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Niche organization of a forest bird community in north-western Italy during autumn and winter. A comparative analysis

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Abstract — The niche organization of a deciduous forest bird community (Passeriformes and Piciformes) in north-western Italy has been described by considering other activities in addition to foraging. Principal Component Analysis suggests that, with regard to foraging, the first factor (PC1) depends on the use of outer parts of branches and middle height of trees in autumn whereas it is mainly concerned with the use of trunk, ash and oak versus the ground in winter. As for singing, the first factor is highly correlated only with particular species of trees in autumn whereas it defines the use of the outermost parts of branches in winter. Such differences reflect well-known seasonal shifts in the behaviour of species. The lack of correlation between foraging and singing rotated loadings suggests that foraging community organization differs from the singing one.
Cluster analysis (Pearson's distance) stresses the ecological isolation of woodpeckers both in autumn and in winter. Also tits and associated species are seen to be separate enough from others both in foraging and in singing. Dendrograms computed on data collected without distinguishing birds' activities are more similar to foraging dendrograms than to singing ones. This seems to suggest that in autumn and winter community organization is more dependent on foraging than on singing activities. Since the results of the Cluster analysis are in agreement with those previously obtained concerning the same data but worked out by simple niche overlap indices, it may be inferred that both methods of data analysis are adequate to describe community organization.

Introduction

Studies on guilds and communities have usually been carried out by taking into account only the foraging activities whereas other bird activities (e.g. singing, resting, comfort behaviour) have been completely neglected (Withmore 1977, Herrera 1978, 1979, Hogstad 1978, Alatalo and Alatalo 1979, Alatalo 1981b, Saether 1982, Sabo et al. 1983, Carrascal 1984, 1985, Laurent 1984, Carrascal and Telleria 1985, Bull et al. 1986, Székely 1987).
The aim of this paper is to describe niche organization of a deciduous forest bird community (Passeriformes and Piciformes) in north-western Italy, by considering other activities in addition to foraging. Data have been analyzed by multivariate techniques both to identify the most important factors pertaining to niche organization and to compare the results with those obtained by making use of common niche metrics (Rolando and Menzio, 1990).

Study area and methods.

The study area is located in north-western Italy, at the mouth of the Susa valley (45° 3'N, 7° 23'E, 370 m a.s.l.). The size of the area is about 60 ha, within the Avigliana Natural Park (Turin province).
The woods have a few open areas and consist of different patches of *Quercion-pubescentis, Carpinion* and *Alno-Ulmion*. The chestnut (*Castanea sativa*) is extensively cultivated and periodically coppiced.
Birds species are listed in the caption to Figure 1. Observations were carried out from October 1985 to February 1986, dividing the period into two parts: autumn (October 1st — December 15th) and winter (December 16th -end of February). In considering the actual activities of birds, we took into account only those species whose observation rate was at least 1% of the total observation time for the whole community and with at least 300 seconds of observations made in the course of at least 15 different bouts. Other species were excluded from the analysis. However, when considering all the data, independently of the birds' activities, these limits were lowered to 0.5%, with 600 seconds of observation and 30 different bouts. The above limits made it possible to take into consideration only those

