

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

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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 Tree-creeper *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.

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

Tab. 1. Composition of multi-species flocks (mean $\pm$ 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 ( <i>Parus major</i> )	2.2 $\pm$ 1.2	2.8 $\pm$ 2.2	0.07
Blue Tit ( <i>Parus caeruleus</i> )	1.5 $\pm$ 1.0	10.3 $\pm$ 10.2	<0.001
Marsh Tit ( <i>Parus palustris</i> )	0.9 $\pm$ 0.9	0.7 $\pm$ 0.9	0.09
Nuthatch ( <i>Sitta europaea</i> )	0.8 $\pm$ 0.8	0.8 $\pm$ 0.8	0.30
Treecreeper ( <i>Certhia</i> sp.)	0.4 $\pm$ 0.6	0.5 $\pm$ 0.7	0.99
Great Spotted Woodpecker ( <i>Dendrocopos major</i> )	0.2 $\pm$ 0.4	0.5 $\pm$ 0.6	<0.001
Other	0.2 $\pm$ 0.5	0.9 $\pm$ 2.0	
All	6.2 $\pm$ 1.8	16.5 $\pm$ 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 $\pm$ 1.5m (mean $\pm$ 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 $\pm$ 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 $\pm$ 1.6 records/day; locust forest 2.6 $\pm$ 1.3 records/day, mean $\pm$ 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-

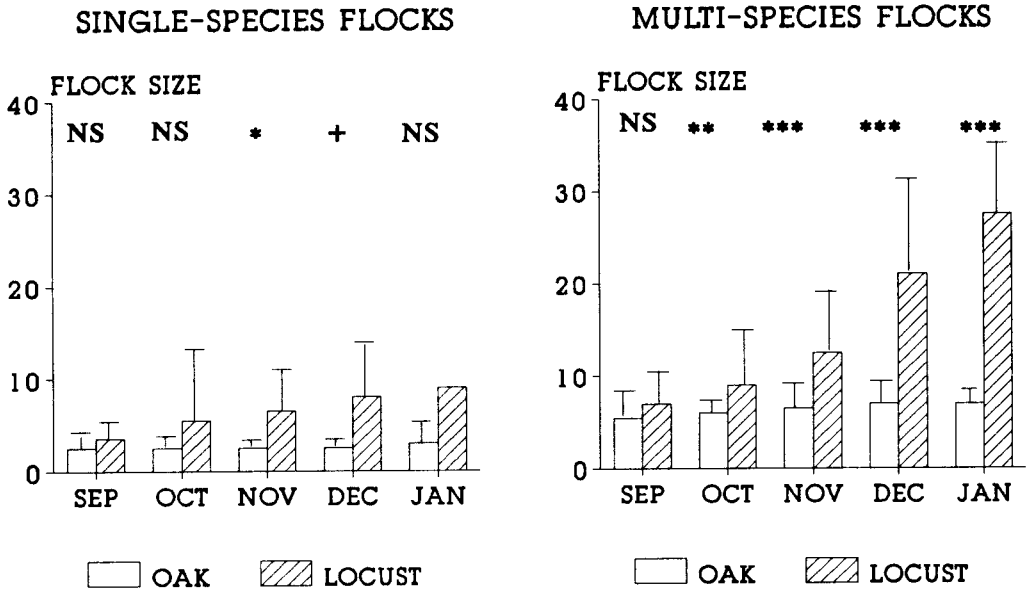


Fig. 1. Size of single-species and multi-species flocks in oak forest and in locust forest (mean  $\pm$  SD). Mann-Whitney U-tests between the two habitats, \*\*\*  $p < 0.001$ ; \*\*  $p < 0.01$ ; \*  $p < 0.05$ ; +  $p < 0.1$ ; NS  $p > 0.1$ .

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  $\pm$  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

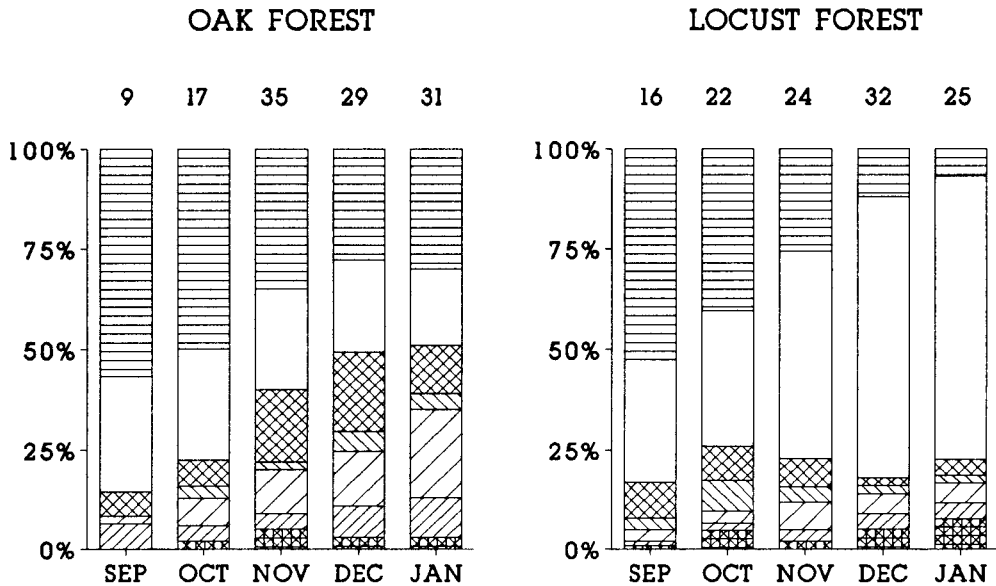









Fig. 2. Composition of multi-species flocks in oak forest and locust forest; Great Tit , Blue Tit , Marsh Tit , Great Spotted Woodpecker , Nuthatch , Treecreeper  and other species . The number of flocks are given above the bars.

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 behav-

iour 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 csoportos viselkedése két élőhelyen

A széncinege *Parus major*, kékcinege *P. caeruleus*, barátcinege *P. palustris*, harkályok *Dendro-*

*copos spp.*, csuszka *Sitta europaea*, és a fakusz *Certhia sp.* csoportos viselkedését vizsgáltuk Debrecen mellett egy tölgy- és egy akácerdőben szeptembertől januárig. Az akácerdőben az egyfajta és a többfajta tartalmazó csapatok több egyedből álltak, mint a tölgyerdőben; a legnagyobb csapat nyolc fajhoz tartozó 61 egyedből állt. Az akácok nagyobb csapatait főként a kékcinegék nagyobb száma okozta, habár ezen csapatok több széncinegét és nagy tarkaharkályt is tartalmaztak. Az akácokban kevesebb magányos madarat és egyfajta csapatot találtunk, mint a tölgyerdőben. Az egyfajta és a többfajta csapatok mérete szeptembertől januárig nőtt az akácerdőben, míg a tölgyerdei csapatok mérete nem változott. A csoportos viselkedés különbségét a két erdőben véleményünk szerint az akácerdő alacsonyabb minősége okozta. Az akácerdő valószínűleg rosszabb 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 territóriális viselkedése megakadályozhatja a nagy csapatok kialakulását.

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# Social dominance in the resident part of a Great Tit (*Parus major*) population in winter

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Social dominance and mortality was studied in wintering Great Tits in a Central-European alder forest. We carried out nocturnal checkings to determine residency of tits. Roosting boxes are assumed to be an essential part of the resources, therefore that sex and age class, which can occupy the boxes for longer time is dominant over the others. The dominance order is as follows: adult male, adult female, immature male and immature female in descending order of dominance.

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## 1. Introduction

Winter survival of the temperate-zone *Parus* species may depend on the ability to hold roosting cavities. Cavities are assumed to be an essential part of the resources, because they provide protection against inclement winter weather and predators (Drent 1987, Bakken 1990). However, the number of cavities are limited. As the social dominance in birds may depend on the resource holding power (Maynard-Smith 1982), that species, sex or age class which can hold the cavities for a longer time can be assumed to be dominant over the others.

This study was made to investigate the within species dominance relations of resident wintering Great Tits (*Parus major*) in an Alder wood in Central Hungary, based on the ability of birds to hold a roost hole. That sex/age class was considered to be dominant over the others, where the relative abundance of individuals increase, that is which class can

hold this part of the resource for a longer time.

## 2. Study area and methods

The study was conducted in the Ócsa swamp region in Central Hungary (47°15'N, 19°15'E). The study area was a small (7 ha) woodlot of alder (*Alnus glutinosa*), surrounded by bushes and reeds, therefore we can assume that the number of natural holes are negligible. Hundred nestboxes were put into the patch in the beginning of 1986.

To avoid the consequences of the resident – floater dichotomy on dominance, we studied only the resident part of the population. For this goal we carried out nocturnal checking, which is an appropriate method to distinguish the stable part of the population (Schmidt et al. 1985, Báldi & Csörgő 1991). The number of recaptures was used as a measure of residency. Ranking order was given to age- and sex classes according to their

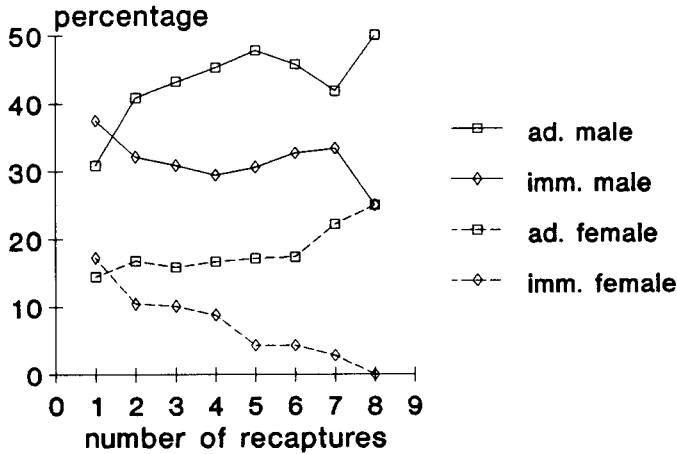


Fig. 1: Changes in composition of resident population of Great Tits based on the number of recaptures of individuals in winter nocturnal checkings (total number of individuals = 255). The values on the horizontal axis reveal to eight 'sub-populations' where all individuals were recaptured at least once, twice etc. The horizontal axis (1-8) can interpret as a scale for increasing residency.

residency. The nestboxes were checked every fortnight after nightfall to record roosting tits. Near to the nestbox area tits were captured by mistnets at a bird feeding station to collect sample from the total (resident and floater) population. The survey went on from December to March in winters from 1986/87 to 1989/90. Data from the winter of 1987/88 were excluded because of a sudden disease, which decimated the roosting population of tits (Báldi & Csörgő 1992). Data from the other three winters have been pooled.

