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COOPERATIVE BREEDING IN AZURE-WINGED MAGPIES, *CYANOPICA CYANA*, LIVING IN A REGION OF HEAVY SNOWFALL[1]

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Abstract. The frequency of occurrence of helpers, their age and sex, and certain behavior at nests were investigated in Azure-winged Magpies, *Cyanopica cyana*, living in central Japan, a region of heavy snowfall. One group of 16 birds was a summer visitor and the other two groups of about 20 birds were resident. Out of 14 nests we observed in 1983, six had one to two helpers, one had no helper, and at the other seven we could not confirm whether helpers attended or not. Therefore, 43% to 93% of nests had helpers. One helper was known to attend at least four nests, and seven of 14 marked individuals (50%) acted as helpers. These results mean that cooperative breeding occurs regularly in this population.

Key words: *Cooperative breeding; helper; Corvidae; group living; feeding; plural nester;* Cyanopica cyana.

INTRODUCTION

Cooperative breeding, which involves care of young by individuals other than parents, has been reported in a few hundred avian species in a wide variety of taxonomic groups. Most cooperative breeders occur in tropical or subtropical regions or in temperate zones with equable climate (Grimes 1976, Rowley 1976, Woolfenden 1976, Zahavi 1976). Two basic reasons for the distribution of cooperative breeding have been proposed (Emlen 1982a, 1982b). In stable and predictable environments high population density near the carrying capacity results in increasing intraspecific competition and decreasing chances for new breeders to establish territories. Thus, fledglings stay in their parents' territories and help the resident breeders with nesting activities (Brown 1974, Woolfenden and Fitzpatrick 1984). By contrast, in fluctuating and unpredictable environments, such as occur in subtropical savannas, environmental factors restrain young from dispersing (Grimes 1976, Rowley 1976, Orians et al. 1977). Situations similar to the latter may occur in cool-temperate zones, where habitat saturation is less likely because of high mortalities in winter and because of improvement in ecological conditions in spring to summer. Examples of regular cooperative breeders in cool-temperate zones are the Long-tailed Tit, *Aegithalos caudatus* (Nakamura 1972, 1975; Gaston 1973), Pinyon Jay, *Gymnorhinus cyanocephalus* (Balda and Balda 1978), Gray-breasted Jay, *Aphelocoma ultramarina* (Brown 1970, 1972), and Acorn Woodpecker, *Melanerpes formicivorus* (Stacey 1979, Koenig 1981, Koenig et al. 1984).

The Azure-winged Magpie, *Cyanopica cyana* (Corvidae), occurs in eastern Asia including Japan, and disjunctly far to the west in the Iberian Peninsula (Goodwin 1976). Azure-winged Magpies inhabit open woodlands, both coniferous and deciduous, and cultivated or open country with groves. They forage in trees, shrubs, and on the ground. Food consists largely of insects and other invertebrates, and also fruits and berries (Hosono 1966b).

In the nonbreeding season the magpies move around within their group home range in a tight group of about 20 birds (Hosono 1967, 1968), and defend their group territory against magpies of other groups (Hosono, unpubl.; Yamagishi and Fujioka, unpubl.). Even in the breeding season, all members of a group tolerate each other except close to the nests of the egg-laying stage (Hosono 1971).

Hosono (1983) reported that a banded Azure-winged Magpie at age 1 year fed the brooding female and nestlings in its group, and Araujo (1975) observed that four or more magpies simultaneously visited and fed nestlings in one nest. In this paper we describe the frequency of

