

## Brief report

# Foraging sites of Marsh Tits (*Parus palustris*) in presence and absence of hawks in mixed-species flocks in Korea

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## 1. Introduction

Studies on tits provide a good illustration of how predation risk can affect such different aspects of bird biology as fat storage mechanisms (e.g. Gosler et al. 1995), time budget (e.g. Ekman 1987), size of mixed-species flocks (e.g. Szekely et al. 1989, Suhonen 1993b), and the dominance-mediated spatial distribution of foraging sites of subordinate species in mixed-species flocks (e.g. Ekman 1986, Suhonen 1993a, 1993b, Suhonen et al. 1993). Spatial separation of foraging sites in mixed-species flocks in Fennoscandia and North America has been shown to result from interspecific competition (e.g. Alatalo et al. 1985, 1986, 1987, Cimprich & Grubb 1994, Krams 1998). This competition results in smaller, subordinate species being forced by dominant species to forage in outer tree parts where predation risk is high. However, in response to an increased predation risk from Sparrowhawks (*Accipiter nisus*) and Pygmy Owls (*Glaucidium passerinum*), subordinate species may shift their foraging from outer and more dangerous tree parts to inner and safer tree parts (Ekman 1986, Suhonen 1993a, 1993b, Suhonen et al. 1993, Kullberg 1998), despite a possible increase in agonistic interactions with dominant species.

Studies of such shifts of foraging sites in subordinate tit species, from a geographical region previously not studied, in this respect could tell us how general the effect of predation risk is on the distribution of subordinate species in a flock. The Marsh Tit (*P. palustris*) is the most common member of mixed-species flocks (95% of flocks consisted of *P. palustris*; Lee & Jabłoński 1999) and quite frequently forages in outer tree zones (Jabłoński & Lee 1999). Our observations suggest that the Marsh Tit is subordinate in relation to the Great Tit (*Parus major*), the second most common member of flocks (out of 22 interactions, 15 were between Great Tits and Marsh Tits, and in 85% of those interactions the Great Tit dominated the Marsh Tit). In our study area our results accord well with those from Fennoscandia: the Marsh Tit, being the subordinate species, forages more often in outer tree sections than does the dominant species, the Great Tit (Jabłoński & Lee 1999). Therefore, if predation risk affects foraging site distribution of subordinate species in the same way as in the Fennoscandian tits (e.g. Suhonen 1993a, 1993b), we expect that the Marsh Tit would forage closer to the tree trunk in the presence of a predator. We compared the distribution of Marsh Tits in four flocks when a Sparrowhawk (*Accipiter nisus*) was present with 24 other flocks

observed when the hawk was absent. Since *A. nisus* is a diurnal predator of small passerines it is likely that it imposes a higher predation risk on birds foraging in outer tree parts, and that tits foraging in the outer parts would move to inner parts in the presence of a hawk.

The Great Tit was the most aggressive member of the flocks (P. G. Jabłoński, S. D. Lee, unpublished data); therefore, it is likely that it occupied its preferred foraging niche. The Great Tit foraged more frequently in the inner tree zone than did the Marsh Tit (Jabłoński & Lee 1999), where predation risk is probably low. Hence, the reaction of the Great Tit to predator presence was expected to be weaker than the reaction of the Marsh Tit. Because there are no published data on the response to predation risk on tits in Asia, we believe that our small data set could be valuable to investigators of mixed-species flocks.

## 2. Methods

In December 1996 and January 1997 we observed mixed-species flocks of tits in forests on the slopes of mountains near Seoul, Korea (latitude: 37°58'N, longitude: 127°05'E). The composition of flocks is described in Lee and Jabłoński (1999). For most of the study period, the ground was covered with a thin layer of snow (up to a few centimetres). The days were mostly sunny with temperatures between -15°C to +10°C. Forests consisted of pines (*Pinus rigida*, *P. densiflora*, and *P. koraiensis*), firs (*Abies holophylla*), oaks (*Quercus acutissima*, *Q. aliena*, *Q. mongolica*, *Q. serrata*, *Q. variabilis*, *Q. dentata*) and *Alnus japonica*, *Robinia pseudo-acacia*, *Castanea crenata*, *Rhododendron* spp., *Prunus* spp., *Betula* spp., *Zelkova serrata*.