### 3. Results

Three species were recorded to roost in the nestboxes. The great majority of roosting birds were Great Tits, there were altogether 693 records of 255 individuals. Blue Tits (*Parus caeruleus*) and Tree Sparrows (*Passer montanus*) were recorded rarely, altogether 22 and 11 records, respectively. The number of records of resident Great Tits were ex-

tremely high, from the total 693 records 675 belonged to already ringed individuals in the nestboxes or at the feeding station. The number of recaptures in the Blue Tit and Tree Sparrow were 16 and 1, respectively. As we pointed out in the introduction, that sex and age class of the resident Great Tits, which can occupy the nestboxes for a longer time is dominant over the others (Fig. 1). The

Tab. 1: Equations of the fitted lines on the curves of Fig. 1. The slope of the lines can interpret as a measure of dominance, because they indicate the ability to roost in nestboxes for longer time. (Multiple stepwise regression analysis, independent variable: time, dependent variables: age and sex classes. Regression coefficient, Y-intercept and p are given.)

	Regr. coeff.	Intercept	p
adult males	1.78	35.14	0.0341
adult females	1.26	12.56	0.0047
immature males	-0.89	35.43	0.1057
immature females	-2.15	16.95	0.0001



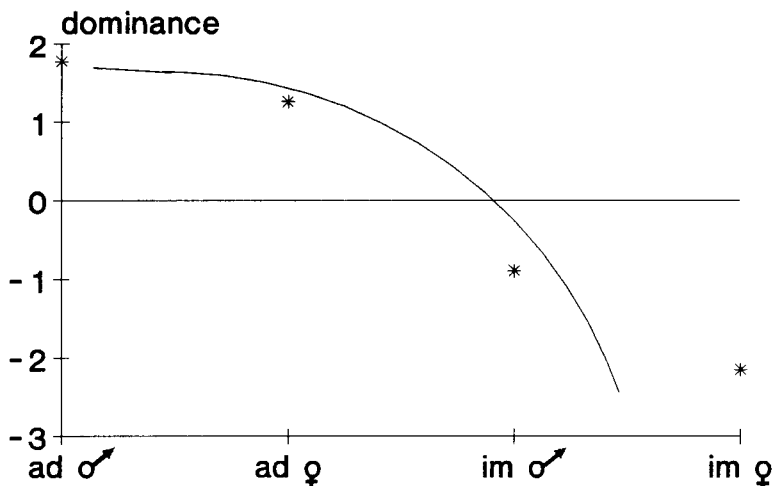


Fig. 2: Proposed model for dominance in the resident part of a Great Tit population in winter (cf. Fig. 8 in Gosler 1987). The values are the slope of lines derived from Tab. 1. (See text for further explanations.)

slope of the fitted lines (Table 1) can interpret as a measure of dominance, because it shows the changes of relative abundance of sex and age classes in more and more resident 'sub-populations'. Thus the winter dominance hierarchy in the resident part of this Great Tit population is as follows: adult males, adult females, immature males and immature females in descending order of dominance. Within age class the distance between sexes was smaller in the adults than in the immatures (Fig. 2).

#### 4. Discussion

Many studies have investigated intraspecific dominance in tits (see Perrins 1979, Ekman 1989, Matthysen 1990). In these studies often only within age/sex class comparisons were made. The following main results have been obtained between groups: males are dominant over females in age class, and adults over juveniles in sex class. Similar results have

been shown for other passerine species, as well (e.g., Enoksson 1988, Cristol et al. 1990, Senar et al. 1990). Within age/sex classes resident individuals are dominant over floaters (Drent 1987, Nilsson & Smith 1988, Desrochers & Hannon 1989, Nilsson 1989, Sandell & Smith 1991). However, there remain uncertainties, for instance the relationship between adult females and immature males. Kluyver (1957) pointed out that adult females are dominant over immature males in the Great Tit, which is supported by this study, but other studies did not strengthen this result (Saitou 1979, Drent 1983, Gosler 1987). When residency is also taken into account the relationships became less clear (e. g., who is dominant, a resident immature female, or a non-resident adult male). Sandell & Smith (1991) studied this problem on male Great Tits in aviary experiments. They found that prior residency determined dominance in age class, but when resident juvenile birds were interacting with late established

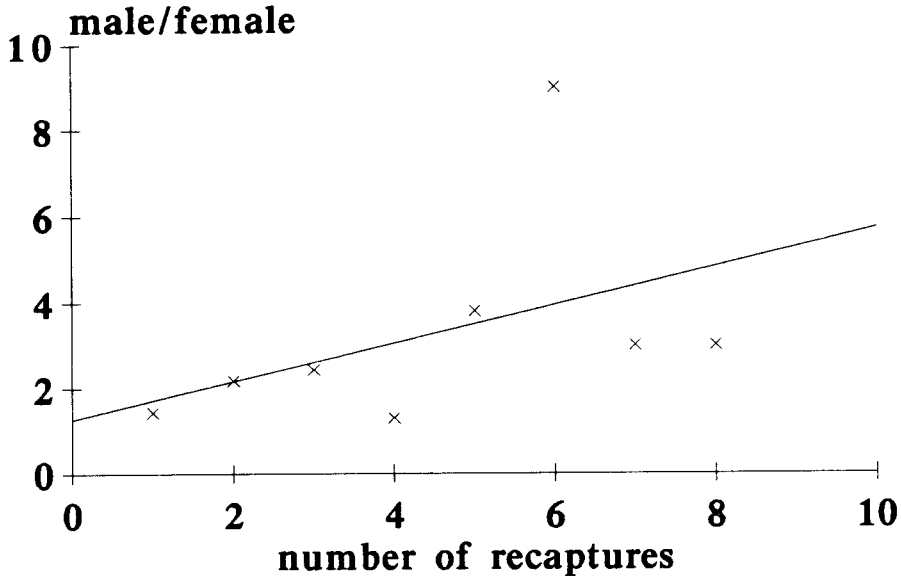


Fig. 3: The changes of male/female ratio in the resident part of a Great Tit population. The fitted line suggests that the proportion of females decreasing, as we sampled more and more resident sub-populations.

adults, the formers often became dominant. However, only experiments can provide such 'simple' cases, in the field, where the whole range of residency, age and sex are acting in determining dominance, the situation seems to be more confused.

The results of our study seem to be in contradiction with findings of Gosler (1987). He proposed a model relating feeding niche and morphology to dominance. His model explained the variation in bill-index between tit classes, and other morphological variations, as well. However, his dominance order was: adult male, immature male, adult female and immature female, in decreasing order of dominance (Gosler 1987), as has been reported by Drent (1983) for this species, whilst this seems to be contradictory with our results. However, in Gosler's study the winter samples were taken from the whole population, not

only from the resident part. Therefore we may suppose that if we did not distinguish between the resident and non-resident part of the population, we might get similar results. The deviation between our results and those of Gosler's (1987) may reflect the importance of considering residency as a crucial factor in winter dominance. To justify our hypothesis on the differences between this study and that of Gosler's (1987) we try to analyse those data, which were collected at the bird feeders near to the nestbox area. Nevertheless, there were not enough recaptures to do the same analyses as in the case of roosting tits. In fact, the feeders were 300 m apart from the nestbox area, therefore resident tits were usually recorded in the nestboxes as well, so after separation of roosting and 'feeding' (recorded only at feeders) tits, no birds occurred who were resident in winter, but did not roost in the nest-

boxes. This result shows that the artificial feeding, which has been reported as crucial factor in winter survival of North-European Great Tit populations (see Orell 1989) is not as significant in this Central-European population.

There is an alternative hypothesis to explain the differences in dominance relationships between Gosler's and this populations. Ekman (1990) found that dominant male Willow Tits (*P. montanus*) provide their mates with protection in winter, therefore these females survived better than low-ranked males even though they were subordinate in direct interactions. May be a similar situation exist in this Central-European Great Tit population, because there is a tendency to be paired in winter, as the mates use nestboxes to roost in near proximity (Báldi pers. obs.). Therefore we can assume that the increasing relative abundance of adult females is a consequence of providing roosting sites to their mates by the adult males. Hence a similar correlation between partners, as described by Ekman (1990) could lead to age appearing more important than sex as a determinant of social status.

It has been recognised that mortality of females is greater than that of males in the Great Tit (Bulmer & Perrins 1973, Orell & Ojanen 1979), but this greater mortality was attributed to predation and breeding trials in the breeding season (Bulmer & Perrins 1973). However, our results suggest that mortality of females may be greater in the non-breeding season also, at least in the resident part of the population, because the ratio of males to females increased as residency increased (Fig. 3). We assumed that mainly the mortality is responsible for the disappearance of tits for two reasons. First, we studied the resident part of the population, where

the proportion of recaptures was very high (see results). Second, the study area has been a forest patch, that is a habitat-island, where the dispersion may be smaller than in a continuous large forest.

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## Összefoglalás

### Dominancia-viszonyok egy téli széncinege (*Parus major*) populációban

Az ócsai égerlápon 1986 és 1990 között vizsgálatokat végeztünk telelő széncinegéken. A terepmunka során kéthetente sötétedés után a mesterséges fészekodúkban éjszakázó cinegékét regisztráltuk. Alapfeltevésvünk szerint a fészekodúk az erőforrások lényeges részét képezik, mert védelmet nyújtanak a ragadozók és az időjárás viszonyosságok ellen. Dominánsnak azt az ivar illetve korcsoportot tartjuk, amelyik relatív gyakorisága nő a tél folyamán az odúkban, hiszen a dominancia az erőforrásokból történő részesedésen alapul. Az így kapott dominancia sorrend: öreg hím, öreg tojó, fiatal hím és fiatal tojó, csökkenő sorrendben. Ez több eddigi eredménytől eltérő, ennek lehetséges okait tárgyaljuk.

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# A note on the social behaviour of rehabilitating wild Barn Owls (*Tyto alba*)

D. Csermely and N. Agostini

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The social behaviour of wild Barn owls (*Tyto alba*) was studied in captivity during rehabilitation before their release back into the wild. The birds showed several kinds of interactions, but none very aggressive. The introduction of a strange Barn owl did not cause an increase in aggression, but rather a more complex system of behaviour interactions. The behaviour patterns displayed suggest that this species possesses an "avoidance order" rather than a "dominance order". The evolutionary implications of such social structure, possibly derived from a more sociable ancestor, are discussed.