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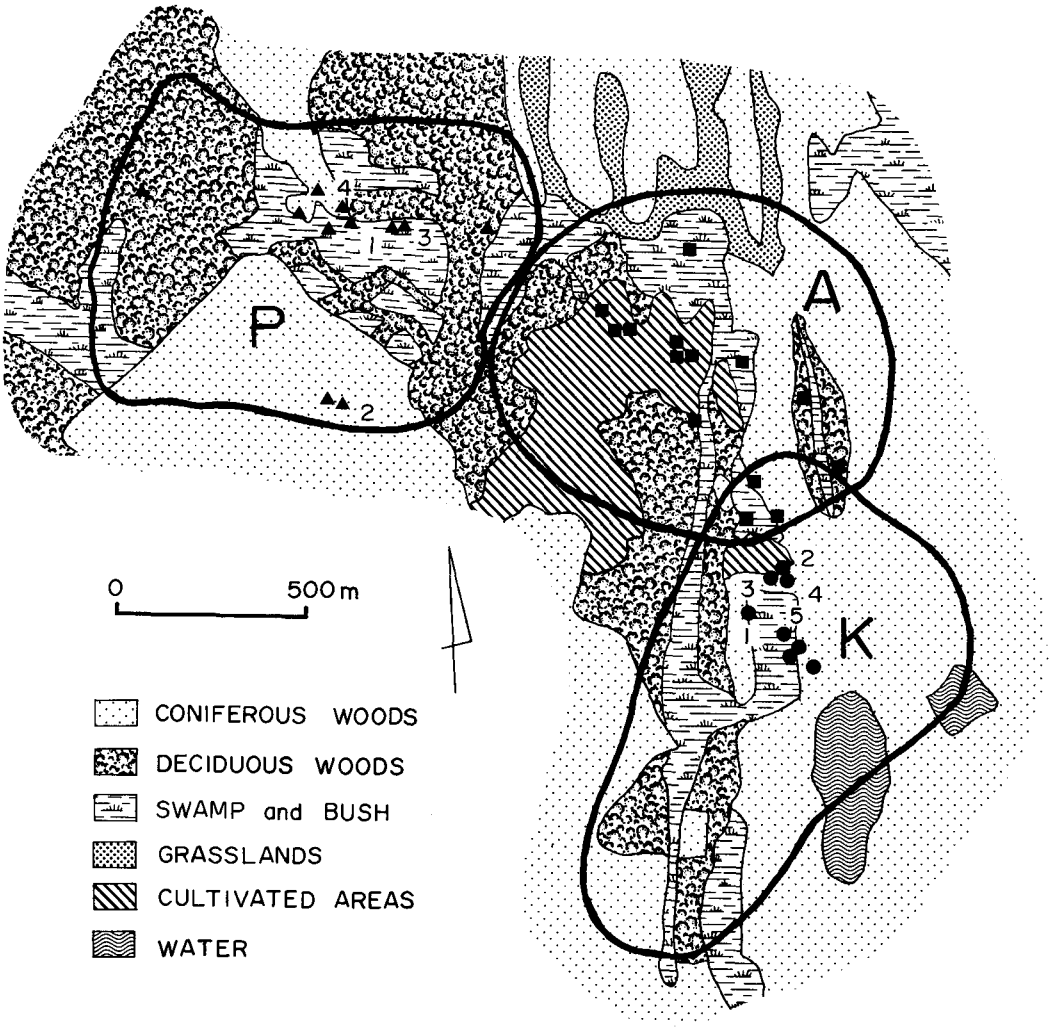

FIGURE 1. The vegetation of the study area and approximate home ranges of observed groups of the Azure-winged Magpie showing locations of nests. Magpies did not use cultivated areas and grasslands. Nest numbers correspond to those in Figure 2 and Table 1.

occurrence of helpers, their age and sex, and their behavior at nests in the Azure-winged Magpie. We wish to stress that regular cooperative breeding occurs even under severe winter conditions with heavy snowfall.

STUDY AREA AND METHODS

We studied the birds at the Iizuna Heights (36°43′N, 138°08′E; about 1,100 m above sea level), Nagano City, in central Japan. The study area (about 2.5 km × 2.5 km) was mainly covered with scattered larch (*Larix deptolepis*), oak (*Quercus serrata, Q. acutissima*), and chestnut (*Castanea crenata*) trees, and *Berchemia racemosa* and *Vitis coignetiae* shrubs. Cultivated fields and several villas and ski lodges were scattered over the western half of the study area (Fig. 1). The magpies did not live in the surrounding larch woods which were 2 to 4 km wide, but did live beyond in villages at the foot of the heights.