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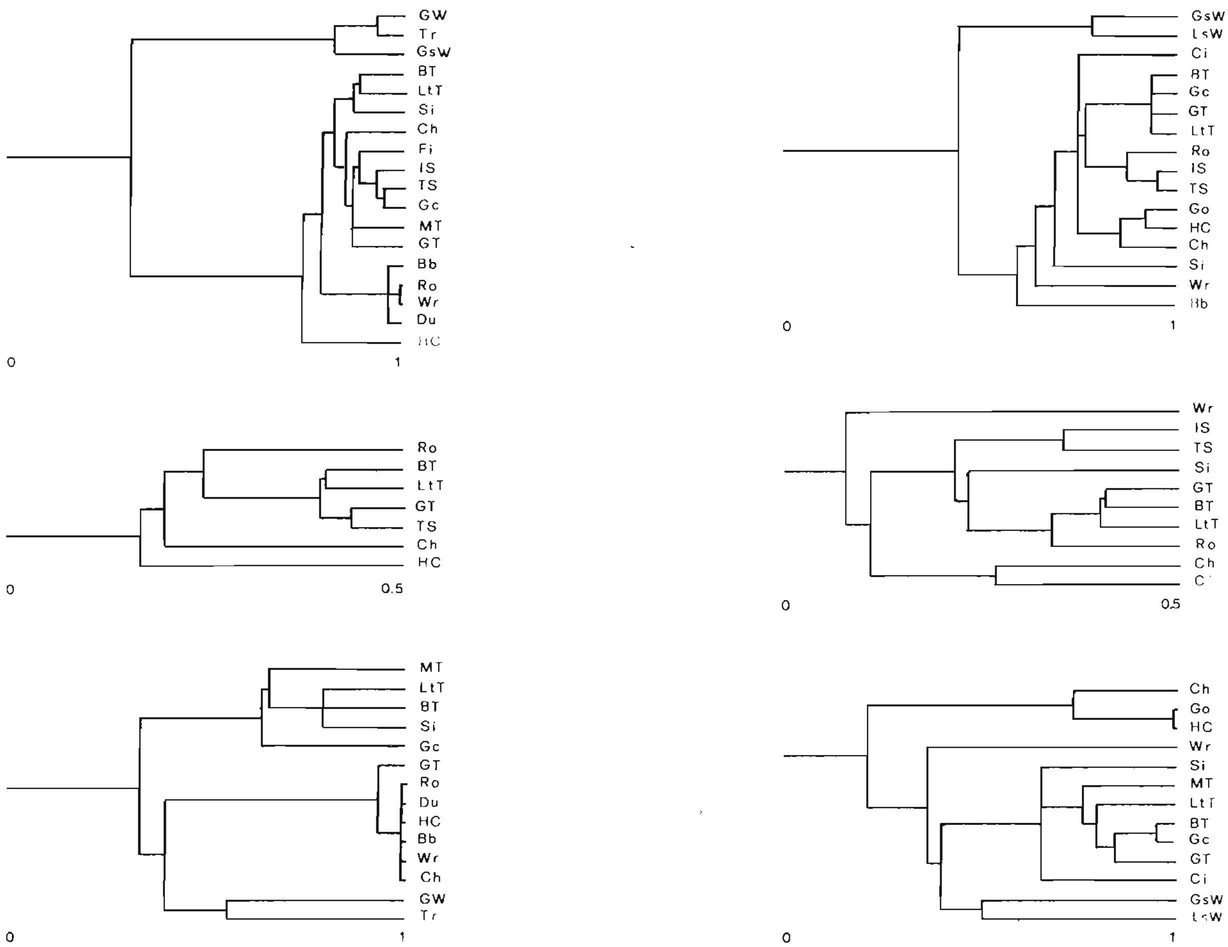

Figure 1. Clusters (Pearson's distance) of species in winter (left) and autumn (right). Three clusters for each season. From top to bottom: foraging, singing and cumulated activities.
Species symbols are as follow: GsW Great spotted Woodpecker *Picoides major*, LsW Lesser spotted Woodpecker *Picoides minor*, GW Green Woodpecker *Picus viridis*, Wr Wren *Troglodytes troglodytes*, Du Dunnock *Prunella modularis*, Bb Blackbird *Turdus merula*, Ro Robin *Erithacus rubecula*, Fi Firecrest *Regulus ignicapillus*, Gc Goldcrest *Regulus regulus*, LtT Long-tailed Tit *Aegithalos caudatus*, MT Marsh Tit *Parus palustris*, GT Great Tit *Parus major*, BT Blue Tit *Parus caeruleus*, Nh Nuthatch *Sitta europaea*, Tr Short-toed Treecreeper *Certhia brachydactyla*, HC Hooded Crow *Corvus corone cornix*, IS Italian Sparrow *Passer italiae*, TS Tree Sparrow *Passer montanus*, Go Goldfinch *Carduelis carduelis*, Ch Chaffinch *Fringilla coelebs*, Si Siskin *Carduelis spinus*.

species that were observed for a rather long period, thus virtually avoiding the problems associated with the scarcity of data due to differential visibility of the birds.
Three types of spatial distribution were examined:
a) choice of tree species,
b) vertical distribution (i.e. ground, ground to 30 cm, 30 cm to 5 m, 5 to 10 m, over 10 m),
c) horizontal distribution (i.e. trunk, inner parts of branches, middle parts, outer parts).

