

Trends in parental care of Montagu's Harrier *Circus pygargus* during post-fledging period – case study from South East Poland

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Zusammenfassung

Brutpflege von Wiesenweiheneltern nach dem Flügghwerden – eine Fallstudie aus Südostpolen

Wie sich das Verhalten von Wiesenweihen zu ihren Jungen nach dem Flügghwerden allmählich ändert, wurde an 14 Familien mit farbmarkierten Jungen untersucht. Im Verlaufe des Älterwerdens der Jungen verbrachten die Eltern weniger Zeit mit ihnen, näherten sich ihnen weniger und fütterten sie weniger häufig. Die Häufigkeit des Fortjagens von Eindringlingen und Aggressivität jenen gegenüber nahm mit dem Selbständighwerden der Jungen ebenfalls ab.

Die erhobenen Daten belegen, dass die größte Zurücknahme der elterlichen Zuwendung am Anfang des Flügghwerdens liegt und dass dann die Jungen allmählich zur Unabhängigkeit geführt werden. Wiederholte Fälle von Eltern, die auf ihre Jungen stoßen und ihnen Beute verweigern, legen während der Abhängigkeitsphase das Bestehen von Spannungen zwischen Eltern und Jungen, die aber für deren weitere Entwicklung biologisch sinnvoll sind, nahe.

1. Introduction

The full understanding of population dynamics of raptor birds, apart from research on biology and ecology of reproduction, makes it necessary to do a close study of a period when young raptors while still in the supervision of their parents, develop their innate skills of flying and hunting. However, to date the post-fledging period has been the subject of but few field studies (NEWTON 1979, BUSTAMANTE & HIRALDO 1993, KOGA & SHIRAIISHI 1994).

Among the papers of particular interest that contain data concerning parental care during the emancipation period in raptors are those from Western Europe (RYVES 1948,

UNDERHILL-DAY 1993, AMAR et al. 2000, ARROYO et al. in press). We still have little knowledge about parental care in populations of Montagu's Harrier from east-Europe where the birds occupy areas of large marshes.

The aim of the present study was to investigate the changes of the main form of parental care over the duration of the post-fledging period. An attempt was also made to determine the extent and nature of aversive behaviour of parental individuals towards their offspring during the stage of reproductive cycle under consideration.

2. Study area and method

Field study was conducted on calcareous marshes near Chelm (51°08'N, 23°37'E) in the years 1989–1992 with a population of 27–42 pairs of Montagu's Harrier nesting in the stands of Saw Sedge *Cladium mariscus* that occupy nearly half of the marsh area (KITOWSKI 1994). Following the example of other investigators of harriers (PANDOLFI 1996, SIMMONS 1988), adult individuals were not captured and marked since it might have induced them to abandon their nests. Instead, individual plumage traits were used to distinguish between them. In females, use was made of the fact that they

undergo moult during incubation (loss of secondaries) and that the colour of wing coverts varies with age – it becomes red in older birds. Males were recognised by feather gaps and by differences in colour (dark head and darker wing coverts in younger birds) which were used as marker traits. I recorded the differences in plumage by either drawings or photographs of individuals. In the field differences manifested by damaged feathers resulting from aggressive interactions with other raptors and attacks by carnivores were extremely useful.

Tab. 1: Pearson correlation coefficients (r) between age of the youngest juvenile Montagu's Harrier in family and variables describing parental investment. Variables: NAC=number of aggressive chases, TSA=time spent in aggressive chases, NDD=number of dives at an alien bird during a defence event, NPP=number of prey items provisioned, TBD=total biomass delivered, TNJ=time spent near juveniles (at least one of the adults, as percent of the observation time), NFN=the number of flights not related to feeding. – *Pearson Korrelationskoeffizienten zwischen Alter des jüngsten Wiesenweihnestlings und Variablen, die die elterliche Zuwendung beschreiben. Variablen: NAC=Zahl von Attacken (gegen Eindringlinge), TSA=Zeitverbrauch für Attacken, NDD=Zahl von Stößen auf Fremdvoegel während eines Verteidigungsaktes, NPP=Zahl der verabreichten Beutestücke, TBD=übergebene Gesamtbiomasse, TNJ=bei den Jungen verbrachte Zeit (wenigstens ein Altvogel, in % der Beobachtungszeit), NFN=Zahl der Flüge ohne Bezug zum Füttern.*

