

Bird community of a spruce forest in the upper mountain forest zone on Polica (Polish Western Carpathians)

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Accepted for publication: 15 Dec., 1990

ŚLIZOWSKI J., 1991. Bird community of a spruce forest in the upper mountain forest zone on Polica (Polish Western Carpathians). *Acta zool. cracov.*, 34(2): 535-551.

Abstract. Thirty-eight bird species were found in the upper (coniferous) mountain forest zone (ca 1150-1360 m a.s.l.) on Mt Polica in 1987 and 1988. The density of pairs in the 10 ha sample plot in a timber spruce forest on the northern slopes of Polica was respectively 49 and 50 pairs/10 ha. In both years of investigation *Fringilla coelebs*, *Erithacus rubecula*, *Regulus regulus*, *Prunella modularis* and additionally in 1988, *Parus ater* were dominant species.

Key words: birds, density, spruce forest, mountains, Carpathians.

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I. INTRODUCTION

In Poland quantitative studies of bird communities in the upper (coniferous) mountain forest zone have hitherto been carried out in the Gorce Mts (KOZŁOWSKI 1974), Tatra Mts (GŁOWACIŃSKI & PROFUS in press) and the Karkonosze Mts (DYRCZ 1973). In the High Beskids, in which Polica belongs, ornithological investigations have been concentrated on both the Polish (RIEBININ 1962, BOCHENSKI 1970, WOŁK 1978) and the Slovakian side (STOLLMANN & KOCIAN 1965, KARASKA 1989) of Babia Góra. They were faunistic investigations; only BOCHENSKI (1970) characterized the communities of birds of various habitats, including those of the upper mountain spruce forests, but exclusively on the basis of their frequency.

The Polica massif has not hitherto been explored and the occurrence of a well-preserved natural spruce forest in the upper mountain forest zone there, relatively easy of access, caused that it was chosen as a study area in order to get to know the qualitative and quantitative composition of the community of breeding birds in that zone.

I wish to express my gratitude to Mr J. PARUSEL of the Babia-Góra National Park for help in field studies and permission to make use of his observations in this paper. I owe my thanks to Prof. Z. BOCHENSKI of the Institute of Systematics and Evolution of Animals,

Polish Academy of Sciences in Kraków for his instructions given and remarks made in the course of collecting and working-out of materials.

II. STUDY AREA

The Polca massif (1369 a.s.l.) belongs to the Babia Góra Range, the culmination of the High Beskids (Fig. 1). It extends for about 20 km evenly with the parallel of latitude and is delimited by the Skawica Valley in the north and the Skawa Valley in the east, in the south it joins the Żeleźnica Range over the Spytkowicka Pass and in the Babia Góra massif over the Krowiarki Pass. The side ridges are strongly dismembered and the northern slopes decidedly steeper than the southern ones (on the basis of the data from the forest management project of the Sucha Beskidzka Forestry).

According to SZAFER and ZARZYCKI (1972), the boundary between the lower (mixed) and the upper (coniferous) mountain forest zone extends at an altitude of about 1150 m and the timber-line at about 1360 m. And so the summit of Polica lies in the timber-line zone, which fact determines the composition and structure of the stands occurring there.

The coniferous mountain forests of Polica spread in the zone of mountain climate, which, according to HESS (1965), is characterized by high annual rainfall (annual mean - 1250 mm), a long occurrence of snow cover (on the average 130 days), a shortened vegetation season (on the average 180 days) and the mean annual temperature of +5°C. Strong S and SW winds in spring and autumn, belated groundfrost in spring, heavy snowfall and long spells of heavy rainfall in early summer may also be regarded as other characteristic features of this climate.

The present investigation covered the upper mountain forest zone of Polica, occupying 143.73 ha the essential part of which is the Z. Klemensiewicz Reserve "Na Policy", 51.22 ha in area. The upper mountain forest zone on Polica extends from Krupowa Hala in the east to Śmietanowa Hala in the west. The contour-line of 1150 m is its lower boundary. The reserve forms a strip on the northern slope of Polica; its upper boundary runs parallel to the ridge and lower coincides with the touristic track from Zawoja to Krupowa Hala.

The reserve "Na Policy" includes Divisions 61, 62 and 63 of the Sucha Beskidzka Forest District. It is a natural coniferous high-mountain forest belonging to the association *Piceetum excelsae-Tatricum*. The spruce stands in the reserve are about 150-170 years old and are differentiated in respect of closeness. They grow on the slopes which are mostly steep and precipitous.

