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**Breeding avifauna in coniferous forests of the Białowieża Primeval Forest**

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In 1974-1977 quantitative studies of birds during breeding season were conducted on 7 over mature stands in five types of coniferous forest communities (140 ha) located in the Białowieża National Park and in the part of Białowieża Primeval Forest that was under management. All these forests show a high degree of naturalness since they appeared as a result of natural restoration. A total of 47 species of birds were noted, out of which 41 are breeding in this area. The density of pairs was low (24.8-53.9 pairs/10 ha). The core of avifauna in all plots was formed by 4 species: *Fringilla coelebs*, *Phylloscopus sibilatrix*, *Regulus regulus* and *Erithacus rubecula*. Majority of species, also the dominant ones, attain a somewhat higher density in the National Park than in the remaining part of Białowieża Forest. Natural mixed coniferous forests in different parts of the Forest have similar bird communities, clearly differing from those of the bog moss spruce forest *Sphagno Girgensohnii-Piceetum*.

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Гнездовая авифауна боров Беловежской пуши.

В 1974-1977 г.г. на семи площадках старого хвойного древостоя представляющего пять типов боров (140 га), находящихся как на территории Беловежского национального парка, так и эксплуатируемой части пуши были проведены в период гнездования количественные исследования по птицам. Все обсужденные боры характеризуются значительной натуральностью, поскольку они возникли в процессе естественной регенерации. Отмечено 47 видов птиц, в том числе 41 гнездящихся. Плотность пар была низкая (24,8-53,9 пар/10 га). Костяк авифауны составляли на всех исследованных площадках 4 вида: *Fringilla coelebs*, *Phylloscopus sibilatrix*, *Regulus regulus* и *Erithacus rubecula*. Большинство видов, как и группа доминирующих видов, достигала в национальном парке несколько большей плотности, чем в остальной части пуши. Исследования показали, что естественные смешанные боры из разных частей пуши имеют сходные комплексы птиц, четко отличающиеся от комплексов, населяющих сфагновые ельники.

Quantitative investigations of bird communities in the Białowieża Primeval Forest were initiated as late as in 1972. The efforts were focussed primarily on coniferous forests since they predominate in Polish stands and their biological resistance is an important economical factor. In the Białowieża Primeval Forest the currently utilized ever mature coniferous stand shows many features of a primeval forest since it appeared as a result of natural restitution. The oldest class of coniferous forest stands was chosen for the studies since due to rapid cuts the stands of natural origin in this age class will disappear in the managed part of Białowieża Primeval Forest, while younger classes represent already planted stands.

The mosaic pattern of forest types is a characteristic feature of the natural stands in the Białowieża Primeval Forest and the forest management further increases this pattern. Such a situation makes rather difficult the choice of spacious homogeneous plots for studies.

The studies aimed at characterizing breeding bird communities of natural coniferous forests in the Białowieża Primeval Forest and verification of the differentiation of these communities connected with the types of plant communities and location of study plots (their surroundings).

#### METHODS

The studies were based on the mapping method (ENEMAR 1959, TOMIAŁOJĆ 1968). Census plots of a rectangular shape included incompletely homogeneous patches of vegetation, which is not a disadvantage since the mosaic pattern is a natural feature of the Białowieża Primeval Forest. Censuses were carried out since mid-April to mid-June, each starting early in the morning. Every plot was surveyed one time in the evening. A survey of 10 ha lasted 1.5 to 2.5 hrs. During the season there were 6 to 9 censuses on each plot. The adopted breeding criterion was the occurrence three times or twice in a season of a bird whose behaviour indicated a settled mode of life. All plots were surveyed in 1975 and two were investigated for three breeding seasons.

The list of bird species split into ecological groups according to the location of nests has been accepted after TOMIAŁOJĆ (1970). The nomenclature of forest plant associations has been accepted after SOKOŁOWSKI (1979). The description of the plots was prepared on the basis of the "Plan of forest management in the Białowieża Primeval Forest for 1 October 1968 — 30 September 1978", as well as on phytosociological records by Aleksander W. SOKOŁOWSKI. The estimation of the number of pairs was checked by Ludwik TOMIAŁOJĆ and Tomasz WESOŁOWSKI. To these persons the authors express their cordial thanks.

## STUDY AREA DESCRIPTION

The Białowieża Primeval Forest is a compact complex of woods 1250 km<sup>2</sup> in area, situated on the western margin of eastern Europe. The configuration of the terrain is little variable, the plant vegetation rich and diversified. The Białowieża National Park and the reserves are especially characterized by a good state of natural plant community preservation and by rather old age of stands (FALIŃSKI 1968, SOKOŁOWSKI 1976).

In the Białowieża National Park — protected since 1921 — the tree stands are characterized by the least influence of man. Coniferous forests occupy the highest terrains (more than 160 m a.s.l.), the stands show mixed species compositions with spruce prevailing. The censuses were carried out on two plots of a total area of 60 ha.

Spruce forests on peat cover rather small areas. The natural over mature stand, least disturbed by management was included among preserved area during the studies. The censuses were conducted on two plots, 30 ha in total area.

Coniferous forests in the part of Białowieża Primeval Forest under management cover about 37 per cent of the total stand area. The largest areas are occupied by *Calamagrostio arundinaceae-Piceetum*. As a result of the biological and climatic factors the pine retreats from habitats of mixed coniferous forest, and the percentage of spruce is increasing. The management activity (renewal after cuts) leads to an increase of the area overgrown with pine. The censuses conducted on three plots — 50 ha in total area.

The study plots (Fig. 1) included mature stands of natural origin differing slightly in the degree of natural-state disturbance and considerably in the type of surroundings. In spite of the efforts made to choose homogeneous forest patches for the studies six types of plant communities were found in the study area.

1. *Calamagrostio arundinaceae-Piceetum*. The stand made up mainly of the spruce, the herb layer typical of coniferous forest with a small percentage of species characteristic of deciduous, oak-lime-hornbeam forests. This is the main type of coniferous forest within the northern range of *Picea abies*, of boreal nature. It occurs at the following plots: Wyspa, Gilowa, Kolejkowa and Niedźwiedzica.

