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Breeding losses in the Collared Flycatcher *Ficedula albicollis* caused by nest predators in the Białowieża National Park (Poland)

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Abstract. The proportion of different nest predators robbing nests of the Collared Flycatcher *Ficedula albicollis* population breeding in natural cavities in the Białowieża National Park was studied during 1988–1998. Robbed nests were examined for signs betraying the predator. Mustelids, (mostly *Martes martes*) destroyed no more than 25% of the Collared Flycatcher nests, while rodents (mostly *Apodemus flavicollis*), and woodpeckers (*Picoides major*) were together responsible for the destruction of c. 75% of all the Collared Flycatchers broods. Rodents destroyed significantly more nests with eggs, whereas woodpeckers and *Martes martes* destroyed mostly broods with nestlings.

Key words: Collared Flycatcher, *Ficedula albicollis*, nest predation, natural cavities, Pine Marten, *Martes martes,* Yellow-necked Mouse, *Apodemus flavicollis*, rodents outbreaks

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INTRODUCTION

Nest predation is considered an important and primary source of nest losses across a wide diversity of species, accounting for 80% of nest losses on average (Ricklefs 1969). Yet, act of robbery lasts very short time and very often researchers notice a traceless disappearance of eggs or nestlings. This is why so scarce information has so far been published on particular species of predators destroying the bird nests. For most of bird species we have usually the lists of confirmed and potential nest predators. This list sometimes exceeds even 30 vertebrate species (e.g. Newton 1998) but the share of different animals destroying nests is rarely known. In papers on nest predation from primeval forest of Białowieża several bird species have a potential list of nest predators but share of them is only very roughly known (Wesołowski 1985, Piotrowska & Wesołowski 1989, Tomiałojć 1994).

The purpose of this study was to determine the share of predators (species or groups), which are responsible for breeding losses in the Collared Flycatcher. Under close to primeval conditions of the Białowieża National Park (BNP), where many potential nest robbers occur, the Collared Flycatcher suffers heavy breeding losses (Walankiewicz 1991, Walankiewicz et al. 1997, Jędrzejewska & Jędrzejewski 1998). In BNP where predators were thoroughly studied the list of cavity robbers is very long (Tomiałojć et al. 1984, Piotrowska & Wesołowski 1989, Wesołowski & Stawarczyk 1991). Yet, the share of different predatory groups in destroying bird broods is usually described only in general statements (e.g. Newton 1998).

STUDY PLOTS

Białowieża Forest (1250 km^2) is a remain of the former vast lowland primeval European forest,

located on the borderline of Poland and Belarus (52°41′N, 23°52′E). From 1921 a part of this Forest has been protected as the Białowieża National Park (BNP). The strictly protected zone of BNP (47.47 km^2) has never been managed. Now it is accessible only for research purposes and to a limited degree for tourists. This forest is largely formed of mature (170–250 year old) oak-hornbeam *Tilio-Carpinetum* stands. The canopy is composed mainly of the hornbeam *Carpinus betulus*, lime *Tilia cordata*, oak *Quercus robur*, and maple *Acer platanoides,* with an admixture of spruce *Picea abies* (Faliński 1986). There is no management while human access is restricted there.

Studies were conducted in two plots within the strictly protected zone of BNP: W and CM, described in details by Tomiałojć et al. (1984). Plot W (36 ha) was studied longer and more intensively (1988–1998). The CM study plot (24 ha), selected in the same forest association — oak-linden-hornbeam type, was surveyed in 1989–1990 and 1996–1997. These were close-to-primeval conditions for secondary cavity nesting birds and birds nested there exclusively in natural cavities, as there were no nest boxes. Characteristics of bird community of this area can be found in Tomiałojć et al. (1984), Wesołowski & Tomiałojć (1995), Tomiałojć & Wesołowski (1996), Wesołowski et al. (2002). Within this bird community the Collared Flycatcher was the most numerous cavity nester which bred in densities up to 22 pairs/10 ha (Walankiewicz et al. 1997).