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## 1. Introduction

Studies on the social behaviour of the Barn owl (*Tyto alba*) are scarce in the literature. Close monitoring of Barn owls in the wild is laborious and perhaps, because of this, most of the studies dealing with the social behaviour of this species have been carried out in captivity (e.g. Harrison 1965, 1969; Trollope 1971). Other aspects of inter-individual behaviour of Barn owls studied in the wild mainly refer to the breeding cycle, such as pair bonding and raising of young, with little information on the social behaviour (Bunn et al. 1982; Cramp 1985; Marti 1989).

This paper deals with a description of intraspecific patterns of behaviour in wild Barn owls in captive conditions in order to increase our knowledge of the social behaviour of the species. In fact, at the Raptor Rehabilitation Centre (RRC) of Parma (Italy) many individu-

als can be kept routinely in the same pen during the rehabilitation period without particular problems of husbandry. This is surprising since the Barn owl is an essentially territorial species. Nevertheless, the high density of birds that is sometimes found in the pens does not appear to be detrimental to the rehabilitation success itself. The high density is often a necessity due to the high number of owls of several species arriving and the consequent lack of suitable space for them.

We then wanted to investigate how those birds cope with the clearly unnatural context and which type of behaviour strategy and social structure they develop for a peaceful cohabitation with particular attention to the possible changes in behaviour when a strange individual is inserted in the group. In addition, we noted from the literature that some displays have been interpreted differently by different workers. Hence, us-

ing the transition analysis of the behaviour patterns we intended to find a more objective interpretation of them and of their motivation.

## 2. Material and methods

The study was carried out on six wild captive Barn owls (4 adults and 2 young) housed at the Raptor Rehabilitation Centre (RRC) managed in Parma by the Italian Society for the Protection of Birds (LIPU). The owls present at the RRC were recovering from various types of injuries (poaching, accident, etc.). Nevertheless, those used in this study had fully recovered and their behaviour, such as flight and general activity, was normal. Hence, they were in perfect conditions and, in fact, were ready for release in the wild.

The sex of the adults was not taken into account, as no reliable method of sexing was found in the literature (Cramp 1985). They were individually recognized by coloured plastic rings. Some other owls of different species but similar in size were housed in the pen: 11 Tawny owls (*Strix aluco*), 2 Long-eared owls (*Asio otus*), and 2 Short-eared owls (*Asio flammeus*).

The Barn owls had already settled down, for they had been housed together for 35 days before the start of the study. The birds were kept in a pen (approximately 4.60 x 4.60 m in size) with concrete floor and provided with three perches inserted obliquely in the pen sides at 1.80 m height. The owls were observed from a blind, fully lined with black sound-absorbing material, at the entrance door. The opening was covered by a thin plastic net (1 mm mesh). The birds were fed twice daily with one chicken carcass per bird, put on a plat-

form (0.73 m in size) located in the middle of the pen. Two open barred windows (0.95 x 1.15 m) were located at the rear side of the pen. A red lamp (100 Watts) was used to identify the birds and observe their activity.

The frequency of interaction and the identity of the birds involved were considered as well as the type of the behaviour patterns displayed. These were as follows: APPROACH (AP)(the close approach to a penmate causing a response, but without a contact between them); DISPLACEMENT (DI)(a bird perches close to another and pushes it with the body, hitting with the flank or wing strikes); THREATENING (TH)(the approach to an individual with a jump or a quick walk, or with a stretching out of the neck emphasizing the bill; the latter pattern was sometimes recorded also while standing, Fig. 1); PHYSICAL-CONTACT (PC)(the close approach to a penmate with a contact between them); ALLOPREENING (AL)(the bill is rubbed against the feathers of another individual); BILL-BILL interaction (BB)(a reciprocal contact with the bills, Fig. 2); AGGRESSION (AG)(striking an opponent bird with the bill or grasping it at the head or neck with the leg, Fig. 3); NO-REACTION (NR)(self-explaining); RETREAT (RE)(the withdrawal from an approaching or interacting penmate).

The whole experiment was carried out from mid-autumn to the end of winter to avoid disturbing effects arising from the reproductive period. The observation sessions lasted 120 min., starting one hour before sunrise and sunset respectively. The starting time was then varied according to their exact moment in every day. The birds were observed for a total of 60 hours, equally divided between the

Fig. 1: The threatening posture, with stretching out of the neck and emphasizing the bill.

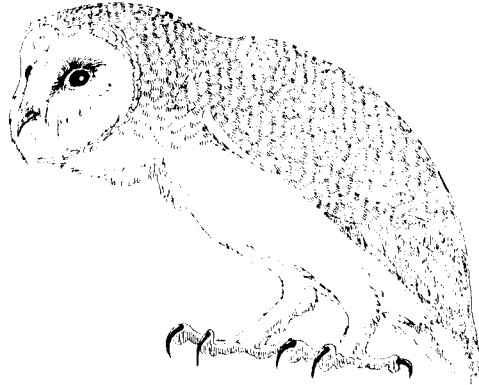


Fig. 2: The rubbing phase of the Bill-Bill interaction.

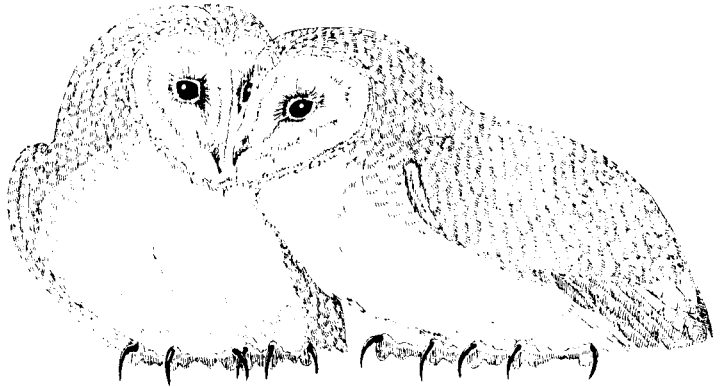


Fig. 3: The aggression by grasping the opponent with the foot.



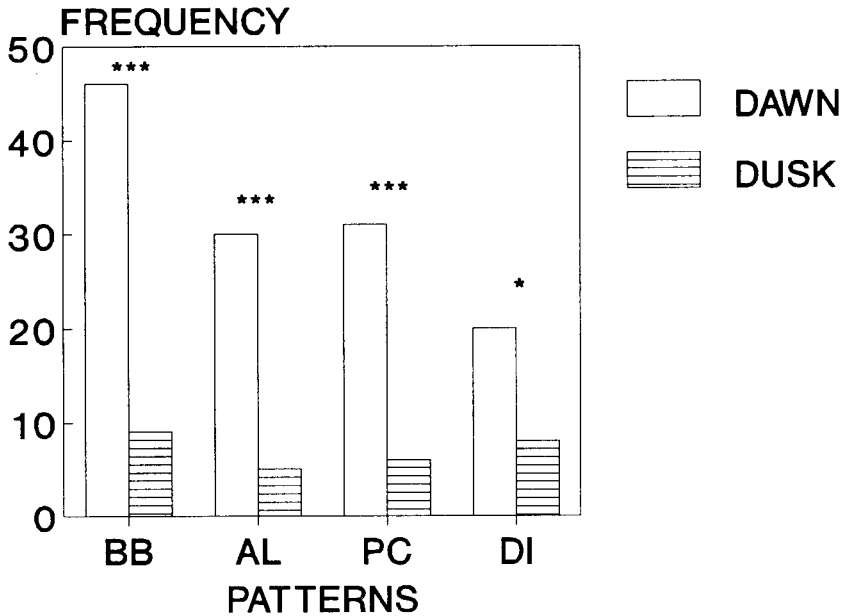


Fig. 4: The observed frequency of several patterns recorded at dawn or dusk during the first group of observations. Only the patterns with significant differences are shown. \* =  $p < 0.05$ ; \*\*\* =  $p < 0.001$ .

sunrise and sunset periods. A constant frequency of two daily sessions was maintained for the whole experiment.

Each bird was then tested in individual predatory tests with a live prey (a laboratory mouse with Agouti phenotype). The tests were carried out in the same enclosure and with the same procedure as described elsewhere (Csermely et al. 1989, 1991).

A second period of observations was then carried out with the same procedure as the previous one. It started immediately after inserting in the pen containing all the above birds, a strange adult Barn owl which had been at the RRC for 110 days, but had never been in contact with the other conspecifics. An additional 40 hours of observation were conducted, again equally divided between dawn and dusk sessions.

The statistics performed for the behaviour analysis were the Wilcoxon

Signed Ranks Test (Siegel 1956), the Chi-square test and the Chi-square component  $z$  value, following the method described by Bishop et al. (1975). The latter method was used for analyzing the transitions between the behaviour patterns and, to our knowledge, was not applied in previous studies on these birds. It can be very useful for giving a clearer insight into the motivation of the displays performed by the owls.