Snow covered the ground of the study area from December to early April. During the coldest season, January and February, snow fell almost every other day and the snowfall measured about one meter. Temperatures regularly fell to −7°C to −8°C. In the hottest season, July and August, the temperature averaged 23.5°C (maximum 29.9°C, minimum 18.6°C). Precipitation totaled

TABLE 1. Contribution of parent and helper Azure-winged Magpies to feeding nestlings. Nest names correspond to those in Figures 1 and 2.

Nest	Stage[a]	No. of visits (%)[b]				Total visits	Visits/hr	Observation time (hr)
		Male	Female	Helper-1	Helper-2			
K1	EL	75.0	25.0			16	2.1	7.6
	IN	37.5	21.9	40.6		32	5.4	5.9
K2	IN	30.0	35.0	35.0		27	3.5	7.7
	LN	29.7	51.9	18.5		30	4.0	7.6
	FL	35.3	41.2	20.6	2.9	39	5.6	7.0
P1	LN	66.0[c]		25.5	8.5	70	9.3	7.5
P2	NB	47.9	62.0	2.8	1.4	85	6.2	13.8
K3	IN	35.7	57.1	7.1		22	2.9	7.5
	EN	59.7	37.7	2.6		93	6.2	15.0
K4	LN	96.3[c]		3.7		27	3.6	7.5
P3	IN	50.0	50.0			25	3.4	7.3
	EN	47.1	52.9			18	2.9	6.3
Pooled		86.0		14.0		484	4.8	100.7

[a] Abbreviated as follows: NB = Nest-building, EL = Egg laying, IN = Incubation, EN = Early nestling, LN = Late nestling, FL = Fledging day.
[b] Visits by unknown individuals are excluded from the calculation of the percentages.
[c] Both the parents were unbanded.

1,083.5 mm in 1983. In winter, magpies fed on garbage discharged from the Iizuna skiing resort, as well as wild berries, such as *Berberis* sp. and *Phellodendron amurense*.

A total of 26 magpies was captured by mist nets and clap nets before the onset of their breeding, from March to May 1983. They were released after attaching unique color bands to all and wing tags to some birds. Although many birds remained unbanded at the end of May, we did not try to capture them in order to reduce disturbance of their breeding activities. The earliest nest was begun on 25 May.

We designated the birds that had dull blue primary coverts tipped with white as "yearlings," but we could not distinguish some that may have molted to adult type by the first spring (Svensson 1984). Individuals that incubated eggs were regarded as females and their mates were those that attended nests and females throughout building and laying periods (Hosono 1966a). Sexes of nonbreeding individuals could not be determined. Out of the 26 banded birds, 19 stayed in the study area in the breeding season of 1983. The fates of the other seven birds were unknown.

We made extensive daylight observations during building, laying, incubating, early nestling, and late nestling stages at 14 of 33 nests detected. We could not confirm the caring individuals at seven nests of the 14 because unbanded magpies were involved. Successful, continuous nest observations were made at the seven nests of two focal groups (see below) for 101 hr (12 nest-days) from 21 May to 31 August 1983 (Table 1). By definition the early nestling stage extends from first hatching (day 0) to day 6 and the late nestling stage extends from day 13 through the day before fledging, which occurs at about day 18 (Hosono 1966a).

RESULTS

NEST DISTRIBUTION

Three groups (A, K, P) lived in the study area during the 1983 breeding season. Each individual lived within the home range of its own group (about 100 ha; Fig. 1).

Distances between one nest and the next ranged from 15 m to 400 m with an average of 85.3 m ± 89.4 SD (n = 33 nest-dyads). We regarded two nests as "synchronous" when the nest-building and/or egg-laying stages overlapped with each other. Thirteen of the 33 nests detected had synchronous nest(s) within 100 m. Whereas, for eight other nests there was no synchronous nest within 100 m. The other 10 nests were located less than 100 m apart, but their breeding was not synchronous.