The birds' activities were timed by a stopwatch and expressed in seconds. Singing activity was taken to include any song and call-note uttered by individuals. In order to diminish biases due to individual behaviour, each subject was kept under observation for no longer than three minutes. We considered 18 different variables, i.e. 9 tree species, 4 horizontal classes and 5 vertical classes.
Data were subjected to Principal Component (PCA) and Cluster analyses. As for PCA, to improve normality, variables were transformed into log (x + 1). The Systat (1985) computer package was used. We produced a PCA with rotations (varimax) of factor and factor scores. In Cluster analysis we used the Pearson distance (Pearson correlation coefficient) with the single linkage method (nearest neighbour)

(Hartigan 1975). Cluster analysis permits detection of natural groupings in niche data, so that such results may be compared with dendrograms of niche overlap previously obtained by Rolando and Menzio (1990).

Results

As for foraging, the first 4 axes derived from PCA accounted for 79% of the variance in autumn and 87% in winter, whereas for singing, percentages were, respectively, 77% and 89%.

As for cumulated data, the first 4 axes accounted for 76% of the variance in the original data set in autumn and 73% in winter.

Component loadings, that may be regarded as correlation coefficients between the original variables and the principal components, are listed in Table 1 (autumn period) and Table 2 (winter period).

Table 1. Autumn data. Rotated loadings (correlation coefficients) of the 18 variables considered on the first four principal components. F= foraging activity, S= singing activity.

Variables	PCI		PCII		PCIII		PCIV	
	F	S	F	S	F	S	F	S
oak	0.73	0.79	0.45	-0.20	0.31	0.28	0.27	0.30
ash	0.70	0.73	0.20	0.13	0.55	-0.43	0.03	-0.23
willow	0.08	-0.12	0.68	-0.20	-0.05	-0.01	0.06	-0.93
chestnut	0.25	0.43	0.10	-0.69	0.71	0.5	0.21	-0.12
poplar	0.28	0.01	-0.16	0.26	0.84	-0.82	-0.01	0.00
false acacia	0.36	0.81	0.19	-0.09	0.41	0.16	0.61	0.09
alder	0.84	0.27	0.05	0.74	-0.11	0.37	0.37	0.37
hazel	0.49	0.77	0.46	0.31	0.39	0.30	-0.05	-0.06
bushes	0.25	0.69	0.76	-0.07	0.44	0.51	0.26	-0.17
ground	-0.31	0.61	-0.33	0.06	-0.58	0.54	0.62	0.05
ground to 30cm	-0.10	0.31	0.78	0.17	0.11	0.75	-0.22	0.06
30 cm to 5m	0.51	0.61	0.72	0.23	0.00	0.37	0.08	-0.49
5 to 10m	0.84	0.16	0.13	0.87	0.34	0.12	-0.24	0.07
over 10m	0.75	0.06	-0.27	-0.30	0.35	-0.81	0.27	0.05
trunk	-0.07	0.48	0.22	-0.20	0.87	0.10	-0.03	-0.60
inner parts	0.50	0.70	0.60	-0.22	0.16	-0.13	0.53	-0.15
middle parts	0.92	-0.37	0.34	0.76	0.03	-0.21	0.10	0.04
outer parts	0.92	-0.31	0.15	0.46	0.21	-0.72	-0.03	0.16
var. exp.	5.75	4.97	3.44	3.12	3.56	3.98	1.56	1.88
% of tot var. exp.	31.95	27.6	19.10	17.33	19.79	22.11	8.70	10.44

Table 2. Winter data. Rotated loadings (correlation coefficients) of the 17 variables considered (false acacia was not considered in winter for lack of data) on the first four principal components. F= foraging activity, S= singing activity.