METHODS

From mid April to about 20 May the plots were checked every morning by 2–4 persons for the presence of Collared Flycatcher males. All the cavity trees, with any bird activity of the Collared Flycatchers noticed, were marked and then frequently checked from the ground for signs of occupation. Later, the cavities were inspected using a small lamp and a mirror on a bendable wire. Breeding cavities were defined as those in which at least one egg was found. Successful nests were those from which at least one nestling has fledged. Robbed nests were, when possible, checked thoroughly for any signs helping to recognize the predator. Additionally, during early stages of the Collared Flycatcher breeding in 1996–1997 (i.e. when eggs were laying, or females started incubation) the pieces of a plasticine material (in size c. 5 x 8 cm) of tree bark coloration were placed below the entrance rim. Aim of this was to obtain more signs of nest robbers. Plundered nests were allocated to several categories listed below. Only the nests found in early stages of breeding i.e. before start of incubation, were included into calculations.

The predator categories have been elaborated basing on more than 20-year field research of bird destroyed nests in natural cavities in BNP as well as on observations made in nest-boxes plot in managed Białowieża Forest. In the latter one Pied Flycatcher *Ficedula hypoleuca* c. 120 pairs breeding in nest boxes population suffered severe predation pressure (sink population): 56–70% of nests were destroyed in 1993–1997 years (Czeszczewik et al. 1999).

Predator categories distinguished:

1. Robber species — were known from direct observation of the robber inside cavity with destroyed nest. Direct observation of the robber removing an egg or nestling from the nest and/or attacked by nest owners.
2. Woodpecker — fresh peckings on the entrance rim or on plasticine-like material covering the entrance rim; the cavity entrance enlarged by woodpecker; an additional new entrance to the cavity made by woodpecker; fresh wood chips in the nest; killed nestlings in the nest with wounds made by woodpecker.
3. Small rodent, presumably Yellow-necked Mouse *Apodemus flavicollis* — small (2–3 mm) fragmented egg shells, nest material cut into small pieces, or the presence of characteristic scat.
4. Dormice, presumably Forest Dormouse *Dryomys nitedula* — egg shells bigger than 3–4 mm or some whole egg shells with a hole, plus rodent-like round (spherical) nest made of flycatcher nest material: nest material disturbed. Partially eaten nestlings or female, feathers of adults, scat which looks like 1–2 cm long dark or black rollers with narrowing.
5. Unidentified rodent — rodent-like signs as above, but not indicating precisely to any particular rodent species (disturbed nest material, partially eaten nestlings or adults, holes in nestling heads, eaten brain, rodent-like teeth marks on plasticine).
6. Pine Marten *Martes martes* — claw marks with about 8 mm distance between marks on the entrance rim or its vicinity, nest material pulled out of cavity, covered with saliva feathers; cut or partially chewed feathers or quills in nest or in its vicinity.
7. Unidentified mustelid — some of signs mentioned above but not indicating clearly

whether it was the Pine Marten or the Weasel *Mustela nivalis*. For instance, partially chewed feathers on the entrance rim in or out of the nest while the cup of nest left not disturbed.
8. Unidentified mammal — some signs of the mammalian activity mentioned above usually slightly disturbed nest material but not indicating any particular species from the group.
9. Unidentified predator — lack of any signs clearly pionting to any specific robber or any group category.

Additionally, in two cases predators (squirrel, and marten) were distinguished by hair left on entrance rim while robbing the nest. The Red Squirrels *Sciurus vulgaris* were even directly observed while destroying nests.

This list does not contain other species, which could potentially destroy bird nests, like the, Edible Dormouse *Glis glis* or Weasel. This is because for these three species we could not specify characteristic signs left by them during the act of robbery. Though, both these species were recorded within the study plot. The Weasel rarely climbs trees thus it could destroy only low nests, though sporadically it was seen in BNP climbing trees several meters above the ground (W. Jędrzejewski pers. inf.). The Weasel and the Edible Dormouse would have been responsible for plundering at least some the Collared Flycatcher nests and they fell into categories „unrecognized mammal" or „rodent" or „mustelid" (categories 5, 7 or 8 above).