2. *Vaccinio myrtilli-Piceetum*. A spruce forest with an admixture of *Betula pendula*, sporadically *Pinus silvestris*. The herb layer of boreal nature. It occurs at the following plots: Jagiellońska and Niedźwiedzica.

3. *Vaccinio myrtilli-Pinetum*. The stand consists of *Pinus silvestris* and *Picea abies*. In the herb layer *Vaccinium myrtillus* is growing exuberantly and *Molinia coerulea* is present. It is found at plots: Gilowa and Niedźwiedzica.

4. *Vaccinio vitis-idaeae-Pinetum*. The driest habitat, *Pinus silvestris* is

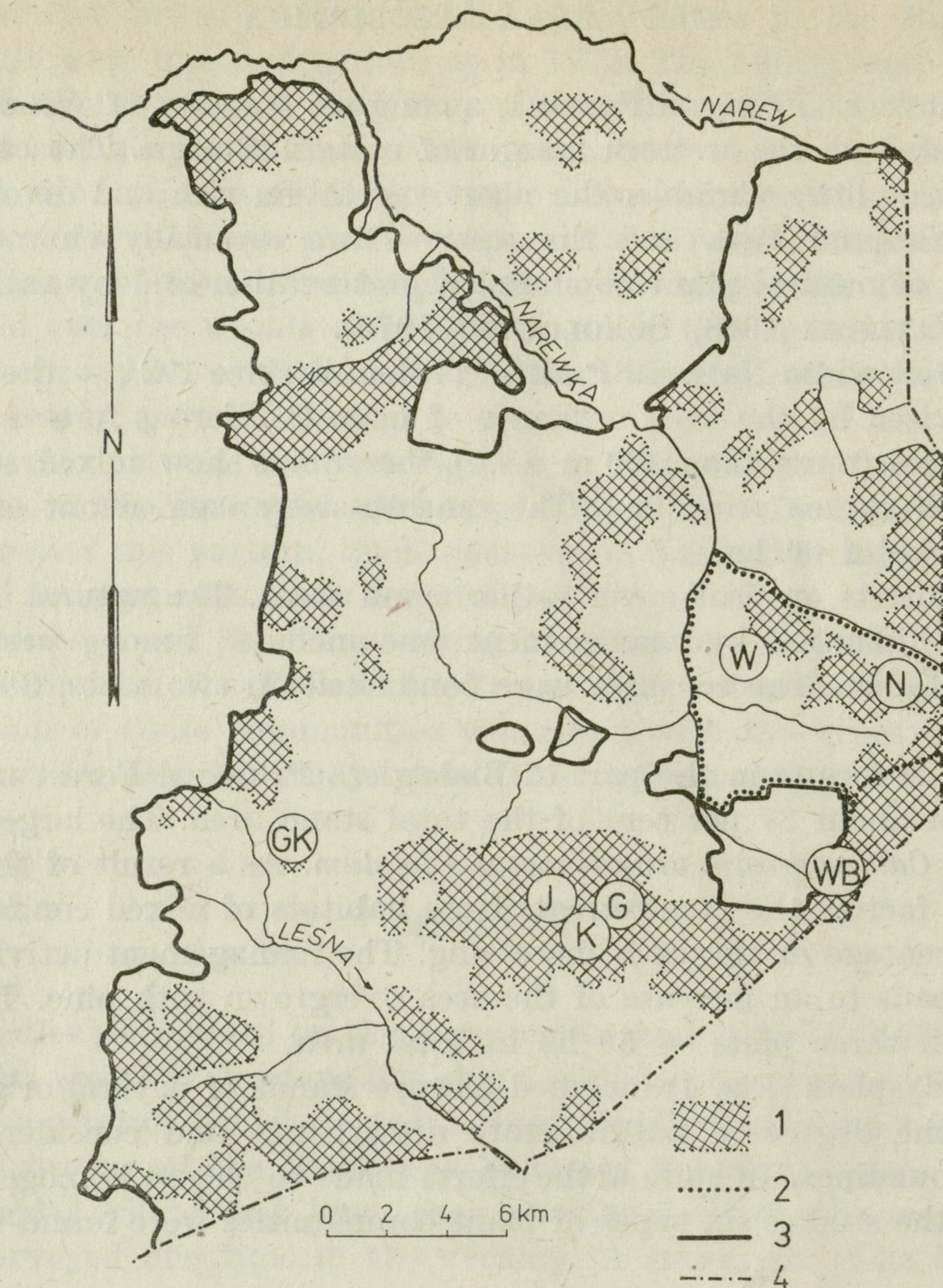


Fig. 1. Distribution of study plots in Białowieża Primeval Forest.

1 — larger coniferous forest complexes, 2 — boundary of the Białowieża National Park, 3 — boundary of the Primeval Forest, 4 — boundary of Poland. Study plots: GK — Głęboki Kąt; J — Jagiellońska; K — Kolejkowa; G — Gilowa; W — Wyspa; N — Niedźwiedzica; WB — Wysokie Bagno.

predominant and *Vaccinium myrtillus* occurs in the herb layer. It is found on the Jagiellońska plot.

5. *Sphagno Girgensohnii-Piceetum*. A spruce forest with an admixture of *Pinus silvestris* and *Betula pendula*. Coniferous forest species and bog species in the herb layer, and among mosses many *Sphagnum* species are found. The plant community is of boreal nature. It reaches here the limit of its southwestern range. It occurs at the following plots: Wysokie Bagno and Głęboki Kąt.

6. *Carici elongatae-Alnetum*. In the tree stand *Alnus glutinosa* prevails with an admixture of *Picea abies* and single *Fraxinus excelsior*. An exuberant herb layer. It occurs on plots: Wysokie Bagno and Głęboki Kąt.