### 3. Results

In the first set of observations, a total of 202 interactions were recorded, involving all the Barn owls at least once. The mean frequency of interaction/bird/hour was very low ( $0.71 \pm 0.21$  SE). Some patterns were performed more often ( $\chi^2$  test) at dawn than at dusk (Fig. 4), particularly those with a typical social



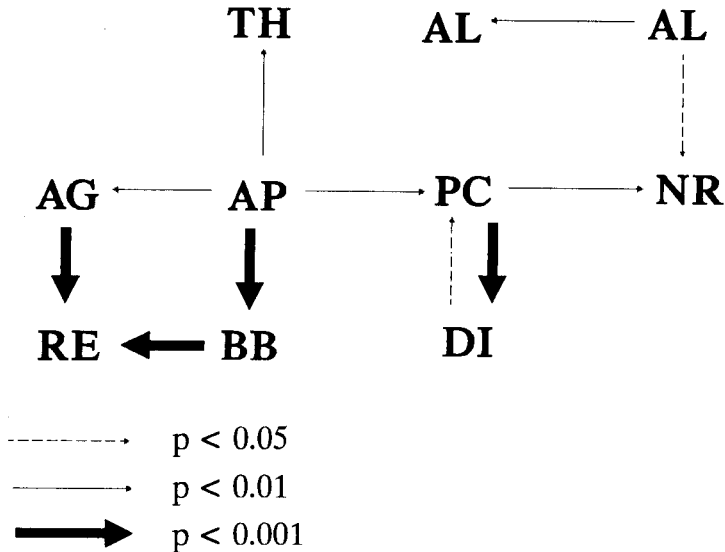


Fig. 5: The flow chart for the transitions of behaviour patterns recorded during the first group of observations using the Chi-square component  $z$  value. AP: Approach; DI: Displacement; TH: Threatening; PC: Physical-Contact; AL: Allopreening; BB: Bill-Bill interaction; AG: Aggression; NR: No-Reaction; RE: Retreat.

motivation, such as BILL-BILL interaction and ALLOPREENING. The behaviour patterns considered were not performed randomly by the birds initiating the interaction ( $\chi^2 = 61.211$ ,  $df = 6$ ,  $p < 0.001$ ). They performed more often than expected ( $\chi^2$  component  $z$  value) ALLOPREENING ( $p < 0.05$ ), PHYSICAL-CONTACT ( $p < 0.05$ ), and BILL-BILL interaction ( $p < 0.001$ ). The same occurred for the birds that were approached by the initiating ones; they performed mostly RETREAT ( $p < 0.05$ ) and above all NO-REACTION ( $p < 0.001$ ). AGGRESSION was rarely recorded (13 [6.44%] interactions performed either by the initiator or by the receiver).

Again, the observed frequencies for the behaviour response given by the approached individuals differed greatly ( $\chi^2 = 275.537$ ,  $df = 7$ ,  $p < 0.001$ ). The behaviour transitions recorded were com-

pared to their expected ones using the  $\chi^2$  component  $z$  value and are shown in Fig. 5. All the patterns are connected with each other and most of them are connected with APPROACH.

The analysis of the feeding behaviour did not reveal any order between the Barn owls concerning the visits on the platform whether collecting a chicken or not. In fact, although they landed repeatedly there after the chicken carcasses were put onto it, they did not always take the "prey". Two birds only (NN and -N) scored a significantly higher frequency of visits to the platform collecting the chicken ( $p < 0.01$  and  $p < 0.05$  respectively,  $\chi^2$  test). They performed most of the recorded BILL-BILL interactions and PHYSICAL-CONTACT, but at the same time they received most of DISPLACEMENT, PHYSICAL-CONTACT, and ALLOPREENING. Those two birds were also successful in catching a live mouse dur-

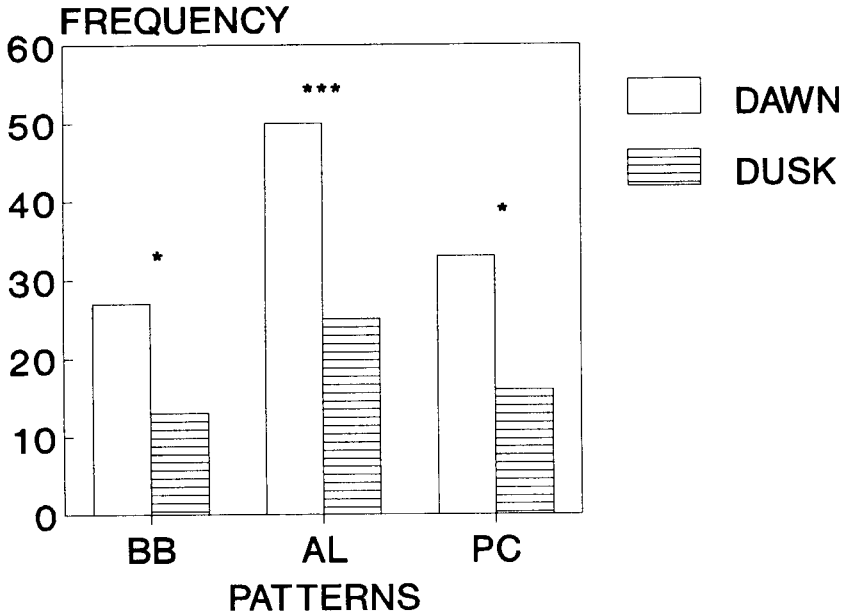


Fig. 6: The observed frequency of several patterns recorded at dawn or dusk during the observations after the insertion of the strange Barn owl. Only the patterns with significant differences are shown. \* =  $p < 0.05$ ; \*\*\* =  $p < 0.001$ .

ing the individual predatory tests. This was not so for all the others, not because failed or were not able, but simply because they refused to prey.

Even in the second set of observations, i.e. after the introduction of a strange Barn owl (2N), all the birds interacted reciprocally at least once. A total of 309 interactions were recorded, with a mean frequency/bird/hour just a little higher than in the previous phase ( $1.11 \pm 0.26$  SE,  $p > 0.1$ ). Once again, as described above BILL-BILL interactions, ALLOPREENING, PHYSICAL-CONTACT, but not DISPLACEMENT were recorded more often at dawn than at dusk (Fig. 6). The use of the patterns was not random ( $\chi^2 = 49.362$ ,  $df = 6$ ,  $p < 0.001$ ) during the interactions. The initiating birds displayed ALLOPREENING and DISPLACEMENT more often than expected ( $p < 0.001$  and

$p < 0.01$  respectively,  $\chi^2$  component  $z$  value). On the other hand, in response, the receiver birds did not display the patterns considered with the same frequency ( $\chi^2 = 532.243$ ,  $df = 7$ ,  $p < 0.001$ ). They used again mostly RETREAT ( $p < 0.05$ ) and NO-REACTION ( $p < 0.001$ ).

The behaviour transitions recorded with a significant frequency were almost similar to those recorded in the first observations (Fig. 7). Apart from the partial different visual aspect of this Figure from Figure 5, the several patterns have similar connections. During the second one we note that BILL-BILL interaction was not displayed more particularly by the approaching animal, but was just a response to APPROACH and AGGRESSION. Besides, RETREAT was no more caused by BILL-BILL interaction, than by THREATENING and

PHYSICAL-CONTACT, together with AGGRESSION as previously. Finally, ALLOPREENING was not performed almost exclusively as a reciprocal pattern, as observed in the first period, but was strongly elicited by APPROACH and in turn caused NO-REACTION.

The newly introduced Barn owl interacted with all the others. Mainly it was allopreened (28.0% of all recordings) and displaced (23.7% of recordings). That bird displayed the patterns without any particular preference and did not interact preferably with any other Barn owl.

Even after the introduction of a strange individual it was not possible to detect a particular order among the birds concerning the approach to the platform during the periods when the chickens were available. When landing on the platform they took the chickens

less often than during the first observation period ( $z = -2.02$ ,  $p < 0.05$ , Wilcoxon Signed Ranks Test). Only the newly introduced Barn owl showed a significantly higher frequency of visits collecting the chicken ( $\chi^2 = 6.545$ ,  $p < 0.025$ ).

#### 4. Discussion

The Barn owl seems then to be a species well adapted to living in groups, even when kept at high density. The interactions tend to occur mostly at dawn, i.e. at the end of the major period of activity, suggesting a similarity with the roosting behaviour of many diurnal species. It is possible that most interactions have a motivation for reciprocal recognition and renewal of the reciprocal social rank among the group. In fact, they occur

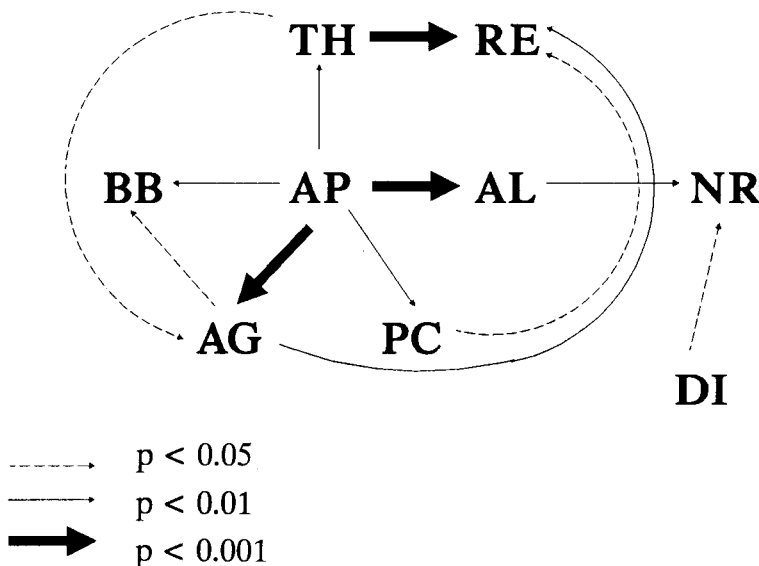


Fig. 7: The flow chart for the transitions of behaviour patterns recorded during the observations after the insertion of the strange Barn owl using the Chi-square component  $z$  value. AP: Approach; DI: Displacement; TH: Threatening; PC: Physical-Contact; AL: Allopreening; BB: Bill-Bill interaction; AG: Aggression; NR: No-Reaction; RE: Retreat.

above all, i.e. with higher frequency, at dawn when, after a prolonged period of activity, the birds come to roost together before the sleeping period. In a natural context the activity would cause the dispersion of birds, which regroup again before resting. Their habit to rest at close contact with each other suggests also that they can have preferred penmates among the group.

The patterns displayed by the birds initiating the interactions are rarely aggressive. In fact, ALLOPREENING, BILL-BILL interactions, and PHYSICAL-CONTACT entail a contact between two individuals, but do not necessarily entail a preceding attack. The BILL-BILL interaction was recorded much more commonly than AGGRESSION. We believe that it is likely either a trial of strength or a means of individual recognition, thus to be allocated among the social, or at least dominance, behaviours. In fact it is performed rarely as a reciprocal pattern but generally as response to a close approach by a penmate. The BILL-BILL interaction resembles what Trollope (1971) quoted as "bill fencing", who nevertheless considered it as a form of play among the owlets or "inefficient aggression". On the other hand, we do not believe that the interpretation given by Bunn et al. (1982), who described it as a "ritualized feeding" used as "appeasement gesture", fits our data completely. Possibly it derived from the feeding context, but it is not used for placating the opponent aggression.