The sample plot lies in Division 63 (Fig. 1) and borders on the western end of the reserve. The greater part of the lower boundary of the sample plot is ca 340-metre section of the green marked touristic track from Zawoja to Krupowa Hala and the upper boundary extends 10-20 m below the ridge of Polica. The sample plot lies between altitudes of about 1200 and 1300 m. It shows a differentiation in slope inclination and in the structure of the stand. The eastern part of the plot is very steep and in its upper portion it is precipitous (up to about 45-50°); the stand is thinned, with gaps, the trees in its upper regions are visibly deformed, undergrowth is present. The herb layer is high and covers the ground

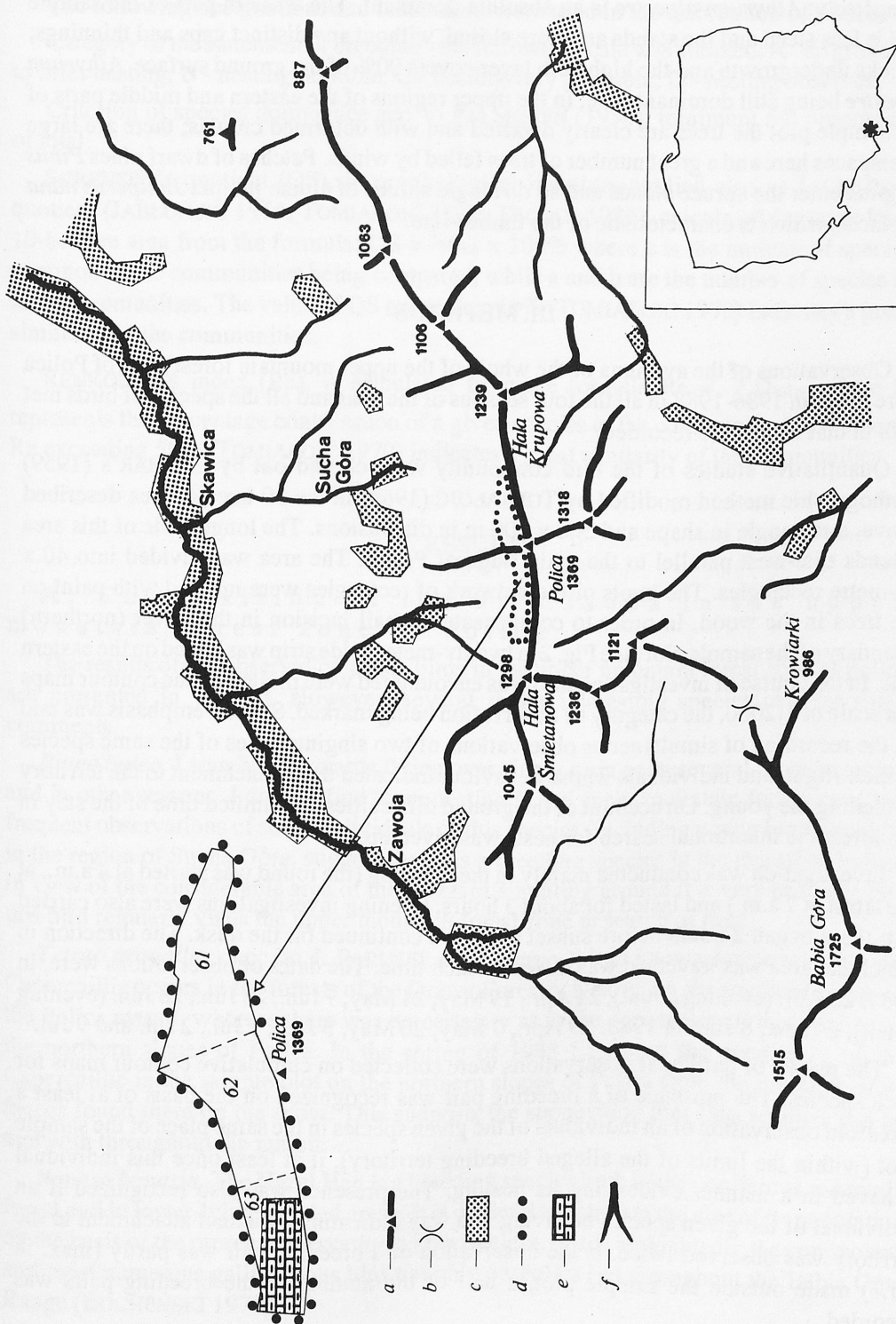


Fig. 1. A sketch map of the Polica range showing the situation of the Z. Klemensiewicz Reserve. a - ridges and summits; b - pass; c - built-up area; d - boundaries of the Z. Klemensiewicz Reserve "Na Policy"; e - sample plot; f - rivers and streams

completely; *Athyrium alpestre* is an absolute dominant. The western part of the sample plot is less steep and the stands are more closed, without any distinct gaps and thinnings; it lacks undergrowth and the high herb layer covers 90% of the ground surface, *Athyrium alpestre* being still dominant here. In the upper regions of the eastern and middle parts of the sample plot the trees are clearly dwarfed and with deformed crowns; there are large interspaces here and a great number of trees felled by winds. Patches of dwarf pines *Pinus mughus* enter the spruce stands and so do single shrubs of alpine juniper *Juniperus nana* in places, which is characteristic of the timber-line.

III. METHODS

Observations of the avifauna of the whole of the upper mountain forest zone of Polica were made in 1986-1988 in all the four seasons of the year and all the species of birds met with in that zone were recorded.

Quantitative studies of the bird community were carried out by ENEMAR's (1959) cartographic method modified by TOMIAŁOJC (1968) in the 10-hectare area described above, a rectangle in shape and 500 × 200 m in dimensions. The longer side of this area extends east-west parallel to the main ridge of Polica. The area was divided into 40 × 20-metre rectangles. The knots of the network of rectangles were marked with paint on the trees in the wood. In order to compensate a small incision in the lower (northern) boundary of the sample plot (see Fig. 2) a twenty-meter-wide strip was added on the eastern side. In the course of investigation the birds encountered were plotted on the contour maps to a scale of 1:2000, the category of observation being marked. Special emphasis was laid on the recording of simultaneous observations of two singing males of the same species or their flight, and individuals whose behaviour indicated their attachment to the territory or feeding the young. On account of the ground difficulties and limited time of the stay in the forest the intentional search for nests was given up.