### Description of census plots

1. Plot Wyspa — compartments 284 and 285 in the Białowieża National Park, size 10 ha, in 1975 nine censuses were made. This plot is located in a *Calamagrostio arundinaceae-Piceetum* patch, 30 ha in area, this plant association covering about 90% of the area. The stand 130–150 years old consists mostly of *Picea abies* (70–80% of total stand). A constant admixture consists of *Pinus silvestris* and *Betula pendula*; *Quercus sp.* is represented by single trees, and *Populus tremula* sporadically. In the southern part of this plot the proportion of *Pinus silvestris* attains 50%. In the lower layer *Carpinus betulus* is present. The height of the stand attains 35 m. The shrub layer is poorly developed. It consists mostly of *Carpinus betulus* and infrequent: *Sorbus aucuparia*, *Picea abies*, *Tilia sp.*, *Populus tremula* and *Frangula alnus*.

2. Plot Niedźwiedzica — compartments 318 and 288 in the Białowieża National Park, 50 ha in area; eight censuses were carried out there in 1975.

The stand, as on plot Wyspa, is characterized by a multilayer structure. The characteristic features are gaps after fallen trees, laying trunks and branches. More than a half of this area is covered by the *Vaccinio myrtilli-Piceetum* community. The stand consists mostly of *Picea abies*, *Betula pendula* and *Pinus silvestris* being represented by single trees, and *Quercus robur*, *Carpinus betulus* and *Tilia sp.* occurring sporadically. The height of the upper layer is about 30 m and that of the lower one, consisting mainly of *Picea abies* — 19 m. The shrub layer is poorly developed. It covers up to 20% of the plot and consists mostly of *Carpinus betulus* and sporadically of *Picea abies*, *Tilia sp.* and *Frangula alnus*. In the relatively poor herb layer coniferous forest species are predominant. Several hectares in the corner of this plot are occupied by *Vaccinio myrtilli-Pinetum*. In the upper layer *Pinus silvestris* is predominant and in the lower one — *Picea abies*. In its northern part *Calamagrostio arundinaceae-Piceetum* community with stands of *Pinus silvestris* and *Picea abies* is found. The shrub and herb layers are alike on the whole plot. The plot is surrounded by similar stands, and only on the southern side does it border on a deciduous forest stands

3. Plot Jagiellońska — compartment 494 in a managed part of the Białowieża Primeval Forest (Białowieża forest administrative unit) of 9.6 ha in area. Six censuses were carried out in 1974, and 7 in 1975 and in 1976.

Over 70% of the plot is covered by *Vaccinio vitis-idaeae-Pinetum* community which changes to the north-west into *Vaccinio myrtilli-Pinetum*. The stand shows many layers with *Pinus silvestris* 110–120 years old, the percentage of *Picea abies* being lowest of all the study plots; the percentage of this species is higher in the lower layers. The plot includes also a young stand (0.3 ha), and in the northern part — a stand 40 years old. The shrub and herb layers are underdeveloped. Wind-fallen trees are removed, while their branches remain, similarly as on the remaining plots of the man-managed part of the Primeval Forest.

4. Plot Kolejkowa — compartment 523 in the managed part of the Primeval Forest (Białowieża forest administrative unit), of 25 ha in area. Nine censuses were carried out in 1975.

The plot represents the *Calamagrostio arundinaceae-Piceetum* community; a multilayer stand of *Picea abies* and *Pinus silvestris*, aged 80 to 110 years; *Quercus sp.* being represented by single trees. The stand height is 25–30 m. In the lower layers the percentages of *Picea abies*, *Betula pendula*, *Populus tremula* and *Carpinus betulus* are higher. The shrub and herb layers are underdeveloped. The surroundings consist of a pine forest separated

by a forest railway on the south, a similar over mature stand on the west, and young forests on other sides.

5. Plot Gilowa — compartment 524 in the managed part of the Forest (Białowieża forest administrative unit), 16 ha in area, censuses were made: 6 in 1974, 9 in 1975 and 8 in 1977.

It is located in an area with the *Calamagrostio arundinaceae-Piceetum* community. A multilayer stand with *Picea abies* predominating and with an admixture of *Pinus silvestris* and *Quercus sp.* and single trees of *Alnus glutinosa*. Age 90–110 years, height about 27 m. In the central part of the plot there is a belt of *Vaccinio myrtilli-Pinetum* (about 3 ha), a stand about 60 years old, height 18–25 m, with a species composition similar (higher percentage of *Populus tremula* and *Alnus glutinosa*), at the edge it changes into a wet meadow (0.5 ha) in the phase of being overgrown with *Betula pendula*. In the whole area the lower layers are with *Picea abies* and deciduous species, and the herb layer is well developed. The surroundings consist of a similar over mature stand and young forest as well as a tree culture.

6. Plot Wysokie Bagno — compartments 477 and 478 in managed part of the Forest (Białowieża forest administrative unit), 15 ha in area. Six censuses were made in 1975.

The *Sphagno Girgensohnii-Piceetum* community covers about 80% of the plot. The stand consists of *Picea abies* with a small admixture of *Pinus silvestris*, *Betula pendula*, and *Alnus glutinosa*. Age 110 years, height of 20–25 m. The shrub layer is poor, mainly with *Picea abies* forming here and there dense clumps. The herb layer is poorly developed, but mosses are well developed. About 4 ha is covered by the *Carici elongatae-Alnetum* community. Tree stand: *Betula pendula* and *Alnus glutinosa*, *Pinus silvestris* and *Picea abies*. In the shrub layer also *Picea abies* and deciduous species are found, the herb layer being well developed. The whole plot is characterized by a hummock-hollow structure of the forest floor what is responsible for the distribution of the moss layer components. In the vicinity a similar stand is found, and on the side of a river there is a young stage of selfsown regenerating forest (*Betula pendula*, *Populus tremula*, *Salix cinerea*) on peat meadows. Presently this area is a reserve.

7. Plot Głęboki Kąt — compartment 439 in the managed part of the Forest (Hajnówka forest administrative unit) 15 ha in area, six censuses were made in 1975.

