BEHAVIOUR OF MONTAGU'S HARRIER JUVENILES DURING THE POST-FLEDGING DEPENDENCY PERIOD IN SOUTHEAST POLAND

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Abstract. The dependency period of 51 fledglings Montagu's Harrier (*Circus pygargus*) was studied on calcareous peat-bogs near Chelm (SE Poland). The juveniles fledged on average 33,6 days after hatching, and continued to depend on their parents for 17–31 days (M = 23,6 ± 3,6 days, n = 42). A progression was observed in the flight behaviour ability of the fledglings: the total time spend flying each day increased throughout this period, as well as the use of energy saving flight types. With progressing dependency period the rate of successfully aerial prey transfers increased. The mortality rate during the dependency period was 17,6 % (n = 51).

Key words: Montagu's Harrier, *Circus pygargus*, Poland, behaviour, post-fledging dependency period, flight development.

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Поведение молодых луговых луней в послегнездовой период в Юго-Восточной Польше. - И. Китовский. - Беркут. 11 (2). 2002. - Послегнездовой период 51 слетка лугового луня изучался на известковых верховых болотах возле г. Хелм (юго-восток Польши). Молодые птицы оставляли гнездо в среднем через 33,6 дня после вылупления и докармливались родителями еще на протяжении 17–31 дня (M = 23,6 ± 3,6 дней, n = 42). Отмечены изменения в способности птенцов летать: с каждым днем увеличивается время, проведенное в полете, и использование более экономных способов полета. Увеличивается количество успешных передач корма в воздухе. Смертность во время послегнездового докармливания составляла 17,6 % (n = 51).

INTRODUCTION

Despite the well known breeding ecology of Montagu's Harrier (*Circus pygargus*) (Schipper, 1978; Leroux, Bretagnolle, 1996) the knowledge about the post-fledging period (hereafter termed the dependency period) of this species is small. Studies on the dependency period of Montagu's Harrier have only been carried out in West Europe, where they nest in agricultural areas (Pandolfi, 1996; Amar et al., 2000). Little is known about the ecology of this species during the dependency period in East-European peat-bogs. Furthermore, previous studies address only some aspects of their ecology during that period, and the behaviour of the juveniles is largely non-described, as well as the mortality of the juveniles in such a critical period. The purpose of this study was to determine the length of the dependency period for the species in SE Poland, estimate the temporal trends in their behaviour (develop-ment of flight skills and hunting behaviour, relationships with their parents and intruders), and determine the rate of post-fledging mortality in the Montagu's Harrier.

STUDY AREA AND METHODS

Observations were conducted in calcareous peat-bogs near Chelm (51°08' N, 23°37' E, southeast Poland). Nearly 50 % of this peatland is densely overgrown with Saw Sedge (*Cladium mariscus*) and the remaining area, with associations of Sedge *Magnocaricion* communities. This Saw Sedge habitat is a nesting site for about 30–50 pairs of Montagu's Harrier depending on the season (Krogulec, 1992). The climate of the study area is typical of southeast Poland, characterised by relatively warm summers: mean temperature in July is 17,8 ⁰C, in August 16,0 ⁰C (Kaszewski et al., 1995).

In the years 1989–1992, 19 pairs of Mon-

tagu's Harriers with 51 fledglings were observed. Nestlings (n = 42) from 14 families were individually Saflag® wing-tagged (Kochert et al., 1983). These patagial tags appeared to have no negative effect on the fledglings' behaviour during our study. Some fledglings were found to lose their tags by the time for migration. The other 9 untagged juveniles were distinguished by feather characteristics (broken rectrices, primaries or wing coverts). Tagging adult birds was given up as abandonment of broods after trapping was suspected (Pandolfi, 1996). Adults were identified by their individual characteristics including moult stage (Lontkowski, Stawarczyk, 1994). Moult proved particularly useful in separating females. Differences in colour of wing coverts and feather losses were useful details obtained from the onset of the incubation period. Differences in head colour helped identify the males. In order to identify each individual during the study, I recorded the differences in plumage by either drawings or photographs of individuals. Age and sex of the offspring were determined during nest examinations using plumage features and the colour of iris (Krogulec,1992).

