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Flocking behaviour of tits (Parus spp.) and associated species: the effect of habitat

T. Székely and T. Juhász

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Flocking behaviour of Great Tit *Parus major*, Blue Tit *P. caeruleus*, Marsh Tit *P. palustris*, and such associated species as woodpeckers *Dendrocopos spp.*, Nuthatch *Sitta europaea*, and Treecreeper *Certhia sp.* was studied from September to January in an oak forest and in a locust forest in Hungary. The size of both single-species flocks and multi-species flocks was larger in locust forest than in oak forest. The larger flocks of locust forest were mostly due to an increased number of Blue Tits, although such flocks also contained more Great Tits and Great Spotted Woodpeckers *D. major*. In both forests more birds were observed in multi-species flocks than either in single-species flocks or while solitary. Size of both single-species and multi-species flocks increased from September to January in the locust forest, but not in the oak wood. The difference between social behaviour in the two forests may have been related to the lack of territories in the locust forest.

T. Székely, Behavioural Ecology Group, Department of Zoology, Kossuth University, Debrecen, P. O. Box 5. H-4010, Hungary. T. Juhász, High School for Agriculture, Pallag, Debrecen, H-4010, Hungary.

1. Introduction

Social behaviour of tits during the non-reproductive period has attracted considerable attention recently (Brawn & Samson 1983, Hogstad 1988, Báldi & Csörgő 1993, reviews: Ekman 1989, Matthysen 1990). Although studies have revealed the adaptive value of flocking (Berner & Grubb 1985, Ekman 1987), much less is known about the relation between flocking and the environment (Ekman 1989). Flocking behaviour has been related to weather (Grubb 1987, Henderson 1989), food (Berner & Grubb 1985, Grubb 1987, Székely et al. 1989) and predator pressure (Székely et al. 1989). Although habitat may also influence social behaviour (Ekman 1989), this relation is poorly documented (but see Morse 1970). This paper investigates the effect of habitat on flocking behaviour of tits and associated species during the non-reproductive season.

2. Study area and methods

2.1. Study sites

Two forest plots were studied in East Hungary (47°35' N, 21°40' E), one dominated by pedunculate oak (*Quercus robur*) and the other by black locust (*Robinia pseudoacacia*). The distance between the two study sites was 0.5km and the altitude of both forests was 120-130 m a.s.l. In both forests the composition and height of trees were estimated within ten 10-m-diameter circles.

The pedunculate oak forest (11.5ha) was located 4.0km from Debrecen. The forest consisted of pedunculate oak

Tab. 1. Composition of multi-species flocks (mean±SD bird per flock). P values of Mann-Whitney U-tests are given (N=240). Species other than those listed included Long-tailed Tit (*Aegithalos caudatus*), Goldcrest (*Regulus regulus*), Middle Spotted Woodpecker (*Dendrocopos medius*), Lesser Spotted Woodpecker (*Dendrocopos minor*) and Grey-headed Woodpecker (*Picus canus*).

Species	Forest type		P
	Oak	Locust	
Great Tit (*Parus major*)	2.2±1.2	2.8±2.2	0.07
Blue Tit (*Parus caeruleus*)	1.5±1.0	10.3±10.2	<0.001
Marsh Tit (*Parus palustris*)	0.9±0.9	0.7±0.9	0.09
Nuthatch (*Sitta europaea*)	0.8±0.8	0.8±0.8	0.30
Treecreeper (*Certhia* sp.)	0.4±0.6	0.5±0.7	0.99
Great Spotted Woodpecker (*Dendrocopos major*)	0.2±0.4	0.5±0.6	<0.001
Other	0.2±0.5	0.9±2.0	
All	6.2±1.8	16.5±12.0	<0.001

(73.1%), and black locust (26.9%). The shrub layer consisted of maple *Acer tataricum*, box-elder *Acer negundo*, hawthorn *Crataegus monogyna* and elderberry *Sambucus nigra*. The height of trees was 22.4±1.5m (mean±SD).

The locust forest (17.7ha) was located 4.5km from Debrecen. That forest consisted almost exclusively of black locust (92.5%), but pedunculate oak (3.0%) and honey locust *Gleditsia triacanthos* (4.5%) also occurred. The only shrub was elderberry and the height of trees was 17.7±1.2m. During the study there was no bird-table within 1.5km of either forest.

2.2. Fieldwork

The two forests were visited on the same days or on consecutive days between 8 September 1986 and 23 January 1987. Observations were collected on 10-14 days in each forest in each month by one observer. Two-four hours were spent in the field on each day. We considered birds to be flocking either if one bird followed another one at least once, or if a cluster of birds moved together (Berner & Grubb 1985). Social behaviour was classified as multi-species flocking, single-species flocking or solitary. To avoid repeated records of the flocks on a day observations were made along circular routes in both forest, and a maximum of 7 social records were taken on a day (oak forest: 3.0±1.6 records/day; locust forest 2.6±1.3 records/day, mean±SD). In some cases the composition of a flock could not be recorded fully; such observations have been omitted. Since the two treecreepers *Certhia brachydactyla* and *C. familiaris* are difficult to distinguish in the field, their records were combined for analysis.