Investigation was conducted mainly in the morning (the round was started at 4 a.m., at the latest at 7 a.m.) and lasted for about 3 hours. Evening investigations were also carried out; these began 2 hours before sunset and were continued till the dusk. The direction in which the area was traversed was different each time. The dates of observations were, in 1987: 23 Apr. (evening count), 24 Apr., 19 May, 24 May, 7 Jun., 28 Jun., 28 Jun. (evening count), 29 Jun., 8 Jul.; in 1988: 29 Apr., 7 May, 20 May, 5 Jun., 1 Jul., 2 Jul. and 9 Jul.

The results of particular observations were collected on cumulative contour maps for each species. The presence of a breeding pair was recognized on the basis of at least a threefold observation of an individual of the given species in the same place of the sample plot (within the limits of the alleged breeding territory), if at least once this individual behaved in a manner evidencing its nesting. The presence was also recognized if an individual of the given species behaving in a way indicating a distinct attachment to the territory was observed twice. If the observation of a breeding pair was partly (max. in 50%) made outside the sample plot, a half of the number of the breeding pairs was recorded.

The following designations and indications were used in the elaboration of results:

Category of the statement of breeding - the following scale was adopted: A - no grounds to infer nesting, B - nesting possible, C - nesting very probable, D - nesting observed.

Criterion of species dominance acc. to PALMGREN (1930): minimum 5% proportion of total.

SØRENSEN's quotient (QS), in ornithological literature applied also as JACKARD's quotient (JABŁOŃSKI 1964, TOMIAŁOJC 1970, TROJAN 1980), calculated for an at least 10-hectare area from the formula: $QS = \frac{2c}{a+b} \times 100\%$ where c is the number of species common to the communities being compared, while a and b are the number of species in these communities. The value of QS exceeding 60% (TOMIAŁOJC 1970) indicates a great similarity of the communities.

RENKONEN's index (Re), is calculated from the formula $Re = \sum D_{min}$, where D represents the percentage contribution of a given species to the community. The value of Re exceeding 50% (TOMIAŁOJC 1970) indicates a great similarity of the communities.

IV. RESULTS

A. Composition of the bird fauna in the upper mountain forest zone of Polica.

The results of the observation of the birds in the upper mountain forest zone of polica are presented in Table I. However, several rather interesting species call for some comments.

Buteo buteo. I watched Buzzards flying over singly or in pairs several times in spring and in other seasons. I did not find them nesting in the upper mountain forest zone, but frequent observations of some individuals of this species (including young birds), mainly in the region of Sucha Góra, suggest that it is a breeding species in the massif of Polica. In view of the considerable area of the Buzzard's hunting ground it is very probable that this bird regularly visits the upper mountain forest zone in search of prey.

Tetrao urogallus. Acc. to J. PARUSEL (oral comm.), it is known for certain that the Capercaillie occurs in the forests of the Orawa Forestry District on the southern slopes of the Polica massif, whereas there was no certainty as to the occurrence of this species on the northern slopes of Polica. In the spring of 1988 I inferred the occurrence of the Capercaillie in the sample plot on the northern slopes of Polica from the presence of its faeces found there on the snow. This supports the supposition that Capercaillies can be met with throughout the massif.

Bonasa bonasia. The Hazel Hen is a breeding species both in the coniferous mountain forest and in lower-lying wooded areas. It is difficult to estimate the size of its population on the basis of the present observations; nevertheless, this is undoubtedly the commonest and most numerous gallinaceous bird not only on Polica but throughout the Babia Góra Range (BOCHEŃSKI 1970).

Table I

List of species observed in the upper (coniferous) mountain forest zone of Polica in 1986 - 1988. The frequency of occurrence and the category of the statement of breeding are given. Frequency of occurrence: ++ frequent, + rare, r very rare. Category of the statement of breeding: see the section on methods.

| Species | Category of the statement of breeding | Frequency of occurrence | Remarks |
|---|---------------------------------------|-------------------------|--|
| 1 | 2 | 3 | 4 |
| <i>Buteo buteo</i> (LINNAEUS, 1758) | B | + | — |
| <i>Tetrao urogallus</i> LINNAEUS, 1758 | A | r | on the basis of faeces |
| <i>Bonasa bonasia</i> (LINNAEUS, 1758) | D | + | — |
| <i>Cuculus canorus</i> LINNAEUS, 1758 | C | + | — |
| <i>Strix aluco</i> LINNAEUS, 1758 | B | r | single observation on the boundary between the upper and lower mountain forest zones |
| <i>Apus apus</i> (LINNAEUS, 1758) | A | + | visiting to forage |
| <i>Dryocopus martius</i> (LINNAEUS, 1758) | C | r | — |
| <i>Picoides tridactylus</i> (LINNAEUS, 1758) | C | + | — |
| <i>Anthus spinoletta</i> (LINNAEUS, 1758) | C | + | exclusively in Śmietanowa Hala |
| <i>Anthus trivialis</i> (LINNAEUS, 1758) | D | + | — |
| <i>Troglodytes troglodytes</i> (LINNAEUS, 1758) | D | ++ | — |
| <i>Prunella modularis</i> (LINNAEUS, 1758) | D | ++ | — |
| <i>Erithacus rubecula</i> (LINNAEUS, 1758) | D | ++ | — |
| <i>Phoenicurus ochruros</i> (GMELIN, 1774) | D | r | — |
| <i>Turdus merula</i> LINNAEUS, 1758 | D | + | — |
| <i>Turdus philomelos</i> C. L. BREHM, 1831 | D | + | — |
| <i>Turdus torquatus</i> LINNAEUS, 1758 | D | + | — |
| <i>Sylvia atricapilla</i> (LINNAEUS, 1758) | D | + | — |
| <i>Phylloscopus collybita</i> (VIEILLLOT, 1817) | D | + | — |