Variables	PCI		PCII		PCIII		PCIV	
	F	S	F	S	F	S	F	S
oak	0.79	-0.19	0.48	-0.51	0.31	0.68	0.16	0.19
ash	0.83	0.30	0.26	-0.00	0.28	0.84	0.18	0.35
willow	0.21	0.58	0.88	0.52	-0.14	-0.18	0.06	0.56
chestnut	0.02	0.04	0.85	-0.03	0.33	0.19	0.36	0.86
poplar	0.43	0.78	0.52	-0.41	0.18	0.41	0.30	0.17
alder	0.20	0.54	0.28	0.46	-0.20	-0.11	0.83	0.68
hazel	0.03	0.29	0.87	0.51	0.34	0.58	0.29	-0.18
bushes	0.23	-0.16	0.24	0.94	0.86	-0.01	0.24	0.12
ground	-0.90	-	0.17	-	-0.01	-	-0.10	-
ground to 30cm	0.02	-0.94	-0.00	0.28	0.88	-0.13	-0.09	-0.13
30cm to 5m	0.66	0.15	0.35	0.88	0.07	0.30	0.52	0.22
5 to 10m	0.77	0.42	0.27	-0.01	0.02	0.53	0.52	0.63
over 10m	0.74	0.18	-0.30	-0.96	0.17	0.11	0.38	0.08
trunk	0.91	0.27	0.38	0.16	0.10	0.88	0.03	-0.01
inner parts	0.35	0.55	0.25	0.52	0.74	0.46	0.43	0.09
middle parts	0.16	0.77	0.15	0.45	0.37	0.20	0.82	-0.02
outer parts	0.35	0.92	0.24	-0.01	0.37	0.26	0.73	0.27
var.exp.	5.13	4.42	3.56	4.35	2.87	3.26	3.20	2.29
% of tot var. ep.	30.20	27.61	20.91	27.20	16.90	20.40	18.84	14.30

Results derived from PCA depend on the season and the activities considered. Factors with clear biological interpretation were obtained from foraging activity data. In particular, considering the first factor (PC1), that explains 31.95% of total variance in autumn and 30.20% in winter, it is rather evident that such a factor defines the use of outer parts of branches and middle height of trees in autumn whereas it defines the use of trunk, ash and oak as opposed to the use of the ground in winter. However, as for foraging, a lot of variables (e.g. trunk, middle parts, ground to 30 cm, bushes, alder) have high component loadings (>0.8) both in winter and in autumn, even though they may pertain to different factors.

Biological interpretation is less clear when singing data are taken into account. At any rate the first factor (27.60% of the total variance in autumn and 27.61% in winter) is highly correlated only with particular species of trees in autumn whereas it defines the use of outermost and middle parts of branches as opposed to the ground-30 cm height class (negative factor loading) in winter.

Foraging rotated loadings are not significantly correlated with singing ones (r values always lower than 0.32, 16 d.f., N.S. in all eight possible comparisons).

Biological interpretation deriving from cumulated data is not evident, and, accordingly, it is not taken into account.

Dendrograms obtained by Cluster Analysis are shown in Figure 1.

Clustering of foraging birds stresses the ecological isolation of woodpeckers both in autumn and in winter. Also tits and associated species are shown to be rather well apart from others, with the only exception of the Great Tit (*Parus major*) in winter. Eventually a distinct guild of foragers on ground is also clearly evidenced in winter (Figure 1).

As for singing activities, tits seem to behave rather homogeneously both in autumn and in winter (Figure 1).

Dendrograms computed on data collected without distinguishing birds' activities are rather similar to foraging ones.

Values of Pearson distances are lower in winter than in autumn both for cumulated and foraging data. Distances between species are lower in singing than in foraging and cumulated dendrograms (0-0.5 scale versus 0-1.0 scale).

Discussion

The results of PCA stress the effect of seasonal variations in community organization, in agreement with other authors (Ulfstrand 1977, Alatalo and Alatalo 1979, Alatalo 1980, Carrascal 1984, Carrascal et al. 1987, Rolando et al. 1989, Wiens 1989).

Seasonal differences according to the different activities are evident from field observations, with, e.g., a general descent of community to the ground from autumn to winter (Rolando and Menzio, 1990). Foraging activity depicts the clearest multivariate seasonal pattern with the first factor reflecting the use of the outermost parts of branches and middle height of trees in autumn and the inner parts of branches and the lowest vertical classes in winter. Therefore the ecological weight of such variables seems confirmed (Holmes et al. 1979, Sabo 1980, Carrascal and Telleira 1985, Carrascal et al. 1987).