Field studies consisted of 12-hour observation periods (8^{00}–20^{00}), in a 1 to 4 day cycle for each of the studied families. From 1989–1992, I conducted 152 observation sessions totalling 1824 hours. The birds were observed with a 60^x telescope and 10 x 60 binoculars at an average distance of 200 m. Field studies started 2–3 days before the estimated first flight (late June – early July). The duration of their behaviours was measured with an electronic stopwatch and the height of juvenile's flights was estimated by comparing with height of trees of known height. Observations ended when the last juvenile of each group left the natal area (late August). For the analyses of the age, beginning and duration of the dependency period observations of all 51 fledglings were used. However, for analyses of behaviour only the observations of the 37 colour marked juveniles were used. Because five wing tagged birds dead.

Correlations used were Spearman rank correlations or Pearson moment product correlations depending on the kind of distribution of each variable (Sokal, Rohlf, 1981). To determine trends in the behaviour of juveniles with their age, Pearson moment product correlation was used. For variables for which the relationship with age of juveniles was exponential rather than linear, I used Pearson moment product correlation after log-transformation of the data. To compare age and duration of the dependency period between the sexes, Student's *t*- test was used. Frequencies were compared using the χ^2 test with Yates corrections as necessary (Sokal, Rohlf, 1981). All means are given ± SD.

RESULTS

Age of first flights and duration of the dependency period

First flights were performed M = 33,6 ± 1,6 days after hatching (range 31–36 days after hatching, n = 51), and the dependency period lasted on average of M = 23,6 ± 3,6 days (range 17–31 days, n = 42). Males performed their first flights at the age of M = 32,8 ± 1,23 days (range 31–35 days, n = 23). Females started flying from M = 34,2 ± 1,50 days after hatching (range 31–36 days, n = 28). The differences between the sexes were significant (*t* = 3,576, P < 0,001, *df* = 49). Young females remained under the parents' supervision up to 52–66 days after hatching (on average M =58,3 ± 3,63, n = 23). Young males remained with adults on average up to M = 55,5 ± 3,48 days after hatching (range 52–65 days, n = 19). Age differences between sexes at the beginning of dispersal were significant (*t* = 2,557, P < 0,02, *df* = 40). Young males dispersed 18–31 days after the first flight, on average M = 22,7 ± 3,31 days (n = 19), whereas females dispersed 17–31 days since leaving the nest M = 24,3 ± 3,59 days (n = 23). The differences in the duration of the dependency period between the sexes were insignificant (*t* = 1,380, n. s). Hatching date (expressed in Julian date) did not influence the age of leaving the nest (Spearman

Table 1

Pearson's correlation coefficients (r) and regression coefficients (a) between variables describing flight ability of Montagu's Harrier juveniles and the total daily number of flights (TDNF)
Коэффициенты корреляции (r) и регрессии (a) между переменными, описывающими способность к полету молодых луговых луней и общее количество полетов в день

Variables	Age of juveniles (days after hatching)	
	31–48, n = 211	49–66, n = 129
Total daily time spent flying (TDTSF)	$r = 0{,}940{**}, a = 1{,}69$	$r = 0{,}721{**}, a = 0{,}963$
Mean daily flight duration (MEAFD)	$r = 0{,}768{**}, a = 0{,}721$	$r = -0{,}255, a = -2{,}377$
Maximal daily flight duration (MXFD)	$r = 0{,}845{**}, a = 1{,}144$	$r = 0{,}238, a = 0{,}367$

** P < 0,0001

$r = 0{,}123$, n = 51, n. s). However, juveniles hatched earlier took advantage of a longer care of adults (Spearman $r = 0{,}591$, n = 42, P < 0,002).