Table I ctd

| 1 | 2 | 3 | 4 |
|--|---|----|--------------------|
| <i>Phylloscopus sibilatrix</i> (BECHSTEIN, 1793) | B | r | – |
| <i>Phylloscopus trochilus</i> (LINNAEUS, 1758) | D | ++ | – |
| <i>Regulus ingicapillus</i> (TEMMINCK, 1820) | C | + | – |
| <i>Regulus regulus</i> (LINNAEUS, 1758) | D | ++ | – |
| <i>Ficedula hypoleuca</i> (PALLAS, 1761) | A | r | single observation |
| <i>Parus ater</i> LINNAEUS, 1758 | D | + | – |
| <i>Parus cristatus</i> LINNAEUS, 1758 | B | r | – |
| <i>Parus major</i> LINNAEUS, 1758 | A | r | single observation |
| <i>Parus montanus</i> CONRAD von BALDENSTEIN, 1827 | C | ++ | – |
| <i>Parus palustris</i> LINNAEUS, 1758 | A | r | – |
| <i>Sitta europea</i> LINNAEUS, 1758 | A | r | – |
| <i>Certhia familiaris</i> LINNAEUS, 1758 | D | + | – |
| <i>Fringilla coelebs</i> LINNAEUS, 1758 | D | ++ | – |
| <i>Carduelis spinus</i> (LINNAEUS, 1758) | C | r | – |
| <i>Loxia curvirostra</i> LINNAEUS, 1758 | B | r | – |
| <i>Pyrrhula pyrrhula</i> (LINNAEUS, 1758) | C | + | – |
| <i>Garrulus glandarius</i> (LINNAEUS, 1758) | A | r | – |
| <i>Nucifraga caryocatactes</i> (LINNAEUS, 1758) | A | r | single observation |
| <i>Corvus corax</i> LINNAEUS, 1758 | C | + | – |

Apus apus. The Swift does not nest in the area of the Polica massif and yet I met with these birds several times in June and July. They occurred in large numbers foraging in the region of the summit. The Swifts flew above the trees of the stands adjacent to the Polica ridge and also in Forest Divisions 62 and 63. I observed their presence only on hot dry and calm days and found them nesting amidst farm buildings of Skawica and Zawoja at the foot of the mountain.

Nucifraga caryocatactes. On July 2, 1988 I came across a Nutcracker in the sample plot, but since that was a single observation and, what is more, made after the breeding season, it says nothing of its nesting in the Polica massif. The Nutcracker has not been recorded from the region of the Babia Góra Range as a breeding species.

Corvus corax. Ravens, not excluding juveniles, are regularly seen both in winter and in spring and summer, which evidences that they are a breeding species in the Polica area. The observations from 1988 indicate that the probable nesting site was located in the lower mountain forest zone on the northern slope of Polica above the Upper Skawica Valley. These birds penetrate large areas and so it is hard to fix their numbers on the basis of the number of meetings.

Phoenicurus ochruros. I regularly saw Black Redstarts in the neighbourhood of the shepherds' chalets and the mountain hostel on Krupowa Hala, where they are breeding birds. They were sporadically observed by the touristic track from Krupowa Hala to the top of Polica and in a clearing with stumps of windstorm-felled trees, next to the summit at the eastern end of the reserve (Division 61).

Anthus spinoletta. The Water Pipit was found in the border-area of the region under study; I observed more than ten individuals in a relatively small area of Śmietanowa Hala. Both the time of observation (June) and the displaying flights of birds indicated their nesting.

Loxia curvirostra. In 1987 and 1988 I sporadically encountered Crossbills. No observations suggested their nesting. The small number of Crossbills seen may have been connected with the exceptionally poor spruce-seed crops (in 1987 the spruce did not crop at all and in 1988 it cropped very poorly). The severe winter of 1986/87 may also have played some role.

B. The results of counts in the sample plot.

Table II presents a list of species observed in the sample plot, their density and the structure of dominance.

A total of 12 nesting species (9 species in either year) and 13 non-nesting species were recorded. The mean density of breeding pairs from 2-year observations was 49.5 pairs/10 ha. Although the density of pairs in two breeding seasons studied was in general similar, there were some differences in the composition of accessory species (nesting of single pairs of *Phylloscopus collybita*, *Bonasa bonasia*, *Certhia familiaris* in 1987 and *Phylloscopus trochilus*, *Regulus regulus* and *Sylvia atricapilla* in 1988). There were also some differences in the structure of dominance (e.g. *Regulus regulus* and *Erithacus rubecula*).