Family	N	NAC	TSA	NDD	NPP	TBD	TNJ	NFN
F1	22	-0.649***	-0.802****	-0.907****	-0.780****	-0.824****	-0.821****	-0.897***
F2	22	-0.860****	-0.843****	-0.808****	-0.502****	-0.704****	-0.601***	-0.844***
F3	9	-0.721*	-0.601*	-0.599****	-0.092	-0.042	-0.858***	-0.733*
F4	9	-0.735*	-0.582**	-0.866****	-0.688**	-0.693**	-0.618	-0.825***
F5	10	-0.170	-0.222	-0.941****	-0.343	-0.311	-0.706*	-0.530
F6	8	-0.742*	-0.888**	-0.333	-0.350	-0.291	-0.895***	-0.679
F7	7	-0.587	-0.440	-0.421	-0.769*	-0.881****	-0.872**	-0.719
F8	7	-0.576	-0.331	-0.123	-0.801*	-0.839****	-0.583	-0.796*
F9	11	-0.843***	-0.855**	-0.899****	-0.885****	-0.799****	-0.827***	-0.929****
F10	9	-0.337	-0.806	-0.607	-0.788**	-0.700**	-0.748*	-0.831***
F11	12	-0.825****	-0.771**	-0.892****	-0.639*	-0.600*	-0.806***	-0.726***
F12	6	-0.784	-0.911*	-0.502	-0.813*	-0.622*	-0.902	-0.850*
F13	12	-0.275	-0.833**	-0.889****	0.074	0.113	-0.525	-0.390
F14	8	-0.453	-0.441	-0.495	-0.713*	-0.502*	-0.690	-0.642
Total	152	-0.541****	-0.362****	-0.774****	-0.523****	-0.468****	-0.730****	-0.725****

* $p < 0.05$, ** $p < 0.02$, *** $p < 0.01$, **** $p < 0.001$

Fourty two nestlings from 14 families (Table 1: F1-F14) were marked individually by using patagial tags according to the pattern suggested by KOCHERT et al. (1983). The tags were made of Saflag®. Juvenile birds were guaranteed to free themselves from the markers relatively quickly as the sheet wore through. In the course of the study no behaviour was observed that would indicate a negative effect of the marker on birds.

The field study consisted of 12-hour observation sessions (8:00-20:00) conducted for each of the families every 1 to 4 days. A total of $N=152$ observation sessions (Table 1) was made, total observation time being 1824 hours. Field investigations were started 3-4 days before the date of the first flight of the oldest juvenile of a brood. This date was calculated by monitoring the nests during hatching and by taking measurements of the primaries. On average, it occurred on the 34th day after hatching. Recording was discontinued as the last juvenile from a family left the breeding territory. In the investigated harrier population

it would occur within $\bar{x}=23.6\pm3.6$ days (range: 17-31 days, $N=42$) from the first flights of the offspring (KITOWSKI 1994, KITOWSKI 2001). For statistical analysis the number of days after hatching of the youngest fledgling in broods was taken as the measure of offspring age. The data of JUSZCZYK (1974), PUCEK (1984) and ROMANOWSKI (1988) were utilized to estimate vertebrate prey biomass. Following ROMANOWSKI (1988) 0.5g. biomass of all invertebrates was assumed.

In the analysis of the results, chi-square tests were applied to examine the fitting of actual data with the expected distribution. To determine trends in parental care with maturation of offspring, Pearson correlation coefficients (r) were used. For variables for which the relationship with age of juveniles was exponential, linear data were log-transformed. The determination coefficient (R^2) was used to determine the a and b parameters of "the best-fitting curves" (SOKAL & ROHLF 1981, FOWLER & COHEN 1992).

3. Results

3.1 Time spent near offspring and chasing away birds

Adult Montagu's Harriers spent a certain amount of time in post-fledging areas of their offspring. The time was devoted to flying, resting or chasing away of intruders. As the offspring were becoming more self-reliant the amount of time spent near juveniles at least of one of the adults, expressed as percent of the observation time (TNJ), decreased ($r=-0.730$, $n=152$, $p<0.001$). The tendency proved to be significant for 8 out of 14 broods to be analysed (Table 1). For all the families under investigation this process is best described by the curve

$y=\text{Exp.}(-0.01x+9.4, R^2=53.23\%)$. While staying with the young the adult birds became actively involved in keeping alien birds off the offspring's immediate vicinity. A total of 731 chasing events was observed involving 878 alien birds (Table 2). As the juveniles grew older there were fewer cases of chasing away by the parents ($r=-0.541$, $n=152$, $p<0.001$). The tendency proved to be significant for 7 out of 14 families (Table 1). A decreasing number of aggressive chases (NAC) (Table 1) was accompanied by the reduced amount of time spent in aggressive chases (TSA) ($r=-0.362$, $n=152$, $p<0.001$). The trend was significant for 5 out of 14 investigated families