We followed each flock for 0.5–2.5 hours recording foraging site positions of birds with regard to height: ground (rank 0), bush (rank 1; mostly < 1.0 m), lower one third of the tree (rank 2), middle one third of the tree (rank 3), top one third of the tree (rank 4). Tree height varied from approximately 8 m to 20 m. If a bird was in a tree, we also recorded the rank distance to the trunk (rank 1: tree trunk and branches up to one third of the crown width; rank 2: between one third and two thirds of the crown width from the trunk; rank 3:

more than two thirds of the crown width from the tree trunk). The birds were not individually marked. We attempted to sample the flock evenly, so that each individual would contribute approximately the same number of foraging records. Also, the possible records of the same individual should be considerably separated in time to decrease the interdependence of records. In order to fulfill these requirements, after each record (bird species, foraging position, tree species) we changed the direction of search for the next bird by 90–180°. In this way, we avoided consecutive records from the same individual in the same tree. For each species in each flock, we calculated mean rank distance to the trunk and mean rank height. During observations of four flocks (hawk-present flocks) birds appeared to perceive a predator: a Sparrowhawk (*Accipiter nisus*) flew over a flock at least once during an observation session. When the birds stopped foraging immediately after predator detection, we stopped recording their locations until they resumed normal foraging again (usually after one minute or so). We recorded their behaviour for 10–30 minutes after normal foraging resumed. During observations of the 24 other flocks the predator was absent (hawk-absent flocks). We used nonparametric tests in CSS Statistica, version 4.5. Because we had apriori expectations about the direction of differences for the Marsh Tit's foraging site distances to the trunk, we used one-tailed tests.

## 3. Results and discussion

Marsh Tits were present in most flocks in the study area, and they usually foraged in outer tree parts (Jabłoński & Lee 1998). Marsh Tits used sites closer to the trunk when the predator was present (Fig. 1, Mann-Whitney one-tailed,  $Z = -2.433$ ,  $P = 0.008$ ). The flocks contained various proportions of the dominant species, the Great Tit (0–60%). This confounded our comparison in that most hawk-absent flocks contained fewer Great Tits than the four hawk-present flocks. More Great Tits within a flock yields a greater number of encounters between the dominant and subordinate species. Because Great Tits frequently use inner tree parts, more encounters with this dominant species should result in less frequent use of inner

tree parts and more frequent use of outer tree parts by the subordinate species (the Marsh Tit) in the hawk-present than in the hawk-absent flocks. The opposite trend occurred (Marsh Tits used inner tree parts more frequently in the presence of predators: Fig. 1), indicating that if an effect of dominance existed it was overridden by the effect of predator presence.

We conducted an additional comparison in which the four hawk-present flocks were compared with four hawk-absent flocks that were the most similar in the numbers of Great Tits to the four hawk-present flocks (the proportions of the Great Tit in the four hawk-absent flocks were 44%, 20%, 18%, and 17%, and in the four hawk-present flocks, 44%, 21%, 21%, and 17%). There was a significant effect of predator presence on the distance to the trunk (Fig. 1, Mann-Whitney,  $Z = -2.021$ , one-tailed  $P = 0.02$ ). Median rank distances to the trunk were 1.64 and 1.42 in flocks with predator absent and present, respectively. To illustrate how Marsh Tits were distributed throughout the three zones with regard to the distance to the trunk, we looked at all records of foraging Marsh Tits for the four hawk-absent flocks and all records for the four hawk-present flocks (Table 1). In the absence of a hawk, birds foraged in the outermost zone twice as often as in the presence of a hawk. Because the records are not independent, no statistical test is feasible.

We cannot reject the null hypothesis of no predator effect on the distance to the trunk in the Great Tit (median rank distances to the trunk are 1.70 and 1.68 in flocks with predator absent and present, respectively;  $Z = -0.504$ ,  $n_1 = 16$ ,  $n_2 = 3$ , two-tailed  $P = 0.614$ ). We did not detect any significant effect of predator presence on rank height for the two species (Mann-Whitney tests,

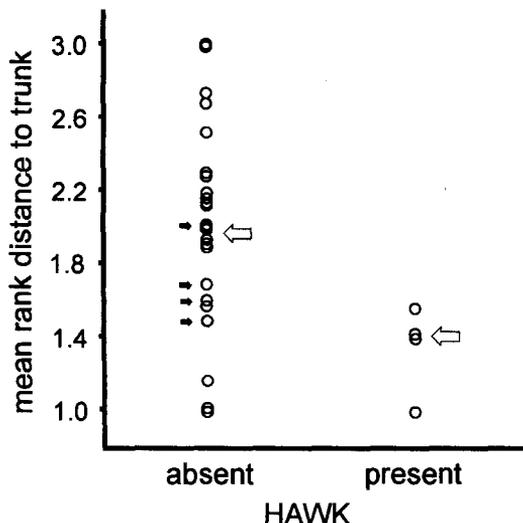


Fig.1. Rank distance to the trunk for Marsh Tits, *Parus palustris*, in 24 flocks with a hawk absent and in four flocks with a hawk present. Each circle represents a flock. The large arrows indicate median values. The small dark arrows indicate the four flocks with a hawk absent that were the most similar ones, with respect to the numbers of Great Tits, to the four flocks with a hawk present.

two-tailed  $P > 0.370$ ).