GROUP MEMBERS

Before and after the breeding season, group K was found at the foot of the mountains about 2 km from the study area. We suggest that group K was only a summer visiting group in our study area. At the beginning of the breeding season this group comprised 15 or 16 birds, including seven

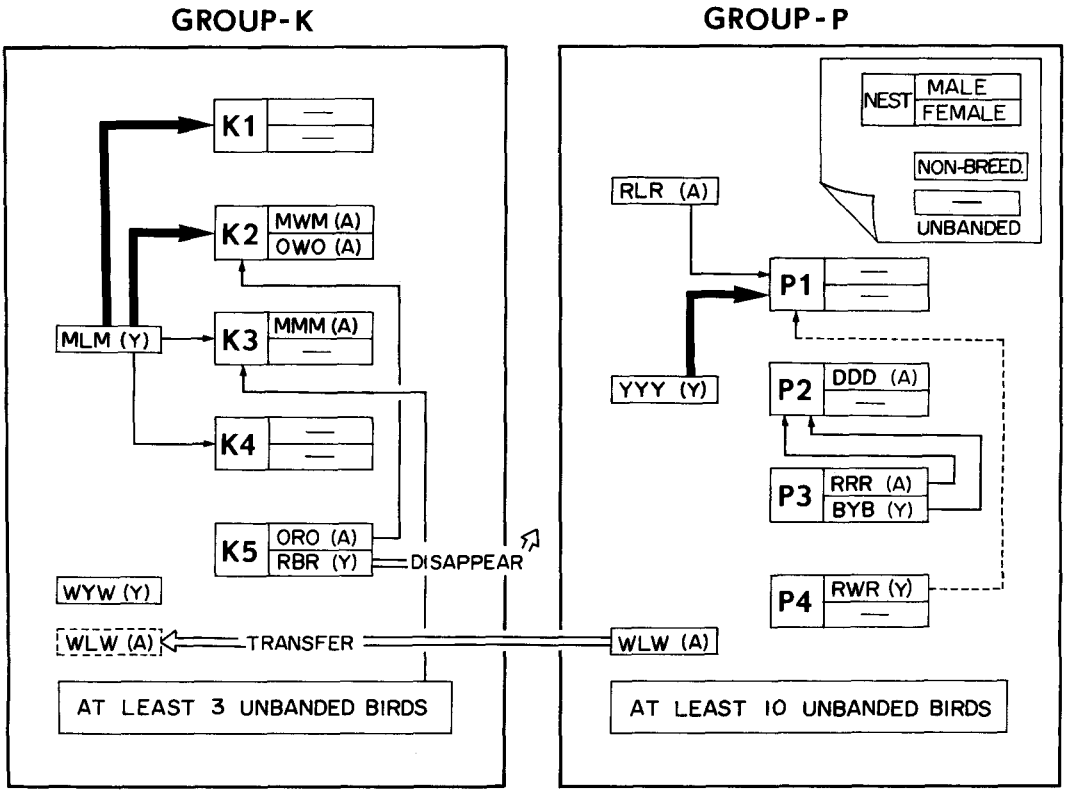

FIGURE 2. Intra-group pairing and helping relationships in two focal groups of the Azure-winged Magpie. A = adults and Y = yearlings. Thick arrows, thin ones, and broken ones express frequent helping, rare helping, and helping outside nests, respectively.

banded birds. Of the banded birds, four were adults, three males and one female, and three were yearlings, one female and two of unknown sex (Fig. 2). All four adults and one female yearling bred, while two yearlings did not breed. In this group, at least four pairs attempted to breed eight times (Fig. 2). In the middle of June, the known female yearling (RBR) disappeared after the abandonment of her first nest, and one of the unknown sex adults (WLW) immigrated into group K from group P at the beginning of August. Only these banded birds changed groups (Fig. 2).

Group P consisted of about 20 birds, including seven banded ones. Of the latter, four were adults, two males and two of unknown sex, and three were yearlings, one male, one female, and one of unknown sex. The four banded known-sex magpies bred; the other three did not (Fig. 2). Three pairs in which at least one member was banded, and two or more pairs in which both members were not banded, bred in this group. Changes of membership by banded birds were not observed except for the emigration of one (WLW) which disappeared in mid-May and was later found in group K (Fig. 2).