Flight development

The length of the first primary was measured on day 30 after hatching in 7 fledglings performing the first flights on day 31 after hatching. The first primary was then only 72,3 % on average of that of the first primary of adult Montagu's Harriers reported by Cramp and Simmons (1980). The first flights were only flapping flights. From M =40,1 ± 1,22 days after hatching, (range 36-42, n = 11) the first short gliding flights were observed. From M =49,0 ± 1,26 days after hatching (range 47–52, n = 16) juveniles performed long lasting thermal soaring flights. The total daily time spent flying (TDTSF) increased significantly with increasing juvenile age ($r = 0{,}750$, n = 340, P < 0,0001), and the increase was exponential ($y = -26{,}56 \text{ x}^{8,7}$)

The total daily time spent flapping by juveniles did not change with their age ($r = 0{,}162$, n. s). However, the percentage of time flying that was flapping as opposed to gliding decreased with age ($r = -0{,}752$, n = 340, P < 0,0001), as the proportion of flying time including soaring and gliding increased ($r = 0{,}524$, n = 340, P< 0,0001). Due to that there appeared a strong correlation between TDTSF

and the duration of total daily time of soaring and gliding flights ($r = 0{,}838$, n = 340, P < 0,0001).

The maximal daily flight duration (MXFD) ($r = 0{,}802$, n = 340, P < 0,0001) and the mean daily flight duration (MEAFD) ($r = 0{,}803$, n = 340, P < 0,0001) also increased exponential with age of juveniles: $y = -22{,}7 \text{ x}^{7,3}$; $y = -15{,}7 \text{ x}^{5,2}$ respectively.

In the interval 31–48 days since hatching the total daily number of flights (TDNF) increased with age ($r = 0{,}710$, n = 211, P < 0,0001). However, after that age no significant correlation was noted between TDNF and the age of juveniles ($r = -0{,}238$, n = 129, n. s). In the first period after fledging, TDNF was significantly and positively correlated with all other variables describing flight duration: MAXFD, MEAFD and TDTSF. After 48 days of age, only TDTSF was significantly correlated with TDNF (Table 1).

Nest ties

The total daily time spent by juveniles in the nest (TDTSN) decreased with age ($r = -0{,}749$, n = 340, P < 0,0001), as did the number of flights starting or finishing in the nest ($r = -0{,}441$, n = 340, P < 0,0001). A strong negative correlation between TDNF and TDTSN occurred for 31–48 days since hatching ($r = 0{,}743$, n = 211, P < 0,0001). Such a relationship was not observed in the second half of

Table 2

Types of food transfers from parents to dependant offspring according to offspring age (days after fledging)

Типы передачи корма от родителей опекаемым птенцам соответственно их возрасту (дни после вылета)

Type of food pass	1–11 days	12–22 days	23–31 days
On the nest transfers	579	177	–
On the ground transfers	62	42	14
Aerial	28	324	422
Total	669	543	436

the dependence period ($r = -0,190$, n = 129, n. s). For the whole dependency period a negative correlation was shown between TDTSN and either MEAFD ($r = -0, 448$, n = 340, P < 0,0001) or MAXFD ($r = -0,401$, n = 340, P < 0,0001).

Aerial food transfers

Initial prey transfers from adult to juveniles were in the nest and on the ground (Table 2). On average, fledglings successfully caught prey from parents in the air from M= 41,5 ± 8,86 days after hatching (range 36–46 days, n = 23). The percentage of successfully caught prey increased through the dependency period ($r = 0,747$, n = 340, P < 0,0001). Of n = 774 aerial food transfers between parents and offspring, 85,3 % were successful. The success of aerial transfers was negatively correlated with TDTSN ($r = -0,682$, n = 340, P < 0,0001) and positively correlated with the maximal daily height of their flights ($r = 0,512$, n = 340, P < 0,0001)

Parent-offspring relationships

The mean time spent on begging flights (MTBF), where juveniles follow their parents emitting soliciting calls, increased with progressing dependence period ($r = 0,679$, n = 340, P < 0,0001). However, the total number of daily flights towards parents did not change significantly with the age of juveniles ($r = 0,176$, n. s.). During feeding, 12 cases of aggression of juveniles towards parents were observed. From M = 49,5 ± 3,2 days after hatching, (range 47–52 days, n = 10) unsuccessful cases of juvenile harriers begging for food from strange birds were noted (Table 3).