(Table 1). Adult birds from the studied families gave up first offspring defence on an average of $\bar{x}=55.5$ days (± 5.03 , $n=14$, range: 47–65). Only in four family groups (F5, F6, F10, F13) were the young defended until the migration started. As the emancipation period advanced, the average number of dives at an alien bird during a defence event (NDD) also decreased ($r=-0.774$, $n=152$, $p<0.001$). This tendency was significant for 11 out of 14 investigated families (Table 1).

3.2 Flights towards the offspring

One of the ways by which the adults showed interest in their offspring was to make flights in their direction. A total of $N=3615$

Tab. 2: Number of birds species chased by Montagu's Harrier *Circus pygargus* in south-east Poland. – Anzahl von Wiesenweihen vertriebener Vögel pro Art in Südostpolen.

Species	N	%N
<i>Ardea cinerea</i>	1	0.1
<i>Ciconia ciconia</i> ad.	22	2.5
<i>Ciconia nigra</i>	4	0.5
<i>Aquila pomarina</i> ad.	1	0.1
<i>Buteo buteo</i> ad.	17	1.9
<i>Pernis apivorus</i>	2	0.2
<i>Accipiter gentilis</i> ad.	9	1.0
<i>Accipiter nisus</i> ad.	13	1.5
<i>Milvus migrans</i> ad.	1	0.1
<i>Circus pygargus</i> ad.	211	24.0
<i>Circus pygargus</i> juv.	141	16.1
<i>Circus aeruginosus</i> ad.	312	35.6
<i>Circus aeruginosus</i> juv.	112	12.8
<i>Falco subbuteo</i> ad.	4	0.5
<i>Falco subbuteo</i> juv.	4	0.5
<i>Falco tinnunculus</i> ad.	7	0.8
<i>Vanellus vanellus</i> ad.	3	0.3
<i>Numenius arquata</i> ad.	3	0.3
<i>Asio flammeus</i> ad.	2	0.2
<i>Corvus corax</i> ad.	3	0.2
<i>Corvus corone</i> ad.	6	0.2
Total No. of individuals	878	100

of such flights in 14 family groups was observed. The number of flights not related to feeding (NFN) declined as the juveniles became more emancipated ($r=-0.725$, $n=152$, $p<0.001$). The highest number of flights ($N=1712$, 47.3%) was made during the feeding context. The number of all offspring-bound flights was significantly related to variables that described chasing away of intruders. The relationship with the time devoted to harass alien birds was significant ($r=0.443$, $n=152$, $p<0.001$) as was the relationship with the number of harassing acts ($r=0.678$, $n=152$, $p<0.001$).

3.3 Provisioning of food

A total of $N=1648$ prey delivery acts from the parents to the juveniles was recorded. Males caught 772 (46.8%) prey items, and delivered 714 (43.3%) prey items directly to juveniles. A small number of feeding events (58, 3.5%) was preceded by aerial food transfers from males to females. Females caught 876 (53.2%) prey items and delivered 934 (56.7%) directly to juveniles. There were intersexual differences between the number of prey items caught for juveniles ($\chi^2=6.56$, $p<0.01$).

The number of prey supplied to the offspring varied. During the 12-hour observation sessions individual broods were observed to be given from 2 to 44 prey items which surpassed the amount supplied while the fledglings were still in the nest. As the juveniles grew older the number of prey items provisioned (NPP) to them by their parents declined ($r=-0.523$, $p<0.001$). A detailed analysis showed that tendency to be significant in 10 out of 14 families (Table 1). The changes in the number of prey items supplied to the juveniles as related to their age is described by the "best fitted" curve: $y=\text{Exp.}(-0.04x+4$, $R^2=27.4\%$). A decreasing number of prey items provisioned to juveniles was ac-

accompanied by the reduced biomass (TBD) ($r=-0.468$, $n=152$, $p<0.001$ (Table 1). In the food delivered to the offspring small mammals such as *Microtus* spp. (79%) and grasshoppers *Tettigonioidea* (18%) were predominant, accounting for as much as 99.2% of the biomass of prey (KITOWSKI 2000b). An annual massive appearance of those grasshoppers on the peatlands coincided with the post-fledging period of Montagu's Harriers.