About 70% of the plot area is occupied by the *Sphagno Girgensohnii-Piceetum* community. Tree stand: *Picea abies* with a small admixture of *Pinus silvestris* and *Betula pendula* aged 110–130 years. The shrub layer — mainly *Picea abies* with an admixture of *Corylus avellana*, *Alnus glutinosa* and *Sorbus aucuparia*. The herb layer is poor with coniferous and bog features. The hummock-hollow structure of the forest floor is responsible for the distribution of the moss layer components. A part of this plot is covered by *Carici elongatae-Alnetum*. Trees: *Alnus glutinosa* and *Picea abies*; the shrub and herb layers well developed. The plot borders on an over mature alder stand, on the west, with an alder young forest on the east, the rest being surrounded by a natural coniferous forest on peat. Presently this area is a reserve.

## RESULTS

In seven study areas (Tables 1–4) of coniferous forests of the Białowieża Primeval Forest, representing over mature stands with features of natural forest, 47 bird species were observed, 41 of which were considered as breeding species. In the coniferous forests under study the overall density of the avifauna ranged from 24.8 to 53.9 pairs per 10 ha. The most abundant species in all

Table 1. Breeding birds of *Calamagrostio arundinaceae-Piceetum*. Plots: Wyspa, Kolejkowa, Gilowa.

+ - a species that nests in the vicinity but recorded on the plot examined. Such species were found on plots at a density below 0.5 pairs/10 ha and were not included among breeding species.

Species	Wyspa	Kolejkowa		Gilowa			Density (pairs/10ha)
	Number of pairs and density* (pairs/ 10 ha)	Number of pairs	Density (pairs/ 10 ha)	Number of pairs			
				1974	1975	1977	
<i>Fringilla coelebs</i>	10.5	20	8.0	14.5	14.5	14.5	9.1
<i>Phylloscopus sibilatrix</i>	6.5	8	3.2	7	7	4.5	3.9
<i>Regulus regulus</i>	5	6	2.4	6.5	6	4	3.4
<i>Erithacus rubecula</i>	5	5.5	2.2	7.5	5	4	3.4
<i>Phylloscopus collybita</i>	2.5	4	1.6	3	5	5	2.7
<i>Turdus philomelos</i>	2.5	3	1.2	4.5	3	2.5	2.1
<i>Parus ater</i>	1.5	3.5	1.4	1	1	1	0.6
<i>Certhia familiaris</i>	1	2	0.8	3.5	2	1	1.4
<i>Parus major</i>	1	2.5	1.0	3.5	1.5		1.1
<i>Turdus merula</i>	1	1	0.4	3	1.5	1.5	1.3
<i>Troglodytes troglodytes</i>	1	1	0.4	1.5	1	1	0.8
<i>Parus cristatus</i>	1	2	0.8	1.5	0.5	+	0.4
<i>Columba oenas</i>	1.5						
<i>Garrulus glandarius</i>	1	0.5	0.2	+	0.5	1	0.3
<i>Parus montanus</i>	1			1	1		0.4
<i>Sylvia atricapilla</i>		0.5	0.2	3	1	1	1.1
<i>Parus caeruleus</i>	1			0.5	0.5		0.2
<i>Sitta europaea</i>	1	+		+	1	+	0.2
<i>Dendrocopos major</i>	0.5			0.5	0.5	0.5	0.3
<i>Anthus trivialis</i>		1.5	0.6	1	1		0.4
<i>Coccothraustes coccothraustes</i>	1	+					
<i>Oriolus oriolus</i>				1	1		0.5
<i>Prunella modularis</i>				1.5			0.3
<i>Ficedula hypoleuca</i>	+	0.5	0.2	1			0.2
<i>Carduelis spinus</i>					1	1	0.4
<i>Tringa ochropus</i>				+	0.5	0.5	0.2
<i>Muscicapa striata</i>					1		0.2
<i>Aegithalos caudatus</i>					1		0.2
<i>Pyrrhula pyrrhula</i>		0.5	0.2	+			
<i>Columba palumbus</i>				0.5			0.1
<i>Dryocopus martius</i>				+	0.5		0.1
<i>Emberiza citrinella</i>					0.5	+	0.1
<i>Nucifraga caryocatactes</i>		+			+		
<i>Turdus viscivorus</i>		+			+		
<i>Ficedula albicollis</i>	+						
<i>Ficedula parva</i>	+						
Total	45.5	62.0	24.8	67.0	58.0	44.0	35.3

\* Plot area 10 ha.

Table 2. Breeding birds of *Vaccinio myrtilli-Piceetum*. Plot Niedźwiedzica.

For explanations see Table 1.

Species	Number of pairs	Density (pairs/10 ha)
<i>Fringilla coelebs</i>	50	10.0
<i>Phylloscopus sibilatrix</i>	21.5	4.3
<i>Erithacus rubecula</i>	20.5	4.1
<i>Regulus regulus</i>	17	3.4
<i>Parus ater</i>	11.5	2.3
<i>Turdus philomelos</i>	9	1.8
<i>Certhia familiaris</i>	7	1.4
<i>Parus cristatus</i>	6	1.2
<i>Phylloscopus collybita</i>	4	0.8
<i>Turdus merula</i>	4	0.8
<i>Ficedula hypoleuca</i>	3	0.6
<i>Anthus trivialis</i>	2	0.4
<i>Oriolus oriolus</i>	2	0.4
<i>Prunella modularis</i>	2	0.4
<i>Coccothraustes coccothraustes</i>	2	0.4
<i>Accipiter nisus</i>	1	0.2
<i>Columba palumbus</i>	1	0.2
<i>Columba oenas</i>	1	0.2
<i>Cuculus canorus</i>	1	0.2
<i>Dryocopus martius</i>	1	0.2
<i>Dendrocopos major</i>	1	0.2
<i>Garrulus glandarius</i>	1	0.2
<i>Troglodytes troglodytes</i>	1	0.2
<i>Sylvia atricapilla</i>	1	0.2
<i>Phoenicurus phoenicurus</i>	1	0.2
<i>Parus montanus</i>	1	0.2
<i>Parus caeruleus</i>	1	0.2
<i>Parus major</i>	1	0.2
<i>Carduelis spinus</i>	1	0.2
<i>Pyrrhula pyrrhula</i>	1	0.2
<i>Tetrastes bonasia</i>	+	
Total	176.5	35.3

types of coniferous forest was *Fringilla coelebs*, attaining even 32 per cent in the quantitative dominance structure. The group of dominant species (over 5 per cent) includes the following species: *Phylloscopus sibilatrix*, *Regulus regulus* and *Erithacus rubecula*. In some stands this group consists of: *Phylloscopus collybita*, *Turdus philomelos*, *Troglodytes troglodytes* and *Parus ater*. Among the low density birds biogeographic species characteristic of the Białowieża Primeval Forest are found (cf. VOOUS 1975).