We excluded group A from continuous nest observation because only three of its 20 birds were banded.

ROLES OF HELPERS AT NESTS

Both sexes built nests, but only the female incubated and the male fed her. At the seven nests observed continuously, no helper was seen at one nest (P3), one helper visited two nests (K1 and K4), and two helpers visited four nests (K2, K3, P1, and P2) (Table 1). Helpers participated in carrying nest materials, constructing nests, feeding incubating and brooding females, feeding nestlings and fledglings, and removing fecal sacs. They did not participate in egg laying, incubating, or brooding. We exclude mobbing predators

from helping at the nest, because this behavior occurred in many places far from nest sites.

The number of nest visits by parents and helpers is shown for the two focal groups (Table 1). Three nests (K2, P1, and P2) had two helpers on the same day. In two of the three nests, one helper often visited (MLM and YYY, respectively), while the other rarely visited (ORO and RLR, respectively). While at the remaining nest, both (RRR and BYB) rarely visited.

The individuals and/or number of helpers, and the frequency of nest visiting were different from day to day at a particular nest (Table 1). At nest K1, no helpers attended in the egg-laying stage, but a helper (MLM) frequently visited in the incubation stage. At nest K3, two helpers (unbanded and MLM) rarely visited in incubation and early nestling stages, respectively. On the other hand, helper MLM frequently visited nest K2 on all the observed days, during incubation and the late nestling stages, and on the day of fledging.

HISTORIES OF HELPERS

A total of seven banded birds acted as helpers in groups K and P. Here we describe their activities during the breeding season (see Fig. 2 and Table 1 for all instances in this section). Three helpers, two yearlings (MLM, YYY), and an adult (RLR), did not breed for themselves, but only helped breeding activities of the group members.

A pair (male RRR, female BYB) of group P helped to construct nest P2 at the end of May and then they nested alone at the end of July. No helpers came to their nest (P3).

A yearling female (RBR) of group K disappeared while she was building a nest. About a month later, her mate (ORO) fed one of the nestlings of nest K2 once on the day of fledging.

Another instance of helping was recorded outside nests. Nestlings in a nest (P4) of group P were preyed upon in the late nestling stage. Five or 6 days after this accident, the male parent, a yearling (RWR), associated with and fed fledglings of nest P1, the only successful family in the group.

Six of the seven helpers helped only at one nest. By contrast, MLM in group K visited all four nests in its group for which we could confirm the caring individuals. MLM frequently visited nests K1 and K2, and rarely visited nests K3 and K4. On 23 July MLM fed a nestling at nest K3, then successively went to nest K2, which was about 24 m away, and fed a nestling. Some nonbreeders, WYW (yearling) of group K and WLW (adult) of group P, neither bred for themselves nor helped any birds. The latter bird transferred to group K in the middle of the breeding season as mentioned earlier.

INTERACTIONS BETWEEN NEST VISITORS

Helpers to nest P2 (RRR and BYB) never visited the nest together with the breeders (DDD and an unbanded female). On 27 May, a helper (BYB), which had been sitting on nest P2 and arranging the nest materials, left the nest as soon as she heard the call of another magpie. Two seconds later, the breeding pair came up to the nest.

MLM visited nest K3 only twice in the early nestling stage. This bird fed the nestlings with fully-stretched neck, perching apart from them, and then flew quickly away without waiting for a fecal sac. During one of these two feedings, the male breeder (MMM) visited the nest almost simultaneously. MLM waited about 30 cm from the nest while the male breeder fed, and looked in the other direction as if nothing were happening. About 90 sec after MMM departed from the nest, MLM landed on the nest rim and quickly fed a nestling.

In contrast, MLM frequently visited another nest (K2), and his behavior at the nest was not distinguishable from that of the breeders. He removed fecal sacs during at least four of five visits in the late nestling stage. Furthermore, in two instances, MLM perched on the nest rim together with the female breeder (OWO) and fed a nestling.