The cumulative contour-maps with the places of occurrence of particular pairs plotted (Fig. 2A and B) illustrate the distribution of the breeding pairs. The designation of the places of occurrence of pairs does not indicate the size and shape of the breeding territory, only their situation in the sample plot.

It turns out that the occurrence of the breeding pairs is not uniform. Their density was distinctly greater in the eastern part of the sample plot both in 1987 and in 1988, whereas the western part was more sparsely inhabited. These differences may have been connected with the nature of the stands and, above all, with their closeness; the smaller closeness of stands and differentiation of trees in respect of height (together with the presence of undergrowth) favour a higher density of breeding pairs.

Table II

Results of the investigations in the sample plot in the spruce stand, situated in the upper mountain forest zone in Reserve "Na Policy" (10 ha) in 1987 - 1988. Species arranged in order of number of pairs

| Species | 1987 | | 1988 | |
|--------------------------------|-------------|-------|-------------|-------|
| | pairs/10 ha | % | pairs/10 ha | % |
| <i>Fringilla coelebs</i> | 23 | 46.9 | 22 | 44.0 |
| <i>Erithacus rubecula</i> | 14 | 28.6 | 10.5 | 21.0 |
| <i>Regulus regulus</i> | 3 | 6.2 | 6 | 12.0 |
| <i>Prunella modularis</i> | 3 | 6.2 | 4 | 8.0 |
| <i>Parus ater</i> | 2 | 4.1 | 4 | 8.0 |
| <i>Phylloscopus trochilus</i> | — | — | 1 | 2.0 |
| <i>Phylloscopus collybita</i> | 1 | 2.0 | — | — |
| <i>Turdus torquatus</i> | 1 | 2.0 | 0.5 | 1.0 |
| <i>Certhia familiaris</i> | 1 | 2.0 | — | — |
| <i>Troglodytes troglodytes</i> | — | — | 1 | 2.0 |
| <i>Sylvia atricapilla</i> | — | — | 1 | 2.0 |
| <i>Bonasa bonasia</i> | 1 | 2.0 | — | — |
| <i>Tetrao urogallus</i> | — | | + | |
| <i>Picoides tridactylus</i> | + | | — | |
| <i>Corvus corax</i> | + | | — | |
| <i>Nucifraga caryocatactes</i> | — | | + | |
| <i>Parus palustris</i> | — | | + | |
| <i>Parus montanus</i> | + | | + | |
| <i>Turdus philomelos</i> | + | | — | |
| <i>Turdus merula</i> | + | | — | |
| <i>Phylloscopus sibilatrix</i> | — | | + | |
| <i>Regulus ignicapillus</i> | + | | + | |
| <i>Ficedula hypoleuca</i> | — | | + | |
| <i>Anthus trivialis</i> | + | | — | |
| <i>Pyrrhula pyrrhula</i> | + | | + | |
| All species together | 49.0 | 100.0 | 50.0 | 100.0 |