ALLOPREENING is a well-known behaviour and has been recorded both in the wild and in captivity (reviews by Harrison 1965, 1969; Forsman and Wight 1979). It has been particularly associated with sexual behaviour (Martin 1974; Smith et al. 1982; Cramp 1985)

and with agonistic behaviour in general (Harrison 1965; Forsman and Wight 1979). From our data we believe that ALLOPREENING is related to the agonistic behaviour, as already hypothesized by Forsman and Wight (1979); in particular it has a great importance in reciprocal recognition, maybe for rank establishment. We confirm that ALLOPREENING, in addition to being silent, was sometimes performed in a very "exaggerated" form, as observed by Trollope (1971). It must also be noted that ALLOPREENING was infrequently performed reciprocally, as instead one would expect if it is not part of agonistic behaviour.

In addition, the approached Barn owl did not respond aggressively, but just with a retreat or with no reply at all. The reluctance to use aggressive patterns is shown also by the virtual absence of increase in the frequency of interaction following the introduction of a strange conspecific. They continue to maintain the same level of activity and display the same patterns as before such an introduction. Only the increase in number of behaviour transition types shows that the new bird is being inserted into the group. Such an increase of transitions very likely shows nevertheless that some sort of social hierarchy does exist among the Barn owl group and that a rearrangement of the reciprocal ranks is in progress.

The newly introduced Barn owl was probably located low in the social hierarchy as well as birds -N and NN. In fact, they all were characterized by frequently receiving ALLOPREENING and DISPLACEMENT. Moreover, they had the strong tendency to feed directly on the platform instead of returning to the perch for the ingestion of the chicken. A high ranking Barn owl is probably de-

fending a personal portion of the perch and makes only short visits to the platform. In particular, it does not remain there for long time feeding on the chickens. Low ranking individuals, on the contrary, will remain to feed on the platform in order to receive less disturbance such as displacement, by high ranking penmates if they return to feed on the perch.

The very high use of nonaggressive patterns by both the initiating and the recipient birds shows a social system connected primarily with the avoidance of other birds rather than with the domination behaviour. We do not believe that previous injuries affecting the owls could account for their lack of aggression or dominance, since the birds were all in perfect conditions and ready for release.

From this point of view the social system of the Barn owl seems very similar to that observed in pig (*Sus scrofa*) females. Although the two species are obviously very different, this does not mean that it is not possible to find a similarity in some aspects of the social organization. Groups of captive sows display a very low aggressiveness (Csermely and Wood-Gush 1986) and their hierarchical system was defined by Jensen (1982) as "avoidance order", compared to the more common "dominance order" of many other species. In fact, the social behaviour is regulated by the submissive patterns displayed by the individual being approached by the dominant individual. As a result, the social ranks can be very easily detected just by recording the submissive postures shown by each individual.

As a support to this hypothesis there is the composition of the sows' social group. When allowed to live in the wild or at least in free-ranging conditions,

they group into 3-5 individuals, with coordinated activities, but spaced out evenly for feeding, and with very low level of aggression (Jensen and Wood-Gush 1984). This description fits very well our data on the behaviour of Barn owls, possibly also in natural conditions, although the birds are found at much lower density. Nevertheless, it is also possible to raise the hypothesis that the Barn owl was originally more sociable than today and evolved progressively towards a strictly territorial species, as we observe nowadays, maybe because of ecological or predatory pressures that led to the necessity to space out the individuals.

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## Összefoglalás

### Fogságban tartott gyöngybaglyok (*Tyto alba*) társas viselkedése

A sérült madarak rehabilitációjával foglalkozó "Ragadozómadár Rehabilitációs Központban" (Raptor Rehabilitation Centre, Parma, Olaszország) fogságban tartott gyöngybaglyok társas viselkedését tanulmányoztuk. A madarak már egészségesek voltak, s egy közös röpdében tartózkodtak a szabadon eresztés előtt.

A baglyok változatos viselkedésformákat mutattak, de közöttük az agresszivitás mértéke igen csekély volt. Ez feltehetőleg a csoportos élethez

történt egykori alkalmazkodásra utal, mely az evolúció során a ma megfigyelhető territorialitás felé fejlődött.

Az egyedek közötti kölcsönhatások hajnalban, tehát az aktív periódus végén voltak gyakoribbak. Egy idegen gyöngybagoly behelyezése a rőpdébe nem növelte az agresszív viselkedés gyakoriságát, helyette sokkal összetettebb viselkedésmintázatok alakultak ki. Mindezek azt sugallják, hogy a gyöngybagolynál nem "dominancia sorrend", hanem "elkerülési sorrend" alakul ki.

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# Egy dél-alföldi gyurgyalag (*Merops apiaster*) populáció kor-struktúrája, költés- és táplálkozás-vizsgálata\*

Gyovai Ferenc

Gyovai, F. 1993. Age structure, breeding and foraging biology of Bee-eaters (*Merops apiaster*) in Hungary. – Ornis Hung. 3:23-32. (In Hungarian with English abstract.)



We studied Bee-eaters (*Merops apiaster*) in a sand-pit in SE Hungary. The distinction between males and females was based on the green belt of the lesser coverts. Mortality was 33% in all age classes. Twenty-seven percent of adults returned to the colony each year, but only 0.4% of young females and 5.9% of young males returned. The breeding pairs preferred the flat or convex vertical walls, without plant cover. Pairs breeding in hard-set sand had shorter nesting holes, and started the breeding about 13 days later, than those nesting in loose sand. The wing length of nestlings showed a linear increasing curve, but body weight showed a unimodal curve, with the peak at 20 day after hatching. The weight of nestlings decreased until they left the nest at age of 30 day. There were  $5.06 \pm 1.29$  fledglings per nest. We observed three cases (two males and one female), when a helper took part in feeding.

There were 78% *Hymenoptera* in the food of a breeding pair. Both diversity and equitability of food were low (Shannon-Wiener diversity measure,  $H' = 0.693$ , equitability,  $J = 0.356$ ). The size of prey items were between 9 and 82mm, with an average of  $\bar{x} = 18.1 \pm 9.6$ mm. The feeding activity was 34.4 feeding/hour in the morning. The male and female showed similar activity.

Management implications for the conservation of Bee-eaters should include (i) the preservation and creation of steep sand or loess walls; (ii) the removing of vegetation; (3) the prohibition of anthropogenic disturbances; and (iv) the strict protection of the colony in the breeding season.

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## 1. Bevezetés

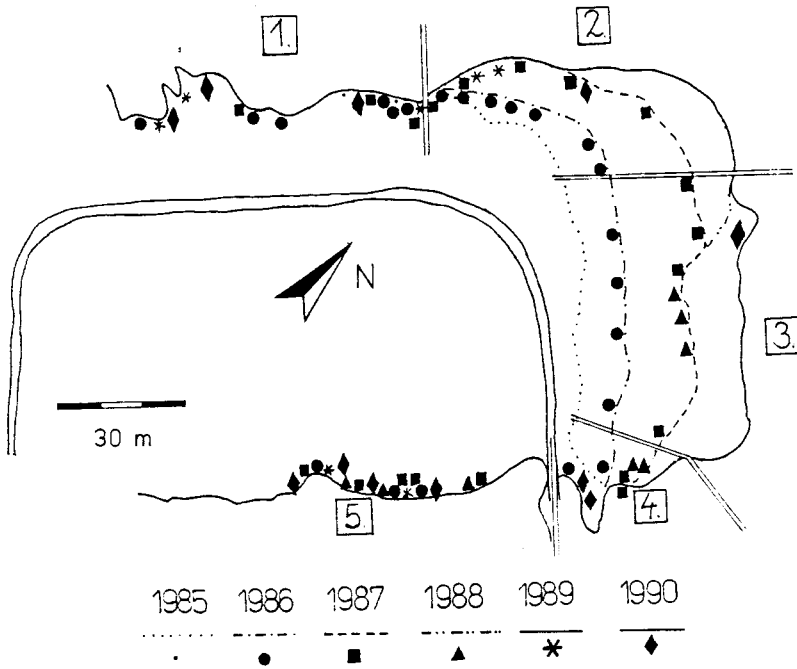
Bár a gyurgyalag (*Merops apiaster*) fokozottan védett, értékes madarunk, a hazai populációt veszélyeztető és korlátozó tényezőkről igen keveset tudunk. Különösen feltűnő az ökológiai alapfeltételek hiánya.

A hazai szakirodalomban a gyurgyalagról többnyire csak faunisztikai jellegű adatok, állományfelmérések, táplálékállatok listái jelentek meg. Ökológiai cikkek csak elvétve találhatók (Dyer és

Demeter 1981, Horváth et al. 1992). Európa más részein jóval alaposabb tanulmányok foglalkoznak a *Merops* fajok energiaforgalmával (Avery et al. 1988), táplálékösszetételével (Martinez 1984), költésbiológiájával (Dyer és Crick 1983, Lessells és Avery 1989, Lessells és Krebs 1989), és szociobiológiai-etológiai jelenségeivel (Crick és Fry 1986, Crick 1987, Wrege és Emlen 1987, Emlen és Wrege 1988).

Vizsgálataink célkitűzései: (i) a gyurgyalag megbízható ivarhatározása (szexálása); (ii) a populáció inherens mintázatának feltárása; (iii) a költést jellemző paraméterek meghatározása;

\* Előadta a szerző a Magyar Madártani és Természetvédelmi Egyesület III. Tudományos Ülésén, Szombathelyen (1991. március 1-3).



1. Abra. A vizsgálati terület térképe. A fészkek helye évenként és 5 szektorban ábrázolva.  
Fig. 1. Map of the study area. Locations of nests are presented by year in five subplots.

és (iv) a táplálékösszetétel, táplálkozási mód és aktivitás meghatározása.

E vizsgálatok eredményei, alapkutatás jellegükön túl, a hazai gyurgyalag állomány hatékony természetvédelmét kívánják szolgálni.

## 2. Vizsgálati terület és módszerek

A Magyar Madártani és Természetvédelmi Egyesület 6. Hódmezővásárhelyi és 37. Újszegedi Helyi Csoportja 1985-től 1990-ig rendszeresen végezte a gyurgyalagok vizsgálatát a Hódmezővásárhelyi Marx Tsz. homokbányájában (1. Ábra). A homokbánya partfalai 2-8 méter magasak, talaja folyami homok. A bányameder területe kb. 1.5 ha, ezt a Tsz. minden évben művelte, búza, kukorica és napraforgó

vetésekkel. A homokfejtés miatt a meder területe évről évre növekedett. A cserjék és ülfák száma meglehetősen kevés volt.