The bird community of the *Sphagno Girgensohnii-Piceetum* association differs from those of the remaining associations by a lower percentage of the main



Table 3. Breeding birds of *Vaccinio vitis-idaeae-Pinetum*. Plot Jagiellońska.

For explanations see Table 1.

Species	Number of pairs			Average density (pairs/10 ha)
	1974	1975	1976	
<i>Fringilla coelebs</i>	9	10	7	9.1
<i>Regulus regulus</i>	7	5	4.5	5.7
<i>Phylloscopus sibilatrix</i>	5	4	3	4.2
<i>Erithacus rubecula</i>	1.5	5	2	2.9
<i>Turdus philomelos</i>	4.5	1.5	1	2.4
<i>Certhia familiaris</i>	2	2	2	2.1
<i>Phylloscopus collybita</i>	1.5	1.5	2	1.8
<i>Parus ater</i>	1.5	1.5	1.5	1.6
<i>Parus major</i>	2	0.5	2	1.6
<i>Turdus merula</i>	1.5	1.5	0.5	1.3
<i>Parus cristatus</i>	1.5	1	1	1.3
<i>Ficedula hypoleuca</i>	1	2		1.0
<i>Turdus viscivorus</i>	1	1	1	1.0
<i>Phoenicurus phoenicurus</i>	1		1	0.7
<i>Carduelis spinus</i>	1	1		0.7
<i>Anthus trivialis</i>	0.5	0.5	0.5	0.5
<i>Garrulus glandarius</i>	0.5	0.5	0.5	0.5
<i>Troglodytes troglodytes</i>		0.5	1	0.5
<i>Sylvia atricapilla</i>	0.5	+	1	0.5
<i>Columba palumbus</i>		1		0.3
<i>Dendrocopos major</i>	1	+		0.3
<i>Sylvia borin</i>	1			0.3
<i>Sylvia curruca</i>	1	+		0.3
<i>Prunella modularis</i>		+	0.5	0.2
<i>Muscicapa striata</i>	0.5		+	0.2
<i>Parus montanus</i>	0.5	+		0.2
Total	46.5	40.0	32.0	41.2

dominants: *Fringilla coelebs* and *Phylloscopus sibilatrix*, a higher percentage of *Erithacus rubecula* and *Phylloscopus collybita* (Table 5), and by a higher density of the majority of bird species (Fig. 2).

Using the density similarity index (WESOŁOWSKI 1975), an analysis was made of the similarity of bird communities. It appeared to be high (60–82). Especially similar are communities occurring in various types of mixed coniferous forest, from which clearly different are communities of bog moss spruce forest (plots WB and GK) (Fig. 3). From this it follows that the coniferous over-mature forest in the Białowieża Primeval Forest is inhabited by bird communities whose species composition is only slightly affected by the phytosociological type, stand structure, and the substrate moisture. The effect of other factors will be discussed later.

Table 4. Breeding birds of *Sphagno Girgensohnii-Piceetum*. Plots: Wysokie Bagno and Głęboki Kąt.

For explanations see Table 1.

Species	Wysokie Bagno		Głęboki Kąt	
	Number of pairs	Density (pairs/10 ha)	Number of pairs	Density (pairs/10 ha)
<i>Fringilla coelebs</i>	14.5	9.7	13	8.7
<i>Erithacus rubecula</i>	8.5	5.7	9.5	6.3
<i>Regulus regulus</i>	9	6.0	5.5	3.7
<i>Phylloscopus collybita</i>	8.5	5.7	5	3.3
<i>Troglodytes troglodytes</i>	6	4.0	5.5	3.7
<i>Phylloscopus sibilatrix</i>	6	4.0	5	3.3
<i>Prunella modularis</i>	5	3.3	3	2.0
<i>Turdus philomelos</i>	5	3.3	3	2.0
<i>Turdus merula</i>	5	3.3	2.5	1.7
<i>Sylvia atricapilla</i>	1.5	1.0	4	2.7
<i>Certhia familiaris</i>	3	2.0	2	1.3
<i>Parus ater</i>	2	1.3	2	1.3
<i>Parus cristatus</i>	1.5	1.0	2	1.3
<i>Parus major</i>	1.5	1.0	2	1.3
<i>Garrulus glandarius</i>	0.5	0.3	1	0.7
<i>Sitta europaea</i>	0.5	0.3	1	0.7
<i>Pyrrhula pyrrhula</i>	1	0.7	0.5	0.3
<i>Columba palumbus</i>	+		1	0.7
<i>Phylloscopus trochilus</i>	1	0.7		
<i>Ficedula albicollis</i>			1	0.7
<i>Muscicapa striata</i>	+		1	0.7
<i>Dendrocopos major</i>	0.5	0.3	0.5	0.3
<i>Tetrastes bonasia</i>	0.5	0.3		
<i>Anthus trivialis</i>			0.5	0.3
<i>Parus caeruleus</i>			0.5	0.3
<i>Dendrocopos leucotos</i>	+			
<i>Picoides tridactylus</i>	+			
<i>Ficedula hypoleuca</i>			+	
<i>Ficedula parva</i>	+			
<i>Parus palustris</i>			+	
Total	81	53.9	71	47.3

## DISCUSSION

The low density of birds in the Białowieża Primeval Forest is striking. Values of similar magnitude (23.5–57.7 pairs per 10 ha) were observed in a boggy habitat (DYRCZ *et al.* 1973) where the vegetation attains the height of 1–2 m only, whereas the stands in the Białowieża Primeval Forest often exceed 30 m. Low densities of birds have already been reported for deciduous forest of the Białowieża National Park (TOMIAŁOJC *et al.* 1977).

