	2	0.16	1.2	2	0.1	0.6	1	0.1	0.7
Sturnus vulgaris	+	5	0.16	1.2	7	0.35	2.2	8	0.8	**5.8**
Luscinia svecica	4	+	0.13	0.9	3	0.15	0.9	-	-	-
Parus caeruleus	2	2	0.11	0.8	2	0.16	1	1	0.16	1.2
Turdus iliacus	4	2	0.1	0.7	8	0.4	2.5	-	-	-
Lanius collurio	-	-	-	-	9	0.6	3.8	-	-	-
Ficedula hypoleuca	2	2	0.08	0.6	5	0.33	2.1	4	0.53	3.9
Luscinia luscinia	2	2	0.06	0.4	5	0.25	1.6	7	0.7	**5.1**
Garrulus glandarius	3	1	0.06	0.4	2	0.1	0.6	1	0.1	0.7
Prunella modularis	-	2	0.04	0.3	2	0.13	0.8	3	0.4	2.9
Oriolus oriolus	1	1	0.03	0.2	1	0.05	0.3	1	0.1	0.7
Anthus trivialis	-	-	-	-	4	0.2	1.3	5	0.5	3.6
Chloris chloris	-	-	-	-	-	-	-	1	0.13	0.9
Ficedula albicollis	-	-	-	-	-	-	-	3	0.4	2.9
Locustella fluviatilis	-	-	-	-	-	-	-	1	0.1	0.7
Total (33 species) Всего (33 вида)	305	326	13.81	100	255	15.87	100	112	13.71	100

Notes: «+» – species was present, but number of pairs is unknown, in calculation of mean density was not accepted; «-» – species was absent, in calculation of mean was accepted; Dominants are indicated in bold.

Примечания: «+» вид присутствовал, но количество пар неизвестно, при расчетах среднего значения не учитывался. «-» - вид отстутствовал, но учитывался при расчетах среднего значения. Жирным шрифтом указаны доминанты.

Table 3. *The breeding passerine bird assemblages of the «northern» floodplain alder forests*

Таблица 3. *Сообщества гнездящихся воробьинообразных птиц в «северных» пойменных ольховых лесах.*

Species Вид	ASn, length 1000 m / длина 1000 м				ABn, length 700 m / длина 700 м		
	Pairs / Пары		Mean / Среднее		2007		
	2006	2007	p/ha пар/га	%	Pairs пары	p/ha пар/га	%
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Fringilla coelebs	**17**	**13**	1	**12.6**	10	0.95	**11.7**
Phylloscopus trochilus	**14**	**9**	0.77	**9.6**	-	-	-
Sylvia atricapilla	**9**	**14**	0.77	**9.6**	6	0.57	**7**
Phylloscopus collybita	**10**	**12**	0.73	**9.2**	7	0.67	**8.2**

Continuation of Table 3.

1	2	3	4	5	6	7	8
Erithacus rubecula	**7**	**11**	0.6	**7.5**	15	1.43	**17.6**
Troglodytes troglodytes	**10**	**10**	0.5	**6.3**	10	0.71	**8.8**
Phylloscopus sibilatrix	6	5	0.37	4.6	3	0.29	3.5
Ficedula hypoleuca	4	**7**	0.37	4.6	1	0.1	1.2
Parus major	**9**	2	0.37	4.6	6	0.57	**7**
Turdus merula	7	7	0.35	4.4	6	0.43	**5.3**
Muscicapa striata	5	5	0.33	4.2	1	0.1	1.2
Turdus philomelos	**10**	2	0.3	3.8	9	0.64	**7.9**
Certhia familiaris	4	3	0.29	3.7	-	-	-
Prunella modularis	3	5	0.27	3.4	4	0.38	4.7
Parus caeruleus	1	3	0.17	2.1	2	0.24	2.9
Sitta europaea	4	1	0.13	1.6	2	0.14	1.8
Locustella fluviatilis	4	1	0.13	1.6	-	-	-
Sylvia borin	-	3	0.1	1.3	-	-	-
Parus palustris	1	1	0.08	1	-	-	-
Parus montanus	2	-	0.08	1	-	-	-
Turdus iliacus	3	-	0.08	0.9	1	0.07	0.9
Hippolais icterina	1	1	0.07	0.8	2	0.19	2.3
Spinus spinus	2	-	0.07	0.8	-	-	-
Garrulus glandarius	1	-	0.03	0.3	1	0.07	0.9
Corvus corax	1	1	0.03	0.3	1	0.04	0.4
Ficedula albicollis	-	-	-	-	4	0.38	4.7
Luscinia luscinia	-	-	-	-	2	0.14	1.8
Total (27 species) Всего (27 видов)	135	116	7.95	100	93	8.11	100

Notes: «-» – species was absent, but in calculation of mean was accepted; The bold – dominants.

Примечания: вид отсутствовал, но учитывался при расчетах среднего значения. Жирным шрифтом указаны доминанты.