Minden év július közepén, a tojások kikelése után, és a gyurgyalag fiókák növekedése idején folytak a vizsgálatok. Az öt szektorra osztott partfalakon a költőüregeket feltérképeztük (1. Ábra). Ezt követően az etető hímeket és tojókat lehetőleg egy időben, maximum egy óra eltéréssel befogtuk az erre a célra készült kisméretű hálókka. A gyűrűzés után a befogott egyedeket megmértük (Szentendrey et al. 1978).

A szexuális dimorfizmus vizsgálatához feljegyeztük a torok, mell, hát, farcsík színét, és mértük a felső könyökfedők zöld sávjának szélességét (2. Ábra). A hordott táplálék méretének a becslésére az adult madarak csőrét a csúcsától



1. Táblázat. A hím és tojó gyurgyalagok mérete (A) és színezete (B).  
Tab. 1. Size (A) and colour (B) of male and female Bee-eaters.

## (A)

	hím/male		tojó/female	
	$\bar{x} \pm sd$	n	$\bar{x} \pm sd$	n
Szárnyhossz / Wing length (mm)	151.18±2.21	33	145.92±3.13	27
Szárnyhegyesség / Wing shape (Holynski index)	182.51±12.22	33	172.96±12.76	27
Farokhossz / Tail length (mm)	117.53±3.86	33	110.92±4.89	27
Középső faroktollak és leghosszabb faroktollak különbsége / Differences between the longest and medium tail feathers (mm)	21.90±5.48	33	17.25±3.53	27
Csőr hossz / Bill length (mm)	33.93±0.93	33	33.14±1.23	27
Testsúly / Weight (g)	56.63±3.00	11	53.11±1.76	9
Zöld fedők szélessége / Width of green coverts (mm)	8.48±3.82	27	20.52±5.19	23

## (B)

Farcsík színe / Colour of tail stripe	arany/ gold	oliva/ olive	zöld/ green	n	arany/ gold	oliva/ olive	zöld/ green	n
	16	6	1	23	0	3	20	23

2. Ábra. Az adult gyurgyalagok ivarának meghatározása a szárnyfedők színezete és szélessége alapján. (Bal szárny felülől, d = könyökfedők zöld színű sávjának szélessége.)

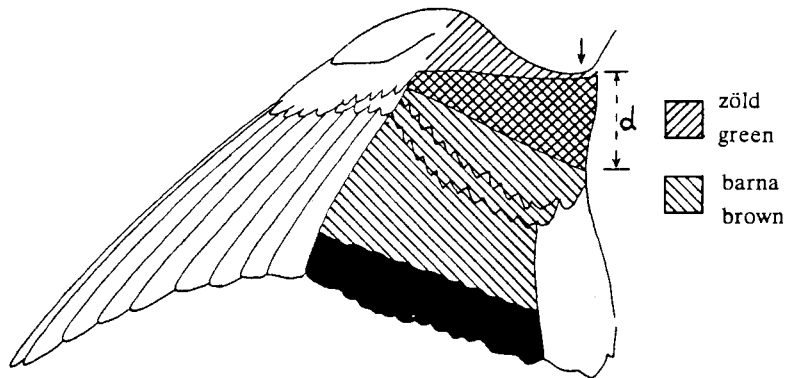


Fig. 2. Identification of sex of adult Bee-eaters according to the colour and width of the feathers. (Upper side of a left wing, d = width of the green belt.)

2. Táblázat. A gyurgyalag populáció élettáblázata (+ : az adott korú, vagy annál idősebb).  
Tab. 2. Life-table of the Bee-eater population (+ : the given age or older).

Életkor (év) / Age (year)	Egyedszám / Number of individuals	Túlélés valószínűsége / Probability of survival	Túlélők száma / Number of surviving ind.
(x)	(n)	( $p_i$ )	( $l_x$ )
0	279	0.708	1000
1+	90	0.228	323
2+	16	0.041	57
3+	5	0.013	18
4+	3	0.008	11
5+	1	0.003	4

kezdve 1-1 cm-ként vékony fehér vonalakkal megfestettük. Továbbá a hímek mellét, vállát és hátát egy fehér folttal megjelöltük, így bármelyik oldalról figyelve könnyen meg lehetett különböztetni őket a nem jelölt tojóktól. Az etetések időpontjának mérése, a zsákmányállatok méretének és minőségének meghatározása távcsöves megfigyelésekkel, lessátorból történt. A megfigyelők kétóránként váltották egymást. A fiókák kikelésük sorrendjében gyűrűztük meg, amit szárnyhosszuk és testsúlyuk alapján állapítottunk meg. Néhány nap múlva a fiókat ismételtelen lemértük.

Az éves minták számbeli kicsinységük miatt statisztikailag nehezen volnának értékelhetők, ezért az öt év fogási- és visszafogási eredményeinek összevonásával készült a vizsgált gyurgyalag populáció élettáblázata és túlélési görbéje.

### 3. Eredmények és értékelésük

#### 3.1. Biometriai adatok és az ivari dimorfizmus vizsgálata

A gyurgyalagnál az ivarok elkülönítését a méretek és színezet nem teszi le-

hetővé, habár a hímek átlagos szárnyhossza nagyobb a tojókénál (Lessells és Ovenden 1989). Glutz és Bauer (1980) főként a színezet alapján próbálták az ivarokat elválasztani. Vizsgálataik szerint a tojóknál a zöld szín, főként a hátrész és a farcsík környékén, kifejezettebb, néha a közepes és a nagy szárnyfedők is zölden szegettek. A hímek viszont élénkebb színezetűek, tollazatukban a barna és aranyárga színek dominálnak, a szárny- és farokhosszuk nagyobb, mint a tojóké.

A nemek elkülönítése két tulajdonság alapján végezhető el: (1) a felső szárnyfedők zöld sávja 2-15 mm hímeknél, míg tojóknál 13-28 mm (1. Táblázat, 2. Ábra); és (2) a farcsík színezete a hímeknél szalmasárga vagy aranyárga, a tojóknál zöld, vagy zöldes színű.

#### 3.2. Korstruktúra, mortalitás, visszatérés

A gyurgyalag populáció élettáblázatát a 2. Táblázat mutatja be. A metodikai nehézségek miatt az évenkénti kóborlásokat és áttelepüléseket nem lehetett nyomonkövetni. Ezért az adult madarak visszatérési gyakorisága e vizsgálatoknál túlélésként van feltüntetve. A gyurgyalag populáció mortalitása korcso-

3. Táblázat. Különböző korú és ivarú gyurgyalagok visszatérési aránya a fészkelő kolóniába a következő években.

Tab. 3. Percentage returning of the Bee-eaters in the next few years after fledging.

Visszatérési arány / returning percentage				
	hím / male	tojó / female	összesen / sum	n
Adult	12.9%	14.9%	27.7%	101
Juv.	5.9%	0.4%	6.3%	239

tonként egyenletes. A madarak kétharmada feltehetően elpusztul, az egyes korcsoportok túlélése évről évre hasonló arányú, átlagosan 33%. E nagyfokú mortalitás okozati háttere egyelőre nem tisztázott, de feltehetően jelentős szerepe van ebben az afrikai telelőhelyeken használt peszticideknek. A mortalitásból eredő veszteséget jól kompenzálja a magas reprodukciós ráta (5.06 utód páronként), ami a populáció fennmaradását biztosítja.

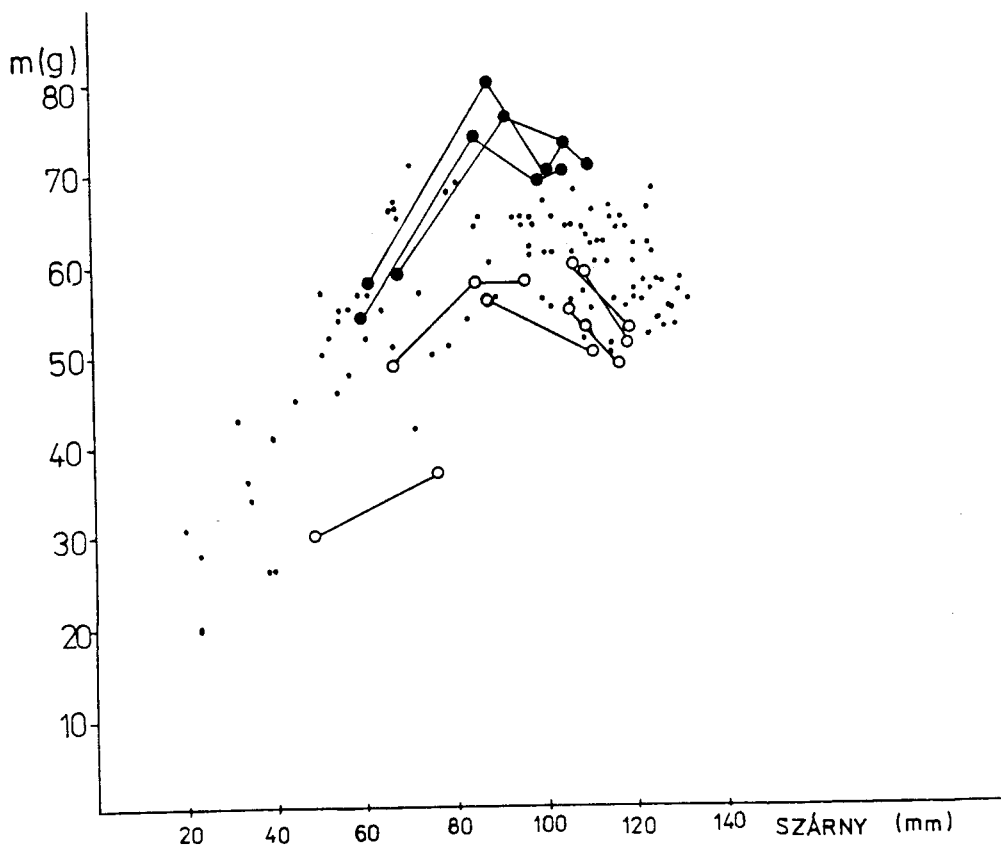
A madarak visszatérési aránya a költőhelyre életkoruk és nemük szerint lényeges eltéréseket mutat (3. Táblázat). A fiatalok túlnyomó része a születését követő évben feltehetően elkóborol, nem valószínű, hogy alacsony visszatérési rátájuk csupán a mortalitással magyarázható. Figyelemre méltó a fiatal tojók rendkívül alacsony visszatérési aránya. Lessells és Krebs (1989) vizsgálatai a gyurgyalagnál azt mutatták, hogy az 1 éves madarak bizonyos hányada nem költ, viszont az összes költő madaraknak 50%-a (43-65%) egy éves. Vizsgálataik szerint az egy éves tojók nagy része költött, míg a hímek nagyobbik része még nem szerzett párt magának, ami jelentősen eltér, sőt, ellentétes a mi eredményeinkkel. Lessells és Krebs (1989) kimutatták, hogy az adult madarak 34%-a (33% hím, 35% tojó) a következő évben visszatért a

kolóniába, és ismételten költött. Hódmezővásárhelyen az adult gyurgyalagok közül jóval kevesebb tért vissza, de a hímek és tojók visszatérésének egymáshoz viszonyított aránya jó egyezést mutat Lessells és Krebs (1989) eredményeivel. Ők arra a megállapításra jutottak, hogy leginkább fiatal-fiatal, illetve adult-adult párok alakultak ki. Ezzel szemben saját vizsgálataink azt mutatták, hogy a fiatal hímek gyakran álltak párba és költöttek idősebb tojókkal már az első életévük során. A gyűrűzések segítségével bizonyos párhússágot sikerült kimutatni a gyurgyalagnál. Feltehető azonban, hogy a gyakori pusztulás miatt időnként az új párok e kényszerfeltétel miatt alakulnak ki.