Other species, which could potentially destroy the Collared Flycatcher nests like the Stoat *Mustela erminea* and the Polecat *M. putorius* prefer different habitats. Also shrews *Sorex* spp. were excluded from potential brood robbers because they were never been found climbing trees (pers. obs.) or searching nest-boxes (Nowakowski & Boratyński 2000).

RESULTS

A traceless disappearance of eggs or nestlings was recorded in 189 cases (59%). Below only 132 cases were analyzed in which it was possible to identify at least a group of suspected robbers i.e. unrecognized mammal, mustelid, rodent, or woodpecker.

Only four predator species were noticed „caught red-handed" robbing nests (Table 1). These cases consist 7.6% (n = 132) of robbed nests when at least the mammalian or woodpecker was seen during robbery.

Mammals were found to be more important as the nest robbers than woodpeckers. The most important groups were the mustelids (24.2%), the rodents (21.2%), and woodpeckers (20.5%). However, many destroyed nests fell into the category of „unrecognized mammal" (34.1%), which apparently consists of rodents and mustelids. Hence, all recognized and unrecognized mammalian robbers are responsible for 65–80% of losses while woodpeckers for c. 18–35% (Table 2).

Table 1. Direct observations of the Collared Flycatcher nest robbers. N - number of observations.

Species	N
Dendrocopos major	4
Sciurus vulgaris	3
Dryomys nitedula	3
Apodemus flavicollis	1
Total	10

Table 2. Number of broods destroyed by various predator groups/species (plot W).

Nest robber	N	%
Sciurus vulgaris	3	2.3
Dryomys nitedula	3	2.3
Apodemus flavicollis	4	3.0
Unrecognized rodent	18	13.6
Total rodents	28	21.2
Martes martes	26	19.7
Unrecognized mustelids	6	4.5
Unrecognized mammals	45	34.1
Total mammals	105	79.5
Dendrocopos major	4	3.0
Unrecognized woodpecker	23	17.4
Total woodpeckers	27	20.5
Total	132	100

Table 3. Number of broods destroyed by various groups/ species of robbers according to the stage of breeding. Data only from the plot W.

Species/category	Eggs		Nestlings	
	N	%	N	%
Unrecognized rodent	7	36.8	4	12.1
Apodemus flavicollis	2	10.5	2	6.1
Dryomys nitedula	2	10.5	0	0
Sciurus vulgaris	2	10.5	0	0
Total rodents	13	68.4	6	18.2
Martes martes	4	21.1	14	42.4
Woodpeckers	2	10.1	13	39.4
Total	32	100	39	100

Comparison of three category groups (i.e. all rodents, Pine Marten and woodpeckers) revealed that rodents destroyed significantly more nests with eggs while woodpeckers and Pine Marten destroyed mostly broods with nestlings (χ^2 = 13.40, df = 2, p = 0.0012; Table 3)

DISCUSSION

The most often directly observed robber was the Great Spotted Woodpecker what is probably explained by its diurnal behavior. Unexpected is the lack of direct observations of the Pine Marten plundering, despite the fact that this species destroyed up to a quarter of all the Collared Flycatcher nests. It seems that nocturnal behavior of this mammal could be responsible for this (Zalewski et al. 1995), although sometimes it was also observed during the day within the study plots.

Of three groups of nest predators, only rodents may occur in BNP in very high density (outbreak years), but in much lower density during crash years. The most important species is the Yellow-necked Mouse which in its outbreak years reaches density 70 individuals/1ha in the hornbeam-linden stands. (Jędrzejewska & Jędrzejewski 1998). This is a very efficient tree climber (Borowski 1963, Nowakowski & Boratyński 2000). The Great Spotted Woodpecker, which is presumably the only avian predator of the Collared Flycatcher, nests breeds in density up 2–5 pairs/10 ha, i.e. up to one individual/1 ha. This species fluctuates much less in numbers (Tomiałojć & Wesołowski 1990, 1994, 1996, Wesołowski et al. 2002). Much less numerous Pine Marten (0.4–0.8 individuals/km^2) is a heavier and very effective predator which can climb in BNP to tree tops (Walankiewicz 1991, Jędrzejewska & Jędrzejewski 1998, Zalewski et al. 1995).