Table 4. *The comparative characteristics of main structural parameters of bird assemblages of the floodplain forests*

Таблица 4. *Сравнительная характеристика главных структурных параметров сообществ птиц пойменных лесов.*

Parameters Показатели	Oak forests Дубравы			«Southern» black alder forests «южные» черноольшаники			«Northern» black alder forests “северные” черноольшаники	
	FF-1	FF-2	FF-3	AZs	ATs	APs	ASn	ABn
Total assemblage Все сообщество								
Number of species Количество видов	24	15	18	27.5±0.5	28	26	22.5±1.5	20
Overall density (pairs/ha) Общая плотность (пар/га)	13.32±0.22	12.08	13.03	13.61±0.48	15.87	13.71	7.95±0.49	8.11
Cumulative participation of dominants (%) Общая доля доминантов (%)	62.5±4.9	75.7	73.2	69.2±3.1	62.6	63.5	64.8±0.9	73.7
Densities of nesting groups Плотность гнездящихся групп								
Ground nesters Наземногнездящиеся виды	3.77±0.23	2.11	3.63	3.85±0.58	4.66	4.09	1.99±0.21	1.1
Openly nesting on trees and shrubs Виды, открытогнездящиеся на деревьях и кустарниках	5.68±0.08	5.03	4.07	6.66±0.01	7.96	5.68	3.88±0.17	4.15
Hole-nesters Дуплогнездники	3.87±0.53	4.94	5.33	3.1±0.11	3.25	3.94	2.08±0.12	2.86

Note: Mean values ± standard deviations in individual plots.

Примечание: Среднее значение ± стандартное отклонение по отдельным площадкам.

The total bird density varied between 7.46 (plot ASn in 2007) and 15.87 pairs/ha (plot ATs) (Table 2, 3). The mean density for all years was the lowest in the plots of «northern» black alder forests despite of similar number of species in assemblages in comparison with bird assemblages of other forests. The mean density of birds in the oak plots was high (Table 1) and similar with assemblages of alder forests of Polesye but the participation of species was lower than in black alder stands.

The group of dominants was composed of 17 species. The number of dominants was 11-13 species in each type of forests in mean. The composition of the group of dominants was similar between all the plots and the number of species varied from 6 to 9. Only two species (*Fringilla coelebs* and *Phylloscopus collybita*) were dominants in all the plots. *Parus caeruleus* and *Certhia familiaris* were dominants only in the floodplain oak forests at once, *Hippolais icterina* and *Luscinia luscinia* - in «southern» alder forests and *Muscicapa striata* – in «northern» tree stands. The floodplain alder forests are characterized by presence of *Troglodytes troglodytes* in the structure of dominants. Participation of dominant species in breeding assemblages of a single plot made from 57.6% (plot FF-1, 2005) to 75.7% (plot FF-2) (Table 4).

From 31.2% (plot FF-3) to 51.4% (plot AZs, 2000) of species of bird assemblages bred openly on trees and shrubs in a single plot, 25.4% (plot FF-1 in 2004) - 40.9% (plot FF-2) were hole-nesters (Table 4). The group of the species nesting on the ground was represented by 12 species (19.6% of all number) and their participation in the population amounted to 13.6% (plot ABn) - 31.4% (plot AZs in 2001).

Discussion

The effect of woodland structure and diversity of vegetation on bird assemblages has been widely documented (Solonen 1996; Jokimäki, Huhta 1996; Elmberg, Edenius 1999; Sallabanks et al. 2000; Laiolo 2002; Brotons et al. 2003). The type of forest stand and bushes composition plays the main role in the organization of bird assemblage. The division of assemblages of birds into three groups according to types of forests confirmed the aforesaid. Five species made the greatest contribution to this grouping. *Phylloscopus trochilus*, *Troglodytes troglodytes* and *Aegithalos caudatus* undoubtedly preferred the flooded black alder forests. It is possible the last species at the forest-edge. *Turdus philomelos* preferred drier and lighter oak forests, although bred in high densities in flooded alder forests as well. The nesting of *Sturnus vulgaris* depended on availability of holes and it nested at the forest-edges. The floodplain oak forests better correspond to these conditions. *Sturnus vulgaris* also nested in high density in «southern» black alder forests due to inclusions of solitary old oak trees.

Generally the bird assemblages of the floodplain forests were characterized by a high species diversity and density. The bird assemblages of the studied groups of floodplain forests were highly similar in species composition, total bird density and density of particular species. The overall density and partly species richness were changing along a habitat gradient from the highest in the floodplain black alder forests of Polesye Region to the lowest in «northern» alder stands with impurity of spruce. The structure of bird assemblages of «southern» black alder forests was similar rather with assemblages of oak stands than the «northern» ones. In spite of the fact that the species richness of birds in «northern» black alder forests was similar to data of floodplain forests of Polesye, the densities of some species - *Fringilla coelebs, Phylloscopus collybita, Phylloscopus sibilatrix, Parus major, Sylvia atricapilla, Turdus merula, Hippolais icterina* and *Sylvia borin* in the assemblages were smaller and overall density was low. The tendency of increase of density of birds assemblages with movement from the north to the south for different types of woodland landscapes was discussed (Novikov 1960). *Alnus glutinosa* is situated in the area of optimum distribution in Polesye Region (Yurkevitch et al. 1977) and these