### 3.3. Költés, fiókák növekedése, fészkelj-méret

A partfalak égtáj szerinti pozíciójának feltehetően nincs hatása a madarak fészkelőhely választásában (1. Ábra). Egyes párok évről évre a partfal 5 szektora közül következetesen ugyanazt a szakaszt választották, vagyis az előző évi üreg közelében ásták ki új költőüregüket. A madarak nagyobbik hányada azonban nem mutatott hűséget a fészkelőhely iránt. Ezek évről évre változtatták a helyüket, más más szektorban ásták fészkeüregüket. Ebben gyakran szerepet játszott az is, hogy sok madár előző évi párját elveszítve (vagy elhagyva) új párjával kísérelte meg a költést.

A függőleges (oldalirányban sík) vagy konvex (kidomborodó) falakat a költő párok jobban preferálták a konkáv (homorú) felszínekkel szemben. Ez feltehetően a madarak kedvezőbb kilátási pozíciójával, jobb biztonságérzetével magyarázható. A vegetációval borított



4. Ábra. Gyurgyalag fiókákák testsúlyának változása a szárnyhossz függvényében (o : 3 fiókás fészekalj, . : 4-6 fiókás fészekalj, o : 7 fiókás fészekalj).

Fig. 4. Weight of Bee-eater nestlings as a function of wing length (o : nests with 3 nestlings, . : nests with 4-6 nestlings, o : nests with 7 nestlings).

(elgyomosodó, indákkal és cserjékkel takart), vagy rézsúsen leomlott falakban szinte egyáltalán nem történt költés, vagy ez a következő években, a növény(borítottság kiterjedésekor, megszűnt. A harmadik szektorban viszonylag kevés gyurgyalag költött, mert itt a magas és gyakran bányászott partfalakat minden évben 300-800 parti fecske (*Riparia riparia*) foglalta el.

A talaj szilárdsága a költőhely

megválasztásában nem, a tojásrakás szempontjából azonban lényeges tényező. A kemény homokban a költőüregek mélysége kisebb, s a fiókák is jóval később kelnek ki. 1990-ben a puha talajú 1. szektorban június 27-én, a legkeményebb 5. szektorban csak július 10-én keltek ki az első fiókák (13 napos kérés). Az 5. szektorban ráadásul átlag 29 cm-rel rövidebbek voltak a költőfolyosók. Feltehetően ilyen ked-

4. Táblázat. Egy gyurgyalag-pár zsákmányösszetétele négy trofikus szint alapján.

Tab. 4. Composition of the prey in four trophic categories delivered by one pair of Bee-eaters. (n = 241)

Táplálkozási kategória / Foraging category	%
növényevő – herbivore	6
ragadozó – predator	12
dekomponáló – decomposer	4
nektárszívogató – nectarivore	78

vezőtlen körülmények között az üregek kiásása sokkal több időt és energiát kíván a madaraktól, ezért tojásrakásuk is késleltetett. Mindezek ellenére ezen a kemény falszakaszon minden évben több pár is fészkel, ami talán a falak optimális meredekségével magyarázható.

A fiókák szárny- és farokhossza a kirepülés napjáig lineárisan nőtt. Testsúlyuk azonban kb. 20 napos korukban érte el maximumát, majd a fészekben töltött további 10 nap során csökkent (4. Ábra). Hasonló tendenciát mutatott ki gyurgyalag fiókáknál Lessells és Avery (1989), sarlósfecskénél (*Apus apus*) Pellantová (1981). Lessells és Avery (1989) megfigyelései szerint a gyurgyalag fiókák táplálékellátása 3 hetes korukban maximális, szárnyuk hossza ekkor átlag 92mm (80-100mm), testsúlyuk pedig átlag 65g (50-75g), a nevelési idő kb. 28 nap. Ezek az értékek jó egyezést mutatnak saját vizsgálatainkkal. Ezek szerint a fiatalok kb. 30 napos korukban hagyják el a fészket. Ekkor szárnyhosszuk kb. 130mm, s ez további növekedése során még júliusban eléri a 143mm-t. Kisebb fészkealjokban gyorsabb a testsúly növekedésének üteme, s az elért maximális testsúly is nagyobb, mely a kedvezőbb fiókankénti ellátási rátával, illetve a fiókák közötti kompetícióval magyarázható (4. Ábra).

5. Táblázat. Egy gyurgyalag-pár zsákmányösszetétele az etett rovarrendek szerint.

Tab. 5. Prey composition of a Bee-eater pair according to insect orders. (n=241).

Zsákmány / Prey	%
<i>Odonata</i>	5.3
<i>Orthoptera</i>	1.2
<i>Heteroptera</i>	4.9
<i>Homoptera</i>	0.4
<i>Coleoptera</i>	3.3
<i>Lepidoptera</i>	2.9
<i>Diptera</i>	3.7
<i>Hymenoptera</i>	78.3

1986 és 1990 között a kirepülő fiókák száma 4.50-5.17 között változott évenként, a vizsgált 61 fészkealj átlaga  $5.06 \pm 1.29$ . A legnagyobb fészkealjból 8 fióka repült ki. Lessells és Krebs (1989) 4.42-4.81 fiókaszámot közölt.

Hódmezővásárhelyen a gyurgyalagok fiókanevelésében 3 esetben (2 hím, 1 tojó) segítő madár (helper) is részt vett, de ezek sajnos nem képezhették részletesebb vizsgálatok tárgyát. Ennek a jelenségnek, mely igen gyakori a *Merops* fajoknál, előnyeit és jelentőségét Dyer és Crick (1983), Sjöström (1985), Crick és Fry (1986), Wrege és Emlen (1987), Emlen és Wrege (1988), és Lessells és Avery (1989) tárgyalja.

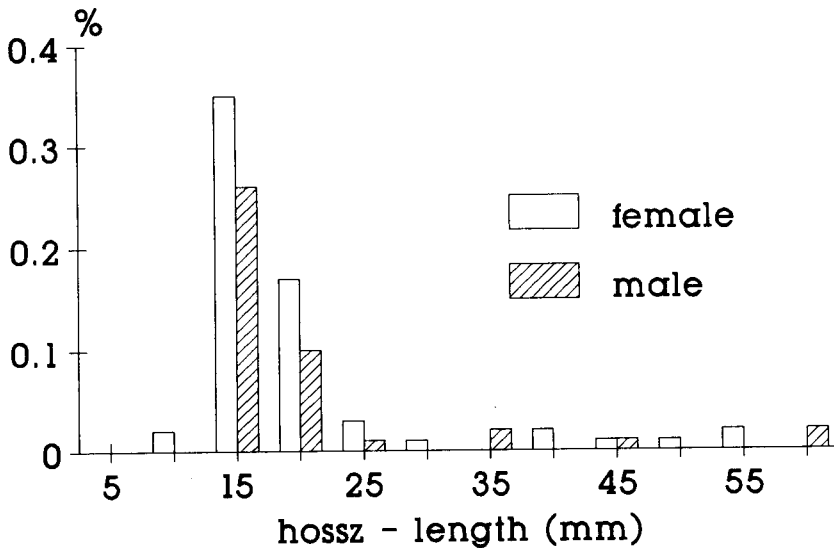
#### 4. Táplálkozás: táplálékösszetétel, preferencia, etetési aktivitás

A gyurgyalagok életmódjának megfelelően túlnyomórészt repülő rovarokkal táplálkozik. Az etetésnél megfigyelt zsákmányállatok négy trofikus szintbe sorolva kiemelendő a nektárszívó csoport 79%-os részesedése (4. Táblá-

zat). A madarak táplálékából összesen 36 fajt lehetett meghatározni, melyek 8 rendbe tartoznak (5. Táblázat). A Hymenopterák kiemelkedő (52-93%-os) aránya miatt a táplálék változatos összetétele ellenére alacsony a diverzitás és egyenletesség (5. Táblázat). A Hymenopterák túlsúlyát mások is kiemelték, így Jazenja (1966, cit. Glutz és Bauer 1980) Ukrajnában, Fintha (1968) Magyarországon, Kiss (1985) Romániában, Martinez (1984) Spanyolországban, Sjöström (1985) Afrikában, Calver et al. (1987) Ausztráliában. Több tanulmány is alátámasztja, hogy a gyurgyalag semmiképp nem okoz jelentős kárt a méhészetekben, mert háziméheket csupán a hosszan tartó esős időszakokban fogyasztanak nagyobb mennyiségben (Fintha 1968, Kiss 1975). A zsákmány méretét tekintve a gyurgyalag feltehetően szintén alkalmazkodik a kínálkozó lehetőségekhez. A zsákmány mérete alapján bizonyosan válogatnak

aszerint, hogy csak egy bizonyos méret-hatás fölötti prédát vesznek üldözőbe. Az elfogyasztott, vagy etetéskor hordott táplálékállatok mérete 9-82mm között változott, de viszonylag kevés nagytestű rovar (*Odonata*, *Lepidoptera*) szerepelt a fogyasztásban (5. Ábra). Emiatt az átlagos zsákmányhossz nem magas érték, szórása ellenben nagy ( $18.15 \pm 9.64\text{mm}$ ). Avery et al. (1988) a zsákmányállatoknak kis-, közép-, és nagytestű, azaz háromféle méretkategóriáját határozták meg.