These results are consistent with extensive studies of predation risk effects on foraging site selection in Fennoscandian tits (e.g. Ekman 1986, Suhonen 1993a, 1993b, Suhonen et al. 1993, Kulberg 1998). Thus, our study suggests that the effects of predators on the behaviour of *Paridae* in mixed-species flocks, well documented in Fennoscandian tits, are also present in mixed-species flocks of temperate Asia. Therefore, our results suggest a similarity between predator-induced effects in various geographical areas and in flocks of various species composition.

Table 1. Distribution of records of foraging Marsh Tits in four flocks observed when a hawk was present in the study area and for four other flocks of similar composition with regard to the number of Great Tits, observed during the absence of a hawk. Percentage of the total number of records are shown.

	Parts of tree		
	Inner	Intermediate	Outer
Hawk present during observations (n = 64 records)	66.7%	23.3%	10.0%
Hawk absent during observations (n = 60 records)	56.2%	17.2%	27.6%

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## Selostus: Pedon vaikutus korealaisten viitatieisten ruokailupaikan valintaan

Korealaisissa tiaissekaparvissa talitiainen on dominoivampi laji kuin viitatieinen. Kuten Fennoskandiasta aiemmin saadut tulokset ovat osoittaneet, ruokaili arvoasteikossa alempana oleva viitatieinen yleensä kauempana puun rungosta kuin dominoiva talitiainen. Ilmeisesti suurempi (dominoiva) laji pakottaa pienemmän lajin ruokailemaan näkyvimille paikoille, joista petojen olisi ne helpompi havainta. Kirjoittajat tutkivat, vaikuttiko pedon läsnäolo korealaisten viitatieisten ruokailupaikan valintaan. Tutkijat vertailivat parvia, joiden yli varpushaukka lensi ainakin kerran havaintojakson aikana, parviin, joiden alueella ei ollut varpushaukkaa. Pedon läsnäollessa viitatieiset ruokailivat lähempänä puun runkoa kuin pedon poissaollessa. Viitatieiset siis välttivät ruokaillessaan puun osia, joista pedon olisi ne helpompi havaita. Koreasta saadut tulokset ovat yhteneviä Fennoskandian ja Pohjois-Amerikan tiaissekaparvista saatuihin tuloksiin. Havainnot antavat viitteitä siihen, että riippumatta maantieteellisestä sijainnista ja parven lajikoostumuksesta, pedon vaikutus tiaisten ruokailupaikan valintaan olisi samansuuntaista.

## References

- Alatalo, R. V., Eriksson, D., Gustafsson, L. & Larsson, K. 1987: Exploitation competition influences the use of foraging sites by tits: experimental evidence. — *Ecology* 68: 284–290.
- Alatalo, R. V., Gustafsson, L., Linden, M. & Lundberg, A. 1985: Interspecific competition and niche shifts in tits and the goldcrests: an experiment. — *J. Anim. Ecol.* 54: 977–984.
- Alatalo, R. V., Gustafsson, L. & Lundberg, A. 1986: Interspecific competition and niche changes in tits (*Parus spp.*): an evaluation of nonexperimental data. — *Am. Nat.* 127: 819–834.
- Cimprich, D. A. & Grubb, Jr. T. C. 1994: Consequences for Carolina Chickadees of foraging with Tufted Titmice in winter. — *Ecology* 75: 1615–1625.
- Ekman, J. 1986: Tree use and predation vulnerability of wintering passerines. — *Ornis Scand.* 17: 261–267.
- Ekman, J. 1987: Exposure and time use in Willow Tit flocks: the cost of subordination. — *Anim. Behav.* 35: 445–452.
- Gosler, A. G., Greenwood, J. J. & Perrins, C. 1995: Predation risk and the cost of being fat. — *Nature* 377: 621–623.
- Jabłoński, P. G. & Lee, S. D. 1998: Foraging niche differences between species are correlated with body-size differences in mixed-species flocks near Seoul, Korea. — *Ornis Fennica* 76 (1) : 17–23.
- Krams, I. 1998: Rank-dependent fattening strategies of Willow Tit *Parus montanus* and Crested Tit *P. cristatus* mixed-flock members. — *Ornis Fennica* 75: 19–26.
- Kullberg, C. 1998: Spatial niche dynamics in the Willow Tit *Parus montanus*. — *J. Avian Biology* 29: 235–240.
- Lee, S. D. & Jabłoński, P. G. 1999: Species composition of mixed-species flocks of tits in Korea. — *Acta Orn.* 34. (In press.)
- Suhonen, J. 1993a: Risk of predation and foraging sites of individuals in mixed-species tit flocks. — *Anim. Behav.* 45: 1193–1198.
- Suhonen, J. 1993b: Predation risk influences the use of foraging sites by tits. — *Ecology* 74: 1197–1203.
- Suhonen, J., Halonen, M. & Mappes, T. 1993: Predation risk and the organization of the *Parus* guild. — *Oikos* 66: 94–100.
- Szekely, T., Szep, T. & Juhasz, T. 1989: Mixed-species flocking of tits (*Parus spp.*): A field experiment. — *Oecologia* 78: 490–495.