In all types of coniferous forests a very low density of hole nesting birds

Table 5. Density (pairs per 10 ha) — upper number and dominance (%) — lower number of species groups differing by location of nests in various types of coniferous forest

Letters symbols of plot are explained in Fig. 1.

Prevailing plant community		<i>Calamagrostio arundinaceae-Piceetum</i>			<i>Vaccinio-myrtilli-Piceetum</i>	<i>Vaccinio-vitis-idaeae-Pinetum</i>	<i>Sphagno Girgensohnii-Piceetum</i>	
		W	G	K	N	J	GK	WB
Nest location	In tree holes	7	6	4	7	7	8	6
		17	16	17	20	17	17	11
	On trees and higher bushes	19	15	11	15	19	14	17
		42	41	43	44	46	30	31
	On ground and bushes less than 1.5 m high	18	15	10	13	15	25	31
		41	43	39	37	37	53	58

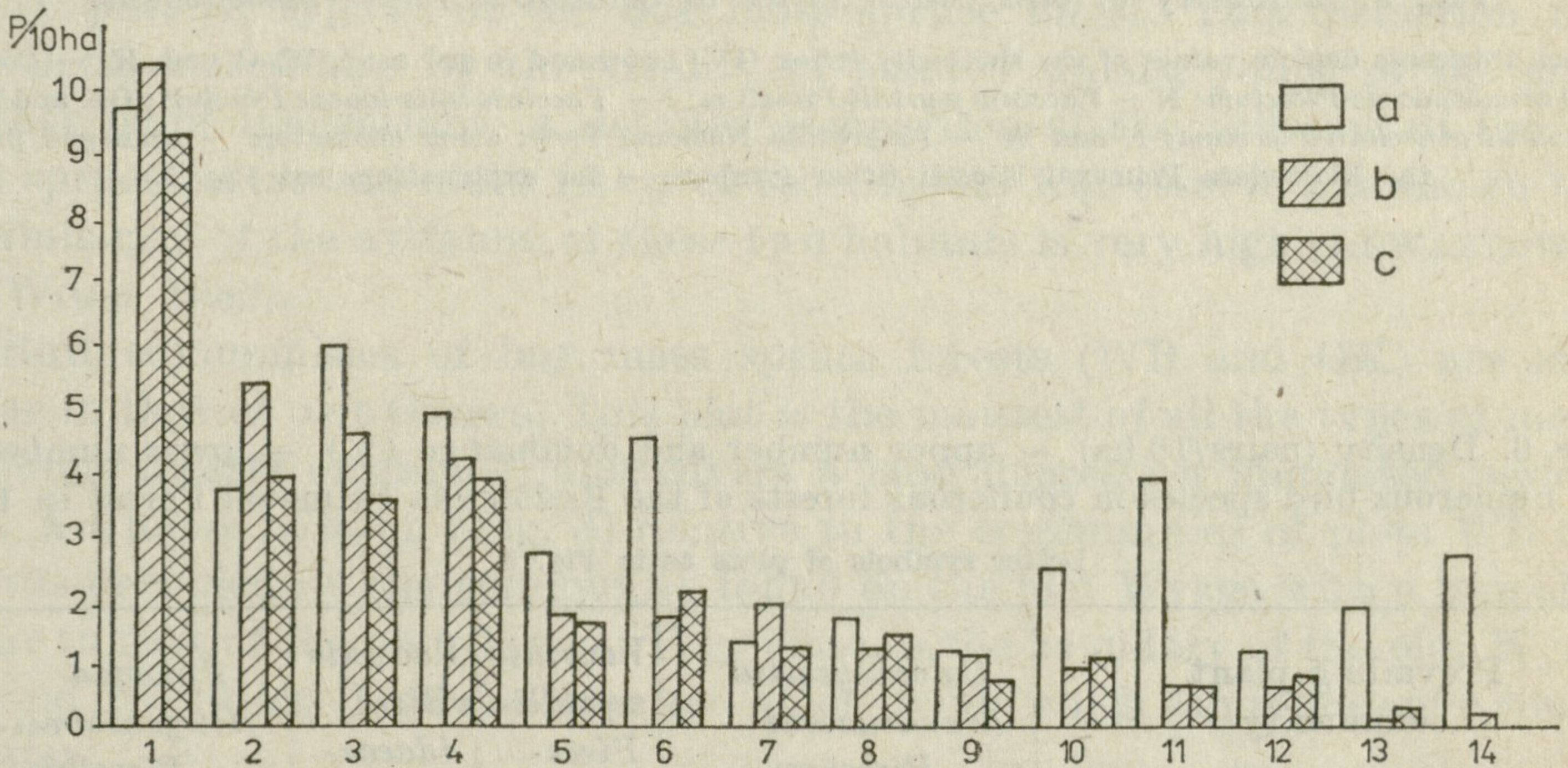


Fig. 2. Density of pairs of more numerous bird species.

a — *Sphagno Girgensohnii-Piceetum*; b — *Calamagrostio arundinaceae-Piceetum* and *Vaccinio myrtilli-Piceetum* in the Białowieża National Park; c — *Calamagrostio arundinaceae-Piceetum* and *Vaccinio vitis-idaeae-Pinetum* in the man-managed part of Białowieża Primeval Forest. 1 — *Fringilla coelebs*; 2 — *Phylloscopus sibilatrix*; 3 — *Erithacus rubecula*; 4 — *Regulus regulus*; 5 — *Turdus philomelos*; 6 — *Phylloscopus collybita*; 7 — *Parus ater*; 8 — *Certhia familiaris*; 9 — *Parus cristatus*; 10 — *Turdus merula*; 11 — *Troglodytes troglodytes*; 12 — *Parus major*; 13 — *Sylvia atricapilla*; 14 — *Prunella modularis*.

was observed (Table 5) in spite of the presence of trees with holes, especially in the National Park. Under the conditions of a compact forest complex in the Białowieża Primeval Forest *Sturnus vulgaris* does not nest. It is one of the dominant species in other forests (MRUGASIEWICZ 1974). The density values