Vizsgálataink szerint viszonylag nagyfokú a kellemetlen szagú és ízű Heteropterák, a tömör szórbundát viselő *Bombus* fajok, és a fullánkos Hymenopterák részesedése a fogyasztásban. Egy egy madáregyednél a határozott irányú egyedi preferencia-viszonyok a zsákmányolt rovertípusok eltérő mértékű fogyasztását eredményezheti. A specialista predátor egyedek határozott irányú szelektív tevékenységei jelentősen



5. Ábra. Egy gyurgyalagpár zsákmányállatainak testméret szerinti megoszlása egy délelőtti etetés során.

Fig. 5. Size distribution of the prey of a Bee-eater pair collected from sunrise to midday in one day.

összeolvadnak a populáció szintjén, s változatos, nagyobb diverzitású és egyenletességű táplálékösszetételben összegződnek (Curio 1977, Gyovai 1986 -- gyíkokon).

A zsákmányállatok időbeni aktivitása feltehetően jelentősen befolyásolja az etetések gyakoriságát, ritmusát (9. Ábra). Az etetési aktivitásban a hím és a tojó között nem mutatható ki lényeges eltérés egy délelőtti folyamán. A tojó óránként átlagosan 19.3-szor, a hím 15.2-szer hozott táplálékot. Reggel 8 óra és dél körül mutatkozik egy-egy aktivitási csúcs. Fintha (1968) egy további csúcsot állapított meg délután 14-16 között. Dyer és Crick (1983) 5.8-12.9 etetést figyeltek meg a kooperatív költésű *Merops albicollis*-nál.

## 5. Természetvédelmi javaslatok

A hazai gyurgyalag populációk, kolóniák védelmét elsősorban a fészkelőhelyek számának növelésével és tervszerű fenntartásával lehet biztosítani. Olyan területeken, ahol kedvezőek a mikroklimatikus viszonyok, gazdag a rovarfauna, s ahol kb. 20 km távolságban nincs alkalmas másik költőhely, ott nagyobb gödrök kiásásával, vagy függőleges falak kialakításával készíthető elő a gyurgyalagok megtelepítése. A művelésből kivont, régi homokbányák falait szintén célszerű néhány évenként "felfrissíteni". Ez a művelet egyúttal a gyomosodást is megszünteti, sőt, helyenként a gyorsan felnövekedő fás növényzetet is ki kell irtani. Az ilyen munkálatok elvégzését, vagy a működő bányákban a talaj fejtését áprilistól augusztusig mindenképpen fel kell függeszteni. Költési időben csak az ilyen célokra kijelölt szakaszon szabad engedélyezni a bánya művelését. A költőhelyeken ilyenkor az emberi

zavarást a legteljesebb mértékig meg kell szüntetni, s ennek betartásáról és ellenőrzéséről folyamatosan gondoskodni kell. A gyakran elfogult méhészek körében felvilágosítással esetenként megelőzhető a madarak szándékos pusztítása. Ha a gyurgyalag kolónia élőhelyének fennmaradását komoly veszély fenyegeti, a terület megvásárlása és védetté nyilvánítása jelenthet megoldást.

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## Short communications - Rövid közlemények

### The role of residency in population changes of wintering tits: a hierarchical approach

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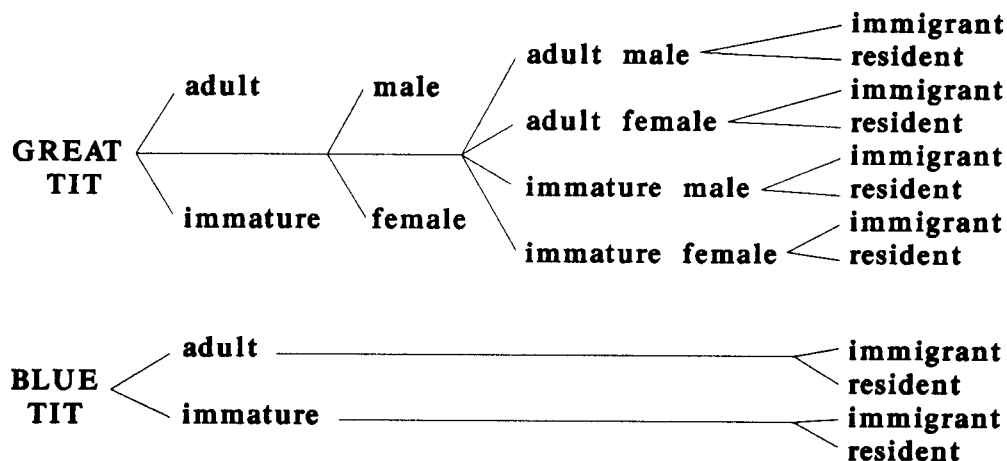
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Population fluctuations of passerine birds have been studied extensively at the species level (e.g., Källander & Karlsson 1981, Bejer & Rudemo 1985) and at the intra-species level (e.g., Balen 1980, Smith & Nilsson 1987, Orell 1989). However, these studies often used only one or two levels to analyse a problem. In the present paper we investigated the population changes of tits at several hierarchical levels to identify the robustness of the results (Allen & Starr 1982). Our approach is similar to the one which is applied to spatial scale (e.g., Wiens 1989, Fuisz & Moskát 1992,

Moskát et al. 1992.), that is we analysed the data on finer and finer scales.

The study was conducted in the Ócsa Landscape Conservation Area in Central Hungary (47°15' N; 19°15' E) (details in Báldi & Csörgő 1991). Great Tits (*Parus major*) and Blue Tits (*P. caeruleus*) were captured at feeders by mist-nets between 1983 and 1989. Captures between October and March in each year are analysed. Species, age, sex and residency status was determined. Residents were those birds already captured in summer or in more winters, immigrants were the newly arrived tits. We

Tab. 1. The hierarchical levels of divisions of the tit groups in the regression analysis.



Tab. 2. Results of the stepwise multiple regression calculations between the environmental factors and number of tits by class (see Tab. 1). The regression coefficient and the corresponding value of *t* are given in parenthesis.

	temperature	snow cover	number of feeding sites	number of nestboxes
Blue Tit	NS	NS	NS	0.66 (5.108)***
Great Tit	NS	NS	0.58 (4.186)***	NS
Blue Tit ad.	NS	NS	NS	0.53 (3.601)***
imm.	NS	NS	NS	0.66(5.158)***
Great Tit ad.	NS	NS	0.57 (4.023)***	NS
imm.	NS	NS	0.56 (3.962)***	NS
Great Tit male	NS	NS	0.52 (3.571)**	NS
female	NS	NS	0.60 (4.422)***	NS
Great Tit ad. male	NS	NS	0.56 (3.952)***	NS
ad. female	NS	NS	0.45 (2.945)**	NS
Great Tit imm. male	NS	NS	0.48 (3.181)**	NS
imm. female	NS	NS	0.60 (4.317)***	NS

\*\*  $p < 0.01$

\*\*\*  $p < 0.001$

analysed the relationships between four environmental factors (see below) and numbers in different groups of tits (Tab. 1) by regression analysis. Stepwise multiple regression analysis of SPSS/PC+ (Norusis 1986) was used on the summed monthly number of individuals corrected for number of mist-netting days. The independent variables were the monthly mean temperature, percentage of days with snow cover in a month, number of bird tables (range: 0-4) and number of nestboxes (range: 0-56).

The ecological explanations of the results are discussed in Báldi & Csörgő (1991), here we focus mainly on the robustness of the results on different levels.

On species level there were clear relationships. The number of Great Tits in-

creased with increasing number of feeders, while the number of Blue Tits increased with increasing number of nestboxes (Tab. 2). At the age and sex levels these relationships did not change in either of the species. Similar results were obtained in the Great Tit when sex and age classes were considered (Tab. 2).

The results changed considerably after separation of resident and immigrant tits. At this level, in some classes of Great Tits, the available roosting sites emerged as a significant factor affecting winter population changes. In the Blue Tit temperature and feeding also became significant factors besides the nestboxes (Tab. 3).

There are two important conclusions of our study. The first is concerned with ecology, and reflects the importance of

Tab. 3. Results of the stepwise multiple regression calculations on the final division of tit classes. The regression coefficient and the corresponding value of *t* are given in parenthesis.

		temperature	snow cover	number of feeding sites	number of nestboxes
<b>Blue Tit</b>					
adult	immigrant	0.38 (2.390)*	NS	NS	NS
adult	resident	NS	NS	0.62 (2.310)*	0.53 (2.464)*
immature	immigrant	0.67 (2.293)*	NS	NS	0.60 (4.306)***
immature	resident	NS	NS	NS	0.64 (4.914)***
<b>Great Tit</b>					
adult male	immigrant	NS	NS	0.38 (2.386)*	NS
adult male	resident	NS	NS	0.59 (3.126)**	0.65 (2.077)*
adult female	immigrant	NS	NS	NS	0.46 (3.053)**
adult female	resident	NS	NS	0.42 (2.696)*	NS
imm. male	immigrant	NS	NS	NS	NS
imm. male	resident	NS	NS	0.59 (4.310)***	NS
imm. female	immigrant	NS	NS	0.49 (3.261)**	NS
imm. female	resident	NS	NS	0.65 (4.919)***	NS

\*  $p < 0.05$

\*\*  $p < 0.01$

\*\*\*  $p < 0.001$

residency status in determining winter population changes. Behaviour of individuals largely depends on dominance status, and residency seems to be predominantly responsible for dominance, more than age or sex (Sandell & Nilsson 1991, Báldi & Csörgő 1993). The role of status in the nonbreeding season has already been shown at the individual level (e.g., Nilsson & Smith 1989), but papers at the population level are rather scarce.

Second, the hierarchical approach is rarely applied to such problems as in this study, even though it can reflect the complexity of data. Using the hierarchical approach, investigations on several levels may give different answers to the

same question. That is, a question may be valid at one level, but not at another. Wiens (1989) also pointed out the importance of appropriate scale in ecological studies. The statement, that there is no difference for example between the winter population changes of adult and immature Great Tits may be misleading and largely meaningless, because the responsible factor is not age, but residency.

Our conclusion and suggestion is that the hierarchical approach to ecological questions may give more information and more complex understanding of the problem than the one-level analysis of the same data-set.

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