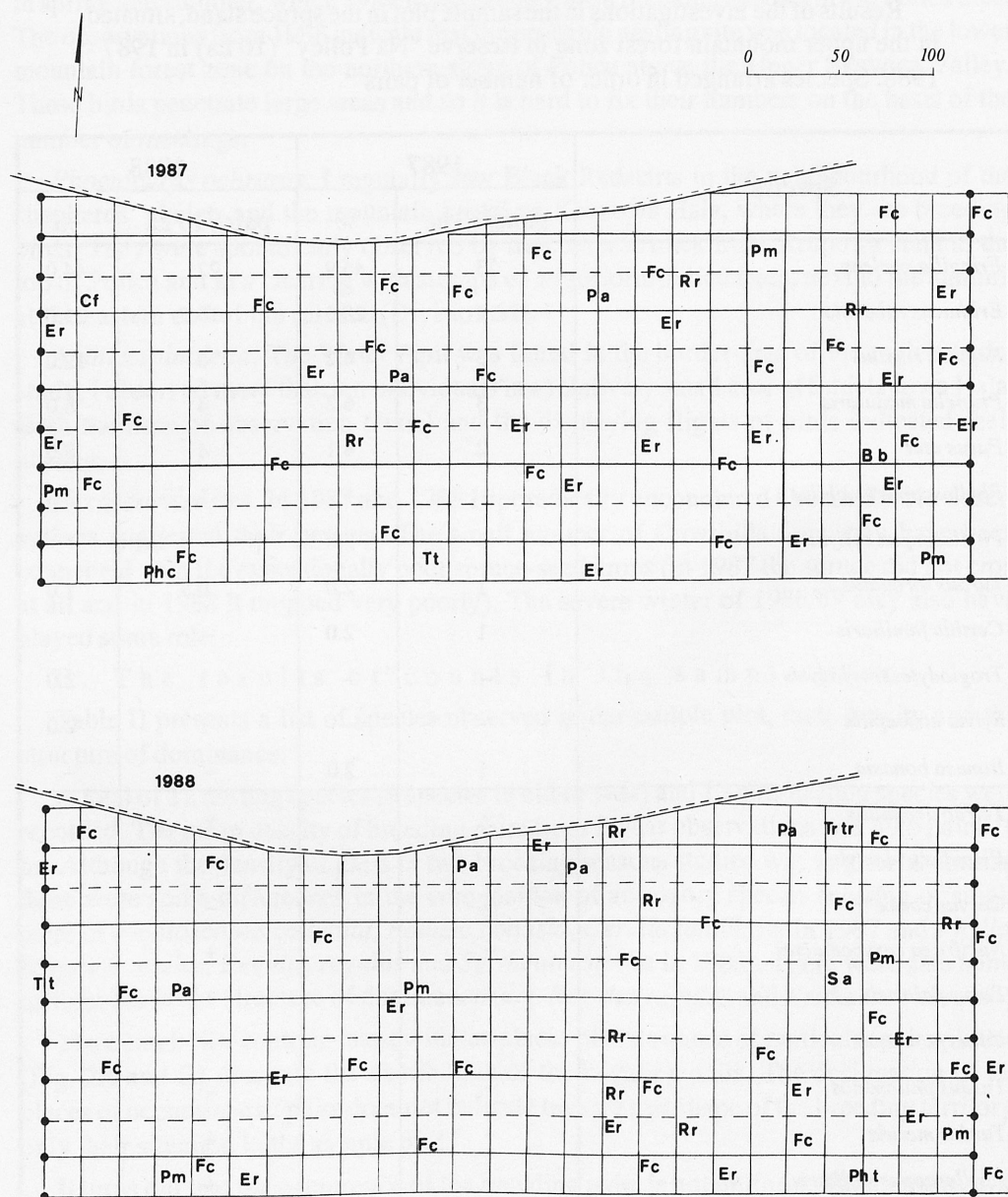


Fig. 2. The distribution of breeding pairs (letter designations) in the study area. Designations of species: Bb - *Bonasa bonasia*; Cf - *Certhia familiaris*; Er - *Erithacus rubecula*; Fc - *Fringilla coelebs*; Pa - *Parus ater*; Pm - *Prunella modularis*; Phc - *Phylloscopus collybita*; Pht - *Phylloscopus trochilus*; Rr - *Regulus regulus*; Sa - *Sylvia atricapilla*; Tt - *Turdus torquatus*; Trtr - *Troglodytes troglodytes*

V. DISCUSSION

The list of 38 species occurring in the upper mountain forest zone of Polica (Table I) is perhaps not full. The omission of some species is probably connected with the difficulty of their detection, especially as regards the species having large breeding territories and those occurring sporadically. On the other hand, several of the species recorded are undoubtedly passing or chance visitors from lower-lying regions. Among them we can number *Ficedula hypoleuca*, *Sitta europea*, *Parus major*, *Apus apus* and *Nucifraga caryocatactes*.

The number of species found in the upper mountain forest zone of Polica approximates to those reported from other mountainous areas. And so on the neighbouring Babia Góra 37 species were noted present (RIABANIN 1962, BOCHEŃSKI 1970, WOŁK 1978), in the Gorce 46 species (KOZŁOWSKI 1974, GŁOWACIŃSKI 1990) and in the Karkonosze Mts 28 species (DYRCZ 1973).

Table III comprises a comparison of the percentage proportions of dominant species on Polica and in the areas studied in the mountain spruce forest of the Gorce (KOZŁOWSKI 1974) and Karkonosze Mts (DYRCZ 1973). The dominant species always formed at least 80% of the breeding pairs of the community (Table III), thus exerting a decisive influence upon its density. *Fringilla coelebs* was an absolute dominant, always most numerous in the communities compared, while the remaining species from the groups of dominants changed in order, *Erithacus rubecula* or *Regulus regulus* coming usually in second as regards number.

Table III

A comparison of proportions of dominant species in the bird communities of the sample plots in Reserve "Na Policy", "Śmielec" (DYRCZ 1973) and in Reserve "Turbacz" (KOZŁOWSKI 1974)

| Species | Reserve "Na Policy" | Sample plot "Śmielec" | Reserve "Turbacz" |
|---------------------------|------------------------|--------------------------|----------------------|
| | % | | |
| <i>Fringilla coelebs</i> | 45.5 | 25.8 | 31.4 |
| <i>Erithacus rubecula</i> | 24.8 | 16.1 | 15.4 |
| <i>Regulus regulus</i> | 9.1 | 20.0 | 20.7 |
| <i>Parus ater</i> | 6.1 | 6.5 | 13.5 |
| <i>Prunella modularis</i> | 7.1 | 14.6 | 0.9 |
| Five species together | 92.6 | 84.0 | 81.9 |

Table IV

Values of SØRENSEN's quotient (QS) and RENKONEN's index (Re) for particular pairs of bird communities of the coniferous (upper) mountain forest zone

| QS \ Re | Polica Reserve "Na Policy" | Gorce Reserve "Turbacz" | Karkonosze Area "Śmielec" |
|---------------------|-------------------------------|----------------------------|------------------------------|
| Reserve "Na Policy" | – | 62.9% | 64.2% |
| Reserve "Turbacz" | 57.1% | – | 68.6% |
| Area "Śmielec" | 62.1% | 64.5% | – |

The considerable similarity of the communities under discussion, resulting from the analogous state of certain characters of the quantitative structure (Table III) is also shown by the juxtaposition of the values of SØRENSEN's quotient (QS) and those of RENKONEN's index (Re) for particular pairs of the communities (Table IV).