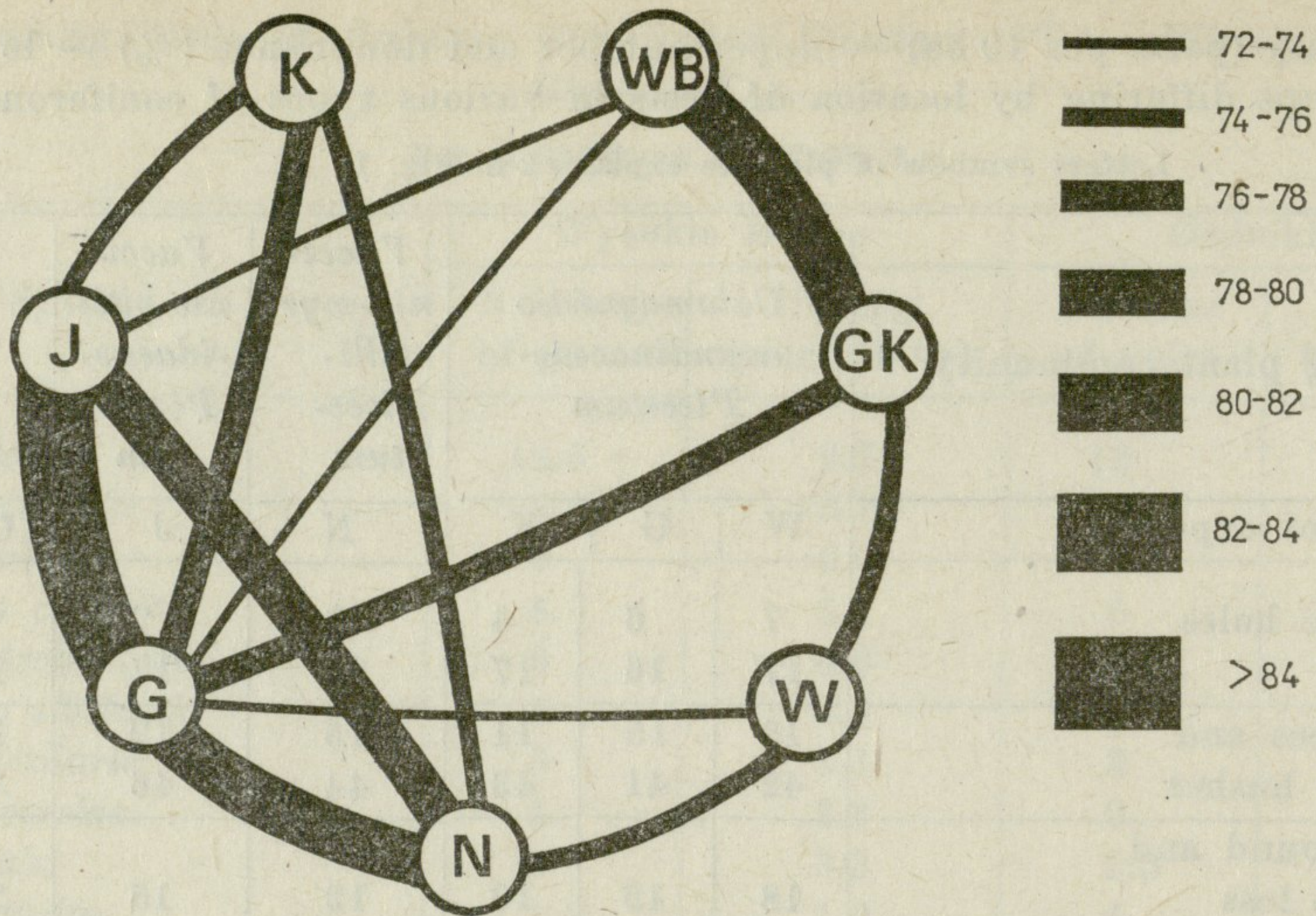


Fig. 3. Similarity of bird communities in coniferous forest associations.

The line thickness depicts values of the similarity index (PZ) expressed in per cent. W, G and K — *Calamagrostio arundinaceae-Piceetum*; N — *Vaccinio myrtilli-Piceetum*; J — *Vaccinio vitis-idaeae-Pinetum*; GK and WB — *Sphagno Girgensohnii-Piceetum*; N and W — Białowieża National Park; other characters — managed part of the Białowieża Primeval Forest. Other symbols — for explanations see Fig. 1.

Table 6. Density (pairs/10 ha) — upper number and dominance (%) — lower number of most numerous bird species in coniferous forests of the Białowieża Primeval Forest in 1975.

Letter symbols of plots as in Fig. 1.

Prevailing plant community	<i>Calamagrostio arundinaceae-Piceetum</i>			<i>Vaccinio myrtilli-Piceetum</i>	<i>Vaccinio vitis-idaeae-Pinetum</i>	<i>Sphagno Girgensohnii-Piceetum</i>	
	W	G	K	N	J	GK	WB
<i>Fringilla coelebs</i>	10.5	9.1	8.0	10.0	10.4	8.7	9.7
	23.3	25.0	32.3	28.3	25.0	18.3	17.9
<i>Phylloscopus sibilatrix</i>	6.5	4.4	3.2	4.3	4.2	3.3	4.0
	14.4	12.1	12.9	12.2	10.0	7.0	7.4
<i>Regulus regulus</i>	5.0	3.8	2.4	3.4	5.2	3.7	6.0
	11.1	10.3	9.7	9.6	12.5	7.7	11.1
<i>Erithacus rubecula</i>	5.0	3.1	2.2	4.1	5.2	6.3	5.7
	11.1	8.6	8.9	11.1	12.5	13.4	10.5
<i>Phylloscopus collybita</i>	2.5	3.1	1.6	0.8	1.8	3.3	5.7
	5.5	8.6	6.5	2.3	4.3	7.0	10.5

observed for hole-nesting species are analogous with those observed by DYRCZ (1973) and KOZŁOWSKI (1974) for planted and natural mountain spruce forest, the spruce being the main forest-forming species in the coniferous forest of the Białowieża National Forest.