forests with the black alder were characterized by a high habitat variety preferable for birds. This factor was the main cause of observed differences in the structure of assemblages. For example, seven types of nest locations of *Turdus merula* were recognized in the «southern» alder forests and five of them occurred frequently. While only five types of nest locations were occurred in «northern» alder stands and only two location types were common. The places for nesting of some other groups of birds were limited in «northern» alder forests with impurity of spruce too. Thus, the ground nesters (*Phylloscopus trochilus, Phylloscopus sibilatrix* and *Erithacus rubecula* too (because of the limited number of holes)) built nests on dry hummocks near tree trunks in flooded forests. Spruces grew together with alders on hummocks in «northern» forests. Such hummocks were covered with needles and become unsuitable for nesting.

Discs of flat root systems of uprooted trees represent a special unit intermediate between the ground and the tree-layers (Tomiałojć et al. 1984) and provide preferable nesting sites for some species. The abundance of *Turdus merula, Pyrrhula pyrrhula* and especially *Troglodytes troglodytes* was positively related to the number of uprooted trees. In black alder forests, where the discs were common, a high density of these species was observed. *Turdus philomelos* and *Prunella modularis* placed the nests there as well. The nests of two species settled down in the discs very often (usually *Turdus merula* was one of neighbors).

The character of the spring high water influenced the group of ground nesting birds. The most changeable group of these species was *Anthus trivialis, Phylloscopus sibilatrix* and *Phylloscopus trochilus*, and their presence and nesting terms directly depended on duration of high water and the character of relief. Different from the previous species *Phylloscopus collybita* can make nests above ground (up to 40 cm) in swampy ash-alder stands (Piotrowska, Wesołowski 1989). The density of ground nesters amounted to not more than 2 pairs/ha in the swampiest «northern» plots and it was 2-2.7 times lower than in other types of forests. On the plot ABn the relief was uniform, dry islands were almost absent and the number of ground nesting species and their density was the lowest (3 species, 1.1 pairs/ha). Due to the presence of considerable number of dry islands the character of spring high water influenced ground nesters in floodplain oak forests areas than in black alder forests.

As for species composition of birds our data were similar to data of the deciduous tree stands (ash-alder, alder-swamp, oak-lime-hornbeam forests) of Białowieża National Park (Tomiałojć et al. 1984; Wesołowski et al. 2002; Tomiałojć, Wesołowski 2004; Wesołowski et al. 2006), but the overall densities of breeding birds were a little higher, mainly due to high numbers of several widespread species characterized by wide ranges in a choice of nest sites. So, 8 species bred with the density exceeding 1 pairs/ha at least one time: *Fringilla coelebs, Erithacus rubecula, Sylvia atricapilla, Phylloscopus collybita, Phylloscopus trochilus, Ficedula hypoleuca, Phylloscopus sibilatrix* and *Turdus merula*. Only *Fringilla coelebs* and *Erithacus rubecula* bred with the same density in «northern» alder forests. The densities of 24% of species in the «northern» black alder forests and 80% - in the oak forests were equal or more than 0.5 pairs/ha. In fact the number of these species was 18 (48%). The densities of *Fringilla coelebs*, *Erithacus rubecula* and *Phylloscopus collybita* were more than 0.5 pair/ha during all the years and in all the plots. High densities of these species can be explained by the fact that still there were some changes in habitat structure, especially in oak forests. The dying of oak and aspen trees, formation of gaps, rapid growth of young trees and bushes in the places contributed to maintenance or even increase of number of some species, mainly forest-edge species. The influence of edges and gaps on abundance of birds is widely considered in the papers (Tomiałojć et al. 1984; Báldi, Kisbenedek 1994; Fuller 2000; Sallabanks et al. 2000). The overall bird density reached the highest level (14.9 pair/ha in ash-alder plot) in BNP in 2001. According to our data the overall bird density was the highest in this year as well. It's obviously those factors acting on a larger scale could have been involved (Wesołowski et al. 2006).

The short-term studies are not quite enough for estimation stability-variability of densities of birds assemblages. We registered the considerable changes in numbers for *Phylloscopus collybita* and *Parus major* in black alder stands. The additional long-term studies outside the plots showed the fluctuation of numbers for *Ficedula albicollis* and *Lanius collurio* in these forests. The fluctuation of numbers of these species happened without any changes in the habitat structure advantageous for these species. Holmes et al. (1986) found that the species with high densities were more variable in number than those occurring at low densities in a temperate deciduous forest.

The bird assemblages of floodplain forests of Belarus were characterized by high species diversity, richness and density. These parameters were made by woodland structural complexity. Changes in hydrology due to flood control are one of the main factors of habitat change in these forests and consequently, of changes in structure of bird assemblages. Undoubtedly all floodplain forests must be taken under protection in Belarus and observations of bird assemblages must be continued.

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