In the incubation stage, MLM visited nests K1 and K2 and fed the incubating female as frequently as each male breeder did, but MLM never visited these two nests together with each male breeder. In one case, MLM visited nest K1 with food during the breeders' absence, but the pair soon returned to the nest, and the male breeder repelled MLM. As soon as the male breeder flew away, MLM came to the nest again and fed the female breeder that had begun to incubate.

NONHELPING VISITS

We witnessed two visits by nonparental conspecifics without food being delivered. In one instance, the male breeder of nest K1 (MMM) approached the adjacent nest (K2) and peered at the incubating female (OWO). The female ut-

tered begging calls, but MMM flew away without feeding.

In the second instance, OWO came to the adjacent nest (K3) and peered at the incubating unbanded female. She dashed off the nest and chased OWO and another bird (probably the mate of OWO) for about 10 m. Because feathers flew during this encounter, some physical contacts probably occurred.

DISCUSSION

Out of 14 nests we observed, six had one to two helpers, one had no helpers, and in the other seven nests we could not confirm whether helpers attended or not. Therefore, 43% to 93% of nests had helpers. The same individual (MLM) helped at four different nests. Therefore, out of the 14 marked individuals in the two focal groups, at least seven (50%) were helpers. Among these helpers, two (MLM and YYY) visited three nests as frequently as parent birds did (Table 1). We conclude that helping is regular in this population of Azure-winged Magpies.

The social organization of the Azure-winged Magpie seems to be similar to that of the Gray-breasted Jay. Both species have group territories and plural breeding with separate nests, and both species live in stable groups throughout the year. Differences exist in group size and in the extent of helping. Ordinary group size is eight to 45 birds with an average of 22.9 (n = 45 groups; Hosono 1968) in the Azure-winged Magpie, being larger than the five to 22 birds reported for the Grey-breasted Jay (Brown and Brown 1985). The nests of magpies frequently were clustered, but those of the jays only rarely (Brown 1963, pers. comm.). More pairs (four to five) breed per group in the Azure-winged Magpie than in the Grey-breasted Jay (one to three pairs; Brown 1972). Both the number of helpers per nest and the frequency of visits by helpers are small in the Azure-winged Magpie. No magpie helped another nest when it had its own active nest. In contrast, not only almost all nonbreeding Grey-breasted Jays but also some breeders help all the nests of the group (Brown 1970, 1972). Furthermore, three of six marked magpies attempted to breed at age 1 year in this study, but yearling Grey-breasted Jays never bred (Brown 1972).

The two types of helpers correspond well to their behavior patterns at nests. Frequently-visiting helpers contributed considerably to feeding nestlings and attending females, and were very calm when visiting nests. In contrast, rarely-visiting helpers seemed not to contribute as feeders. They were nervous and seemed to avoid encounters with parent birds during nest visits. It should be noted that nonfeeding visits by the rare visitors were observed and that the same helper (MLM) acted as a frequently-visiting helper and a rarely-visiting one (Fig. 2).

Because three yearling magpies bred and an adult acted as a helper, we suggest that factors other than age affect a bird's status.

The most widespread hypothesis on ecological correlates of cooperative breeding is habitat saturation, in which young are restrained from dispersal and breeding (Brown 1974, Woolfenden and Fitzpatrick 1984). Similarly, Koenig and Pitelka (1981) stress that a scarcity of marginal habitat selects against dispersal of young. The regular occurrence of cooperative breeding in the Azure-winged Magpie may contribute to this discussion because it lives in zones of cool temperatures where environmental changes are predictable but rather severe. The magpie does not necessarily show K-selected attributes. For example, its clutch size averages 6.4 (Hosono 1966a) and yearling Azure-winged Magpies sometimes bred by themselves in this study. Of the three groups studied, at least one (group K), in which helpers appeared most frequently, migrated seasonally. In other regions, short-distance migration is not rare in the Azure-winged Magpie (pers. observ.). Therefore, K-selected attributes and a completely sedentary existence may not be necessary for the occurrence of helpers.

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