In all types of mixed coniferous forests the percentage of species building open nests at a height above and below 1.5 m is very similar (Table 6), similar are also the proportions of density.

In bog moss spruce forests, on the contrary, the density of birds that nest on the ground and close to it is almost doubled, as compared with the density of birds nesting high in trees. Low nesters attain there the highest density, considerably exceeding the average for the remaining plots, which can be explained by the presence of thick young spruce growth, windfallen trees and heaps of branches where a possibility to hide a nest is rather high. The diversity of these bird communities depends mainly on a considerable proportion of species nesting low and associated with spruce. There is another reason for this situation, though. The vicinity of alder forests within the plots resulted in high numbers of several species, primarily of *Phylloscopus collybita*, *Turdus merula* and *Sylvia atricapilla*. This has distorted the natural bird community pattern typical of the bog moss spruce forest. This distortion may have been caused also by the vicinity of planted stands, young or belonging to other plant associations. A detailed comparison of the avifauna of the bog moss spruce forest and alder forest of the Głęboki Kąt reserve has shown that the similarity of the avifauna of these two habitats is very high (LEWARTOWSKI and WOŁK 1983).

Bird communities of bog moss spruce forests (WB and GK) are most similar to that of plot Gilowa. This plot is the moistest of all the types of mixed coniferous forests examined, and covers a land depression inundated periodically. A similar position (Fig. 3) relative to the communities of plots WB and GK was occupied by the community found on the plot Wyspa with a humidity similar to that of the plot Gilowa. Very close to the boundary of the plot Wyspa in a land depression there are carrs and alder-woods which can represent a source of water.

A comparison of the avifauna of mixed coniferous forest in the National Park and in the man-managed part of the Forest shows no significant differences. In fact, most of the bird species attain somewhat higher densities. These differences can result from a slightly different tree species composition of the stands within the area examined and in their surroundings. It seems that some role is also played by the type of management. In the National Park the stands are compact and more age- and species differentiated. Between the communities of birds in the National Park and in the man-managed part of the Forest quantitative differences were also observed. They are as follows: *Coccothraustes coccothraustes* and *Columba oenas* are nesting exclusively in the National Park and *Emberiza citrinella* and *Turdus viscivorus* — only in the remaining area.

This is presumably associated with a higher percentage of deciduous trees and bushes in the National Park as well as with the presence of cuts outside the Park.

The numbers of bird species recorded in the area surveyed are low as compared with *e.g.* the bird communities of deciduous forests of the Białowieża Primeval Forest (TOMIAŁOJĆ *et al.* 1977). As a rule, they increase with the plot size, which is obvious. Those species which are sparsely distributed or possess large territories can be observed only in vast areas. The diversity of forest associations in the nearest vicinity of a study plot can be another factor that augments the number of bird species. In coniferous forests, the vicinity of deciduous oak-lime-hornbeam forests (in the National Park) and other deciduous associations or age-differentiated stands — cuts, nurseries of young stands (man-manged part of the Forest) have a decisive significance.

A contemporary concern of biologists is the protection against the danger to the natural resources of the Białowieża Primeval Forest from human pressure, and especially by overexploitation of stands. Comparisons of bird species lists indicate that reserve protected coniferous forests do not guarantee the protection of all bird species inhabiting the coniferous forest of the Białowieża Primeval Forest. That is the reason why the formation of a network of further reserves is so important, with a much larger area than that at present. Each reserve should have a protective belt with complete cutting forbidden, which is of great importance for natural bird communities.

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## STRESZCZENIE

## [Awifauna lęgowa borów Puszczy Białowieskiej]

W latach 1974–1977 prowadzono badania nad awifauną borów Puszczy Białowieskiej. Wybrano dwie powierzchnie w Białowieskim Parku Narodowym o łącznym obszarze 60 ha i 5 powierzchni w zagospodarowanej części Puszczy o łącznym obszarze 80 ha. Przedmiotem badań była awifauna lęgowa starodrzewi boru mieszanego (*Calamagrostio arundinaceae-Piceetum*), borów sosnowo-świerkowych (*Vaccinio myrtilli-Piceetum*, *Vaccinio myrtilli-Pinetum* i *Vaccinio vitis-idaeae-Pinetum*) oraz boru świerkowego torfowcowego (*Sphagno Girgensohnii-Piceetum*) z niewielką domieszką olsu (*Carici elongatae-Alnetum*). Liczenia przeprowadzono metodą kartograficzną, ich wyniki przedstawiają tabele 1–4. W okresie badań stwierdzono występowanie 47 gatunków, z których 41 gnieździło się na powierzchniach. Otrzymane zagęszczenie wahało się w granicach od 24,8 do 53,9 par/10 ha.

W zbiorowiskach *Calamagrostio arundinaceae-Piceetum*, *Vaccinio myrtilli-Piceetum*, *Vaccinio vitis-idaeae-Pinetum* i *Vaccinio myrtilli-Pinetum* dominowały następujące gatunki ptaków: *Fringilla coelebs*, *Phylloscopus sibilatrix*, *Regulus regulus* i *Erithacus rubecula*. W zbiorowisku *Sphagno Girgensohnii-Piceetum* do najliczniejszych należały: *Fringilla coelebs*, *Erithacus rubecula*, *Regulus regulus*, *Troglodytes troglodytes* i *Phylloscopus collybita*.

Na wszystkich powierzchniach zagęszczenie dziuplaków było dość niskie, wahając się od 4,1 do 7,9 par/10 ha. W Parku Narodowym stwierdzono nieco wyższe zagęszczenie ptaków niż w zagospodarowanej części Puszczy (ryc. 2).

Przy porównaniu ugrupowań ptaków poszczególnych powierzchni za pomocą wskaźnika podobieństwa zagęszczeń (PZ) okazało się, że awifauna badanych borów białowieskich należy do jednego ugrupowania. Najbardziej wyróżnia się awifauna zbiorowiska *Sphagno-Girgensohnii-Piceetum*, gdzie wyraźnie dominują gatunki związane ze świerkiem (ryc. 3).