Singing is obviously rather infrequent in autumn and, even more so, in winter. The first factor depicts a use of space as a function of tree species in autumn versus that of the outermost parts of branches as opposed to the ground-30 cm class in winter. This might suggest that species behave differently in the two seasons. Perhaps the presence of leaves in autumn give the species a greater opportunity of selecting the different tree species than in winter. The lack of any correlation between foraging and singing rotated loadings suggests that community organization for foraging activities differs from the singing one. This is also confirmed by the fact that foraging distribution of species very often differs from the singing one.

Cluster analysis, as a general interpretation, seems to suggest that community organization is more dependent on foraging activity than on the singing one (in keeping with Rolando et al. 1989). In fact, dendrograms computed from data independent of birds' activity are more similar to foraging than to singing ones. This result is likely to depend on the scarce singing activity of species during the non reproductive season.

Woodpeckers and tits seem to be the most homogeneous guilds since they are always well apart from other species, both in autumn and in winter. All the above is in keeping with the results of a previous paper concerning the same data but worked out by simple niche overlap dendrograms (Rolando and Menzio, 1990). Such an agreement suggests that both methods of data analysis are adequate to describe community organization in order to identify the occurrence of different guilds.

Pearson distances reflect the degree of similarity in the use of space among species. Hence, even though no niche overlap indices have been used here, it might be inferred that in winter the possibility of competition among species is higher than in autumn

(Pearson distances are lower in winter than in autumn). Such a result is again in keeping with previous findings that pointed out that mean overlap values for both foraging and singing were higher in winter than in autumn (Rolando and Menzio, 1990). It has been suggeted that interspecific competition modifies habitat selection in southern Finland (Alatalo 1981) whereas it seems to have a very limited role in habitat selection in Spain (Carrascal 1985). We prefer to speak only about the *possibility* of competition, first because our study focuses on the effect of the different activities of species on community structure dynamics, and, second, because we believe the "ceteris paribus assumption" by Wiens (1989) is correct and, although many investigations focused on competition, it is evident that other processes and factors may have important influences on community patterns as well (Wiens 1989).

These data show that community organization depends on different bird activities. Hence, it might be suggested that community ecology studies, especially those carried on during the breeding period, should also be more focused on individual activities other than foraging, even if this latter activity is obviously very important.

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Riassunto — L'organizzazione di nicchia di una comunità ornitica (Passeriformi e Piciformi) di un bosco deciduo dell'Italia Nord-occidentale è stata descritta considerando varie attività individuali, oltre a quella di ricerca dell'alimento. L'Analisi delle Componenti Principali ha indicato, riguardo alla attività di ricerca dell'alimento, che il primo fattore (PC1) dipende dall'uso delle parti distali dei rami e dalle altezze medie di utilizzazione degli alberi in autunno, mentre in inverno è risultato dipendere da una contrapposizione tra uso del suolo e distribuzione sul tronco e su alberi particolari come querce e frassini. Per quanto riguarda l'attività di canto, il primo fattore è risultato essere altamente correlato con varie specie di piante in autunno mentre in inverno sembra dipendere prevalentemente dall'uso delle porzioni più distali dei rami. La mancanza di correlazione tra i pesi delle componenti di alimentazione e quelli di canto confermerebbe la diversa organizzazione della comunità quando impegnata in attività distinte. L'Analisi dei Cluster ha evidenziato un forte isolamento dei picchi sia in autunno che in inverno. Anche il gruppo dei paridi e specie associate risulta spesso individuabile sia in alimentazione che in attività di canto. I dendrogrammi calcolati sui dati grezzi che non discriminano le varie attività sono più simili a quelli di attività trofica che a quelli di canto. Ciò suggerice che in autunno ed inverno l'organizzazione comunitaria dipenda maggiormente dalla attività di ricerca alimentare che da quella di canto.

Siccome i risultati della Analisi dei Cluster sono in accordo con quelli ottenuti in precedenza sugli stessi dati elaborati sulla base dei classici parametri di nicchia, può essere inferito che entrambi i metodi di analisi risultano adeguati a descrivere il piano organizzativo delle comunità ornitiche.

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