2.3. Statistical procedures

Social behaviour was considered to be independent between field days. This as-

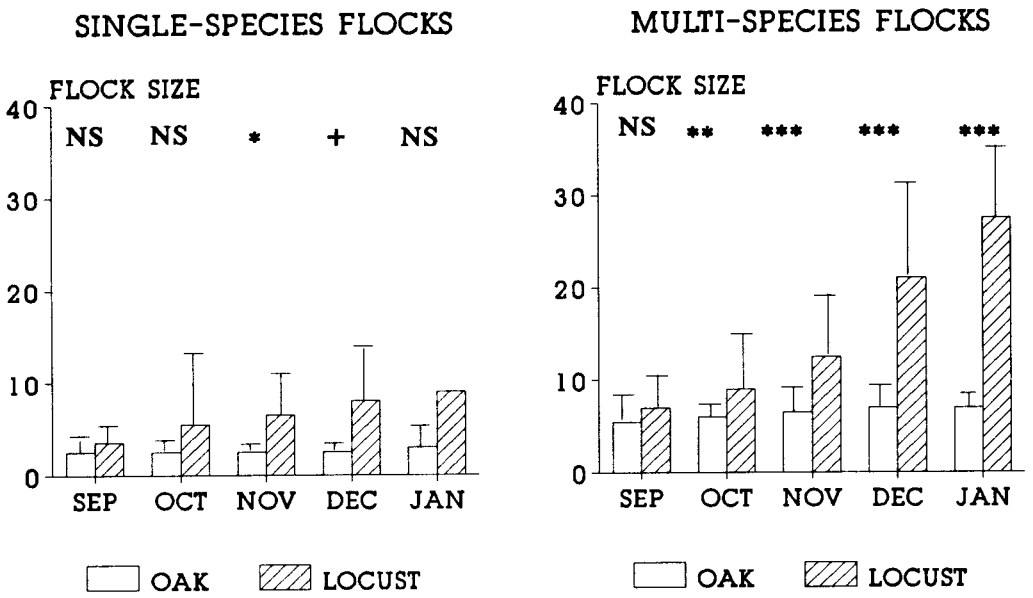

Fig. 1. Size of single-species and multi-species flocks in oak forest and in locust forest (mean±SD). Mann-Whitney U-tests between the two habitats, *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; + $p < 0.1$; NS $p > 0.1$.

sumption was based on our observations that solitary birds were observed to join and leave flocks, and that flocks were found to split and merge. Furthermore, size of multi-species flocks on a day was not related to those of previous field day provided the effect of days has been removed (multiple regression on the current flocksize (CURRENT) by both the previous flock size (PREVIOUS) and no. of days from 1 September (DAYS); oak forest: PREVIOUS $p>0.9$ and DAYS $p<0.03$, $N=46$; locust forest: PREVIOUS $p>0.23$ and DAYS $p<0.001$, $N=52$). Non-parametric statistics were used (Sokal & Rohlf 1981), and two-tailed probabilities and mean±SD are given. SPSS PC package was used for the analyses (Norusis 1986).

3. Results

Eleven species were found in flocks (Tab. 1). Multi-species flocks of locust forest included significantly more Blue Tit and Great Spotted Woodpecker than those of oak forest (Tab. 1). Size of both single-species and multi-species flocks was larger in the locust forest than in the oak forest (Fig. 1). The largest flock was seen on 7 January in the locust forest; it included 61 birds from 8 species, of which 45 were Blue Tits. From September to January, size of both single-species and multi-species flocks increased in the locust forest (Kruskal-Wallis tests, single-species flocks: $H=8.38$, $p=0.06$, $N=24$; multi-species flocks: $H=47.30$, $P<0.001$, $N=119$), whereas the flock size in oak forest did not