Harassing of intruders

Juveniles started to chase aggressively intruders from M = 44,5 ± 3,2 days after hatching (range 37–48, n = 27). As juveniles matured, the frequency of aggressive chases increased ($r = 0,464$, n = 340, P < 0,0001). However, that was not accompanied with an increase of the total daily time spent on harassing intruders (TDTSH) ($r = 0,259$, n. s.). TDTSH was significantly correlated positively with TDTSF ($r = 0,447$, n = 340, P < 0,0001) and TDNF ($r = 0,554$, n = 340, P < 0,0001). A significant relationship also occurred between MTBF and the number of aggressive chases of intruders ($r = 0, 516$, n = 340, P < 0,0001).

Hunting behaviour

As juveniles grew up a significant increase in the number of cruising flights (*sensu* Jimenez, Jaksic, 1989) was observed ($r = 0,503$, n = 340, P < 0,001), which are typical of the hunting behaviour of Montagu's Harrier. From M = 48,5 ± 2,9 after hatching (range 42–55 days, n = 7) juveniles tried to catch dragonflies (*Odonata*) in the air. However, no attempt was successful. Successful hunting of grasshoppers (*Tettigonioidea*) was recorded from M = 49,0 ± 5,54 days after hatching (range 47–54 days). Unsuccessful attempts to catch passerines were observed on seven occasions M = 47,3 ± 3,23 days after hatching (range 45–52 days).

Post-fledging mortality

Nine (17,6 %) of the 51 studied juveniles were found dead. The death of 7 of those ju-

veniles (77,7 %) was caused by foxes (*Vulpes vulpes*). One juvenile was victim of cainism (Kitowski, 1994b) and another one was killed by an undetermined raptor. It could have been killed by Goshawks (*Accipiter gentilis*), Lesser Spotted Eagle (*Aquila pomarina*), Marsh Harrier (*Circus aeruginosus*). During the study, no death of juvenile because of starvation was detected.

DISCUSSION

The duration of the dependency period in SE Poland appeared to be similar to that found in Italy (on average 24 days, Pandolfi, 1996) and in western France (Amar et al., 2000), where 35 wild fledglings remained on average 25 days. However, dependency period in peatland areas of SE Poland was shorter than that observed by Pomarol (1994) in Spain, where the duration of the dependence period of hacked juveniles was 33,7 days.

The results from this study confirm those obtained previously from a smaller sample in relation to the age of first flights (Kitowski, 1994b): males of Montagu's Harrier left the nest at a younger age than females, as observed in other raptors with reversed sexual dimorphism (Schaarf, Balfour, 1971; Newton 1986; Witkowski, 1989). This suggests that male Montagu's Harriers develop more quickly than their female siblings. As in other raptors (Donazar, Ceballos, 1989; Schaadt, Bird, 1993) young Montagu's Harriers started flights when their primaries were not fully grown. It also appeared that in young Ospreys (*Pandion haliaetus*) feathers were the most weakly developed body element of offspring at the time of their first flights (Schaadt, Bird, 1993).

The development of flight skills in juvenile Montagu's Harriers seemed to take place like in other raptors (Bustamante, Hiraldo, 1989; Bustamante, 1993), which increase the total, mean and maximal daily time spent on flights throughout the dependency period. In the Montagu's Harrier, these variables increased exponentially rather than linearly with age. Therefore, by the end of the dependency

Table 3

Frequency of occurrence of begging behaviour by juveniles of Montagus Harrier directed to non-parents