As in this paper only nests with signs allowing to recognize at least the predators group were analyzed, there is a question remaining, what predator destroys nests without any signs or with clues indicating any particular species or group of plunderers. But, it raises another question whether such situation does not bias results. This is because some predators leave more clues than others. For instance this is very unlikely that the Pine Marten can remove nestlings from the nest not disturbing nest material. This carnivore often removes material from cavity as well. In view of this one could conclude that the Pine Martens share as a nest robber is estimated most precisely.

Other two groups, woodpeckers and small rodents, can enter cavity without leaving any traces. In fact the Great Spotted Woodpecker, during this work was four times directly observed while removing nestlings and leaving no traces in the nests or on the entrance of the cavity. Only when the cavity or box entrance is too small the Great Spotted Woodpecker some times widens it leaving wooden chips. Although in BNP many cavities in living and dead hornbeam trunks are inaccessible for woodpeckers because this tree species has very hard wood. During this work many nest cavities were found with fresh woodpecker-made marks (peckings) on entrance rim which indicates that this species attempted to rob many more cavities unsuccessfully (unpubl. observ.).

Another type of nest predators i.e. rodents, particularly the Yellow-necked Mouse can enter into all Collared Flycatcher breeding cavities, including those with narrowest entrance diameter. Rodents like the Yellow-necked Mouse and the Dormouse not always remove eggs/nestlings from cavity leaving no traces. They often destroy eggs or nestlings in the cavity sometimes rebuilding nest (dormice) or cutting the nest material into small pieces (Yellow-necked Mouse). So, it seems that woodpeckers as well as rodents leave traces which was impossible to categorize in this work. In view of that, the share of woodpeckers and particularly rodents as nest robbers seem to be underestimated. Share of the Pine Marten is probably overestimated.

So, roughly it seems that the Pine Marten destroys about 20% of the Collared Flycatcher broods. Rodents (mostly Yellow-necked Mouse) and woodpeckers (Great Spotted Woodpecker) probably have similar share. Together both groups destroy c. 80% of all the Collared Flycatcher broods. The proportions between them vary much in different seasons. Especially rodents fluctuate much in numbers in oak-lime-hornbeam stands, from c. 70 inds/ha (outbreak) to a few per ha in crush years (Jędrzejewska & Jędrzejewski 1998). The Great Spotted Woodpecker densities vary much less (i. e. from 2 to 5 pairs/10 ha; Tomiałojć & Wesołowski 1994, Wesołowski at al. 2002).

In the case Pine Marten functional reaction is probably involved. In the end of May and beginning of June, when in BNP is full of nestlings of different birds, this animal turns to eat birds, including the Collared Flycatcher nestlings (Zalewski et al. 1995, Jedrzejewska & Jędrzejewski 1998). This population fluctuations for The Pine Marten, Weasel and Yellow-necked Mouse are

very well known for the Białowieża Forest (Pucek et al. 1993, Zalewski et al. 1995, Jędrzejewska & Jędrzejewski 1998). Rodent changes in density are followed by quicker (Weasel) or slower (Pine Marten) density changes of "true" predators.

In Białowieża Forest, predation on birds nests was studied directly on several species revealing important role of nest robbers. Heavy predation on broods distinguished bird population of the Białowieża Forest from those of living in human-transformed habitats in Europe (Piotrowska & Wesołowski 1989, Wesołowski 1983, 1985, 1995, Walankiewicz 1991, Wesołowski & Stawarczyk 1991, Tomiałojć 1994).

CONCLUSIONS

Mustelids, (mostly the Pine Marten) destroyed at least than 20% of the Collared Flycatcher nests, while rodents (mostly Yellow-necked Mouse), and woodpeckers (Great Spotted Woodpecker) together destroyed c. 75% of all the Collared Flycatchers broods. The last two groups probably have similar share in nest robbery within 10 years period. The proportions between broods destroyed by them depend much on the predator density. Comparison of three category groups (i.e. all rodents, Pine Marten and woodpeckers) revealed that rodents destroyed significantly more nests with eggs while woodpeckers and Pine Marten destroyed mostly broods with nestlings

Ten-year-long study is long enough to cover the years of rodent outbreak and the crash years and as well years of moderate rodent density. Changes in density of the Great Spotted Woodpecker were less pronounced. Also density of the Pine Marten varied in that time. So, it seems that the results are reflecting the share of different groups of predators in such proportions.