The changes in the density of particular species in two successive years of observation in the reserves "Na Policy" and "Turbacz" (KOZŁOWSKI 1974) proceeded in a similar manner (Fig. 3). In both these places a decrease in the number of *Fringilla coelebs* and *Erithacus rubecula* was correlated with a rise in the numbers of *Regulus regulus* and *Parus ater* (on Polica also *Prunella modularis*). Here we are probably concerned with the effect of compensation (WASILEWSKI 1967, 1979), which is a mechanism that stabilizes the density of breeding pairs at a similar level.

The general quantitative data about the community of birds of the upper mountain forest zona of Polica, the Gorce (KOZŁOWSKI 1974) and Karkonosze Mts (DYRCZ 1973) are compared in Table V with the results obtained from the study areas in mixed mountain forests (GŁOWACIŃSKI 1990, DYRCZ 1973) and in various natural spruce forests in lowlands of north-eastern Poland (PIOTROWSKA & WOŁK 1983, TOMIAŁOJCĆ et al. 1984).

The density of breeding pairs in the upper mountain forest zone of Polica (49.0 and 50.0 pairs/10 ha) virtually underwent no changes in 1987-1988 in spite of marked differences in the weather conditions in these successive years. The data concerning the stands in the lower mountain forest zone and in lowland spruce forests show, for the most part, distinct fluctuations in the density of breeding pairs in successive years, reaching even a level of 20 pairs/10 ha (PIOTROWSKA & WOŁK 1983, GŁOWACIŃSKI 1990). Similarly, remarkable fluctuations in density in 1987-1989 were also found in an area in a natural Carpathian beech forest on Babia Góra (KIEŚ 1991) and therefore near Polica. This may indicate that weather conditions were not an essential factor influencing the changes in the density of breeding pairs in these areas.

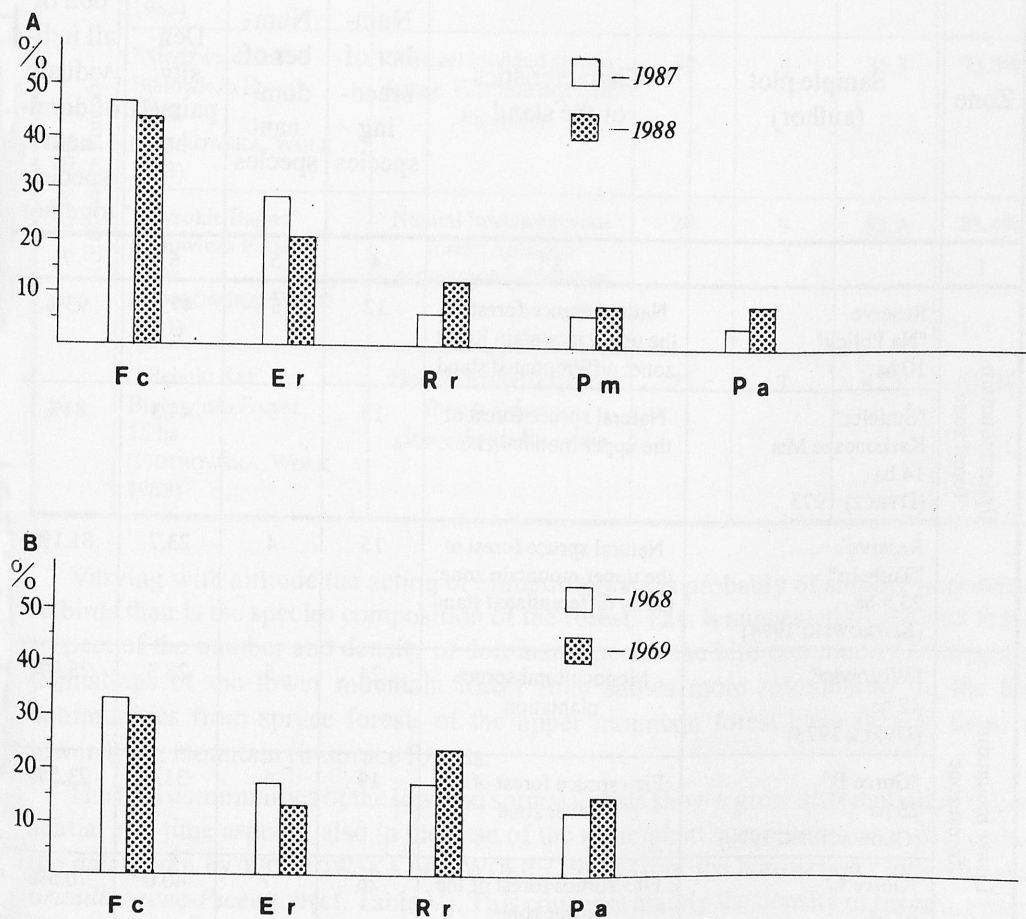


Fig. 3. A comparison of the percentage proportions of dominant species in the study areas in the reserves "Na Policy" (A) and "Turbacz" (B) in two consecutive breeding seasons. Designations of species - as in Fig. 2.