Частота выпрашивания корма молодыми луговыми лунями, обращенного к не родителям

Species	Number cases
Circus pygargus	47
C. aeruginosus	24
Falco tinunnculus	2
Aquila pomarina	3
Ciconia nigra	4
C. ciconia	6
Larus ridibundus	3
Sterna hirundo	3
Ardea cinerea	5
Total	97

period the increase in flying time was accelerated. This was accompanied with a decrease in the number of flights (as each flight bout lasted longer). The disruption of the strong relation relationship between time spent flying and number of flights typical of the first part of dependency period opens unequivocally "the window of dispersion" (Kenward et al., 1993). The time of the departure from the natal area coincided with the peak of flight skills of juveniles. The disappearance of anatomical constraints due to full development of feathers and their hardening (Brown, Amadon, 1968; Bustamante, Hiraldo, 1989) was associated with an extension of the range of flight techniques: gliding and soaring were used by juveniles more frequently in the second part of the dependency period. These techniques require less energy in comparison with the flapping flights (Pennycuick, 1989) typical of the early dependency period.

Soaring and gliding, in contrast to other raptors (Brown, 1990; Bustamante, 1993) are insignificant for foraging of Harriers which used frequently crusing (*sensu*: Jimenez, Jaksic, 1989) what is result of application of

hearing for prey detection (Schipper, 1977; Rice, 1982). However, the ability to perform such flight techniques may also be important for juveniles in the context of the autumn migration (Spaar, 1996).

Offspring of Montagu's Harrier were very efficient during aerial food transfers, similarly than in Central Italy – 89 % successful aerial food transfers (n = 131, Pandolfi, 1996) and even more so than African Marsh Harrier (*Circus ranivorus*) – 78 % (n = 73, Simmons, 1991). The success of aerial food transfers in the studied juveniles depended on the development of skills in flying. Better flight skills allowed them to shorten the distance to the talons of parent, which assured them to grasp the prey.

The results of this study also show that breaking links with the nest by juveniles of Montagu's Harrier resulted from performing a larger number of flights rather than increasing their duration. The ability to make frequent short flights despite not having completely developed feathers may play an adaptive role in this ground-nesting species, reducing the risk of predation by mammals in the early dependency period. The latter is particularly important as the results from this study also show that death by mammal predation is an important risk for juvenile Montagu's Harriers during that period.

The mortality rate of Montagu's Harriers during the post-fledging period observed in this study is relatively high as compared to that observed in Accipitridae raptor species nesting in trees, such as Black Kite (*Milvus migrans*) (6,7 %, n = 15, Bustamante, Hiraldo, 1989), Ferruginous Hawk (*Buteo regalis*) (11,1 %, n = 18, Konrad, Gilmer, 1986), or Red Kites (*Milvus milvus*) (13,5 %, n =37, Bustamante, 1993), but closer to that observed in ground-nesting Hen Harriers (*Circus cyaneus*) (14,2 %, n = 7, Beske, 1982). In falcons, however, a higher post-fledging mortality rate was recorded than in Montagu's Harriers. Of 61 radiotagged juveniles of American Kestrels (*Falco sparverius*), 26 % died (Varland, 1993). Among young Mexican Falcons (*F. mexicanus*) 31 % (n = 152) died before the dispersion (McFadzen, Marzluff, 1996). Of 25 juveniles of Lesser Kestrels (*F. naumanni*) 51% died (Bustamante, Negro, 1994).

In all species, the two main causes of mortality after leaving the nest are predation (Varland et al., 1993) and starvation (Bustamante, Negro 1994). Other causes such as collisions with trees, premature flights because of windy conditions, etc, occur occasionally, but they do not seem to have a big influence (Brown, 1990). In the Montagu's Harrier, attacks of mammalian predators (*Carnivora*) were the main reason of death, similar than what was observed in American Kestrels (Varland et al., 1993) and Black Kites (Bustamante, Hiraldo, 1989). However, attacks by raptors also occurred. Attacks of diurnal raptors such as Goshawks caused considerable losses among emancipation young Sparrow Hawks (*Accipiter nisus*) (Newton, 1986), and may also be important for the Montagu's Harriers.

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