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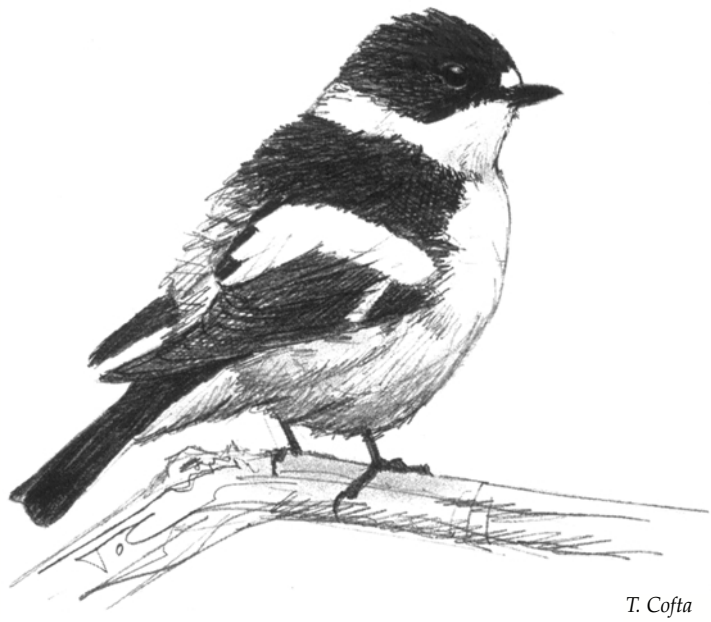
STRESZCZENIE

[Straty lęgowe muchołówki białoszyjej w Białowieskim Parku Narodowym, spowodowane przez rabowanie gniazd]

W latach 1988-1999 prowadzono obserwacje muchołówki białoszyjej *Ficedula albicollis* gniazdującej w pierwotnych grądowych drzewostanach Obszaru Ochrony Ścisłej Białowieskiego Parku Narodowego. Od początku przylotu intensywnie wyszukiwano dziuple lęgowe a następnie kontrolowano je, aby stwierdzić los lęgów (zrabowane lub pomyślny wylot piskląt). W przypadku gniazd zrabowanych dokładnie opisywano pozostawione przez drapieżniki ślady (wielkość skorupek zniszczonych jaj, stan gniazda, uszkodzenia piskląt, ślady pazurów, rozkucie otworu, świeże wióry, pozostawione włosy lub pióra itd.).

Zebrano 132 przypadki zniszczonych lęgów gniazd, w których rabusia zakwalifikowano do gatunku lub przynajmniej kategorii, jak np. „nierozpoznany ssak", „ssak z rodziny łasicowatych" czy dzięcioł (Tab. 2). Zaobserwowano też bezpośrednio cztery gatunki w trakcie rabunku (Tab. 1).

Przybliżony udział trzech najważniejszych grup w stratach lęgów muchołówki: łasicowate (przypuszczalnie głównie kuna leśna) – 25%, gryzonie (głównie mysz leśna) i dzięcioły (dzięcioł duży) – łącznie 75%. Dwie ostatnie grupy mają z pewnością różny udział w zależności od ich liczebności. Na przykład wspinająca się aż na szczyty drzew mysz leśna występowała w grądach Białowieskiego Parku Narodowego w zagęszczeniach od kilku do ponad 70 osobników na 1 ha. Przy tak wysokich zagęszczeniach tego gryzonia prawdopodobieństwo zniszczenia lęgu muchołówki jest bardzo wysokie. Długi okres zbierania danych (11 lat) obejmował zarówno lata bardzo wysokiej liczebności gryzoni (1990) jak i lata załamania się liczebności tej grupy. Również liczebności dzięcioła dużego i kuny leśnej wahały się w badanym okresie, chociaż w znacznie mniejszym zakresie niż gryzoni. Gryzonie częściej niszczyły lęgi z jajami, podczas gdy kuna leśna i dzięcioły preferowały rabowanie gniazd z pisklętami.



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