Table V

A juxtaposition of the main features of the bird communities occurring in the sample plots in mountain and lowland spruce forest.

| Zone | Sample plot (author) | Characteristics of the stand | Num- ber of breed- ing species | Num- ber of domi- nant species | Den- sity: pairs/10 ha | Propor- tion of all indi- viduals of domi- nant species together |
|---------------------------------|---|---|--|--|---------------------------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Upper mountain forest zone | Reserve "Na Policy" 10 ha | Natural spruce forest of the upper mountain forest zone: differentiated stand | 12 | 5 | 49.5 | 93% |
| | "Śmielec" Karkonosze Mts 14 ha (DYRCZ) 1973 | Natural spruce forest of the upper mountain zone | 13 | 5 | 44.3 | 84% |
| | Reserve "Turbacz" 23.5 ha (KOZŁOWSKI 1974) | Natural spruce forest of the upper mountain zone: partly differentiated stand | 15 | 4 | 23.7 | 81.1% |
| Lower mountain forest zone | "Wężówka" 42 ha (DYRCZ 1973) | Monocultural spruce plantation | 24 | 5 | 28.3 | 75.9% |
| | "Gorce B" 25 ha (GŁOWACIŃSKI 1990) | Fir - spruce forest of the lower zone | 19 | 6 | 31.0 | 73.5% |
| | "Gorce C" 25 ha (GŁOWACIŃSKI 1990) | Fir - spruce forest of the lower zone | 26 | 7 | 40.0 | 70.5% |
| Lowlands (Białowieża Forest) | "Wyspa" Białowieża Forest 10 ha (PIOTROWSKA, WOŁK 1983) | Natural lowland spruce forest: <i>Calamagrostio orudinaceae-Piceetum</i> | 19 | 6 | 45.5 | 70.4% |
| | "Kolejkowa" Białowieża Forest 25 ha (PIOTROWSKA, WOŁK 1983) | Natural lowland spruce forest: <i>Calamagrostio orudinaceae-Piceetum</i> | 17 | 6 | 24.8 | 75.9% |

Table V ctd

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---------------------------------|---|--|----|---|------|-------|
| Lowlands (Białowieża Forest) | "Gilowa" Białowieża Forest 16 ha (PIOTROWSKA, WOŁK 1983) | Natural lowland spruce forest: <i>Calamagrostio arundinaceae-Piceetum</i> | 29 | 6 | 35.3 | 69.5% |
| | "Niedźwiedzica" Białowieża Forest 50 ha (PIOTROWSKA, WOŁK 1983) | Natural lowland spruce forest: <i>Vaccinio myrtylli- Piceetum</i> | 30 | 6 | 35.3 | 73.3% |
| | "Wysokie Bagno" Białowieża Forest 15 ha (PIOTROWSKA, WOŁK 1983) | Natural lowland spruce forest: <i>Sphagno girgenshonii-Piceetum</i> | 20 | 9 | 53.9 | 83.4% |
| | "Głębokki Kąt" Białowieża Forest 15 ha (PIOTROWSKA, WOŁK 1983) | Natural lowland spruce forest: <i>Sphagno girgenshonii-Piceetum</i> | 23 | 7 | 47.3 | 67.0% |

Varying with altitude the action of climatic agents is probably of smaller importance to birds than is the species composition of the forest. This is suggested by the fact that in respect of the number and density of dominant species the bird community from spruce plantations of the lower mountain forest zone shows more resemblance to the bird communities from spruce forests of the upper mountain forest zone than to those of lower-lying mountain fir-spruce forests.

The bird communities of the lowland spruce forests show a great differentiation in both spatial and time aspects, also in the case of the same plant community, as evidenced by the data given by PIOTROWSKA and WOŁK (1983) from the association *Calamagrostio arundinaceae-Piceetum* (cf. Table V). This concerns mainly the density of breeding pairs. However, those authors's data suggest a relationship between the structure of the stand and the density of breeding pairs. This phenomenon is analogous with that now observed in the study area on Polica (cf. Fig. 2).

Table V shows that only the bird communities of the spruce forests of the upper zone distinguish themselves positively. The number of breeding species is there distinctly smaller, there being 5 dominant species represented jointly by more than 80% of the breeding pairs of the community. The communities of the lower mountain forest zone and of the lowland forests exhibit too great a differentiation to allow their distinction from each other only on the basis of quantitative analysis. The bird communities of the lowland spruce forest are characterized for the most part by a greater number of breeding birds than that in the lower mountain forest zone, that being the case only in the stands varying

in structure and plant associations occurring in them (PIOTROWSKA & WOŁK 1983, TOMIAŁOJC 1984).

There are also distinct differences in the specific composition of birds. *Turdus torquatus* occurs in the stands of the upper mountain forest zone and in the fir-spruce stands of the lower zone. As a Boreal-Alpine species, this form is absent from the lowlands and in consequence becomes an indicator species of mountain habitats in Central Europe. On the other hand, many of the species occurring in the spruce forests of the lowlands (*Phylloscopus sibilatrix*, *Ficedula parva*, *Ficedula hypoleuca*, *Muscicapa striata* and *Dendrocops leucotos*) as a rule do not turn up above the lower boundary of the upper mountain forest zone only sporadically occur in the coniferous forests of the lower zone.

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