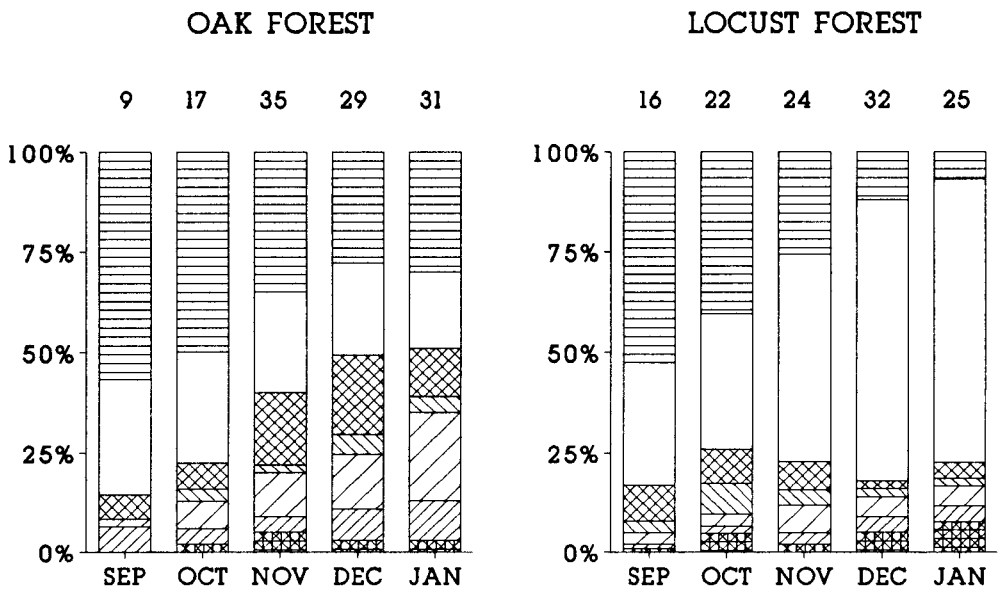

Fig. 2. Composition of multi-species flocks in oak forest and locust forest; Great Tit , Blue Tit , Marsh Tit , Great Spotted Woodpecker , Nuthatch , Treecreeper and other species . The number of flocks are given above the bars.

change (Kruskal-Wallis tests, single-species flocks: $H=0.53$, $p>0.95$, $N=30$; multi-species flocks: $H=4.87$, $p>0.28$, $N=121$). Composition of multi-species flocks changed during the winter (Fig. 2). Both Great and Blue Tits were less often seen in January than in September in the oak forest, while proportion of Blue Tits in multi-species flocks increased from 32.0% (September) to 72.2% (January) in the locust forest (Fig. 2).

Most birds were observed in multi-species flocks in both forests (Tab. 2), although more birds were seen in multi-species flocks in the locust forest than in the oak forest (Tab. 2). In the locust forest solitary birds were seen only twice from September to January, while in the oak forest solitary birds were encountered 13 times during the same period (G-test with Yates correction on frequency of three classes of social behaviour in oak forest vs. locust forest, $G_{adj}=6.65$, $p<0.01$, $df=2$).

4. Discussion

This study showed tits, particularly Blue Tit and associated species less often occur solitary and in single-species flocks in locust forest than in oak forest, and if they flock the flocks are larger in locust forest. We suggest the difference of social behaviour relates to the lower quality of locust tree forest both for feeding and breeding. Flocking behaviour is expected to relate inversely to food supply (Morse 1970, Berner & Grubb 1985, Grubb 1987). Black locust are introduced to Hungary, and these forests considered to have poor insect fauna. Brauns (1964) found the number of insect species is smaller in locust forest than in oak forest. Also, the locust for-

Tab. 2. Percent of observations of birds in multi-species flocks (number of birds both solitary and in flocks). The difference between the two forests is marginally significant (Wilcoxon matched-pairs signed test, $z=1.75$, $p=0.08$, $N=5$).

Month	Forest type	
	Oak	Locust
September	60.8 (79)	70.9 (141)
October	77.2 (123)	86.4 (236)
November	94.4 (230)	93.7 (320)
December	94.4 (197)	97.2 (678)
January	95.2 (208)	98.7 (694)

ests are poor breeding habitat (Török 1984), whereas the oak forests are typically primary breeding habitat (Perrins 1979). Due to the inferior quality of locust forest tits may not maintain territories in winter, only travel through in flocks. While in the oak forest territorial spacing of tits may prevent the formation of large flocks. Although this study emphasises the differences in social behaviour of tits and associated species between two habitats, the proximate and ultimate reason of differences need further studies.

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Összefoglalás

Cinegék (Parus spp.) és társult madarak csapatos viselkedése két élőhelyen

A széncinege *Parus major*, kékcinege *P. caeruleus*, barátcinege *P. palustris*, harkályok *Dendrocopos spp.*, csuszka *Sitta europaea*, és a fakusz *Certhia sp.* csapatos viselkedését vizsgáltuk Debrecen mellett egy tölgy- és egy akácerdőben szeptembertől januárig. Az akácerdőben az egyfajt és a többfajt tartalmazó csapatok több egyedből álltak, mint a tölgyerdőben; a legnagyobb csapat nyolc fajhoz tartozó 61 egyedből állt. Az akácos nagyobb csapatait főként a kékcinegék nagyobb száma okozta, habár ezen csapatok több széncinegét és nagy tarkaharkályt is tartalmaztak. Az akácosban kevesebb magányos madarat és egyfajú csapatot találtunk, mint a tölgyerdőben. Az egyfajú és a többfajú csapatok mérete szeptembertől januárig nőtt az akácerdőben, míg a tölgyerdei csapatok mérete nem változott. A csapatos viselkedés különbségét a két erdőben véleményünk szerint az akácerdő alacsonyabb minősége okozta. Az akácerdő valószínűleg roszszabb táplálékellátottságú mint a tölgyerdő, és kevesebb lehetőséget ad fészkelésre. Emiatt a cinegék nem szívesen tartanak fenn téli territóriumot az akácerdőben, míg a tölgyerdőben telelő cinegék territoriális viselkedése megakadályozhatja a nagy csapatok kialakulását.

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