Three ways of food transfers to the offspring were observed depending on their flying abilities: a) nest transfers, b) ground transfers, c) aerial transfers. As the young became more self-reliant there was a clear tendency for the adults to decrease the number of ground and nest transfers ($r=-0.897$, $n=152$, $p<0.001$). Ultimately, nest and ground transfers were phased out.

3.4 Aversive behaviour displayed by parents towards their offspring

Three types of parental behaviour were recorded that point to the existence of inter-generational tensions: parental behaviour that encouraged the offspring to make flights at the beginning of the emancipation period, refusal of feeding the offspring the prey they solicited, aggressive behav-

iour of adults towards the juveniles, aggressive behaviour consisting in dives towards the offspring.

In the period when the first flights were made by the young, in 4 families a total of 16 cases was observed which could be recognised as encouraging or forcing the offspring to fly. They consisted in landing at a short distance from the nest after a prolonged flight with prey which made the offspring fly over a short distance from the nest to the parent. Once one or several flights by the young had been made, the adults would carry the prey to the nest which again enticed the young to fly in pursuit of the prey.

As many as 65 cases were recorded involving the refusal of the adults to feed their offspring with prey carried to or caught in the post-fledging areas. Each of the cases was accompanied by intensive begging of the offspring. Males made 6 and females 59 such refusals, the difference being highly significant ($\chi^2=42.3$, $df=1$, $p<0.001$). Over the 4 years of the study 175 events were recorded which consisted in threatening dives by the parents against their offspring. Males made 66 and females 109 dives, the difference being significant ($\chi^2=10.6$, $df=1$, $p<0.002$). The frequency of dives of the parents increased as the offspring grew older.

4. Discussion

The cases of "flight-enticing" behaviour by the parents towards their offspring seem to have an adaptive value as diminishing the risk involved in predatory lifestyle. An analogous behaviour consisting in prolonging the flight with a prey, sometimes combined with the presentation of the prey to the offspring, have been also observed in other birds of prey (RATCLIFFE 1980, IKEDA 1985, BUSTAMANTE & HIRALDO 1990). For

the ground-nesting Montagu's Harriers it is of particular importance, especially in the light of considerable damage done by predatory mammals during the nesting period (KROGULEC 1992). As the emancipation of the offspring progresses the amount of time spent by parent individuals with their offspring decreases as well in: American Kestrel *Falco sparverius* (LETT & BIRD 1987), Zone-tailed Buzzard *Buteo albonona-*

tus (HIRALDO et al. 1989), Egyptian Vulture *Neophron percnopterus* (CEBALLOS & DONAZAR 1990), Red Kite *Milvus milvus* (BUSTAMANTE & HIRALDO 1993), Black Kite *Milvus migrans* (KOGA & SHIRAIISHI 1994).

The present study indicates that the aggressive chasing away of other birds by adult harriers may vary with time and the motivations behind the harassment of intruders are also varied and difficult to pinpoint. As they grow mature the young harriers run less risk of falling prey to predators because they are able to defend themselves on their own as are juveniles belonging to some other raptor bird species (ROSENFELD & KANVICK 1983, DONAZAR & CEBALLOS 1990) and – as in all species – they are capable of an increasingly more efficient escape. After leaving the nest it is very unlikely that the predators should kill all the juveniles at once as it happens during attacks on a newly found nest (MONTGOMERIE & WEATHERHEAD 1988). It accounts for the decrease with time in the average number of dives per one intervention.

As the breeding season advances, other widely discussed functions of the aggressive chasing away of alien birds such as keeping off potential competitors to a nesting territory or to a partner or the defense of the territory around the nesting ground (NEWTON 1979, WIKLUND 1990) lose in importance. Likewise, in the case of Montagu's Harriers the role of aggressive chasing away is not to maintain exclusive hunting grounds, which was demonstrated only for Black-shouldered Kites *Elanus* spp. (MENDELSON 1983, DUNK & COOPER 1994). During many months including the period of offspring dependency, adult birds of that genus were busy maintaining exclusive hunting territories. Aggressive behaviour pattern of Montagu's Harriers in the period when the offspring become self-

sufficient is designed mainly to defend the brood against such predators as Marsh Harrier *Circus aeruginosus*, Goshawk *Accipiter gentilis* and to chase away food competitors such as Buzzard *Buteo buteo* and Short-eared Owl *Asio flammeus*. (Table 2). A weighty motivation behind harassing of Buzzard by adult Montagu's Harriers is the possibility that juveniles could be hurt by it during aerial plays.

An important function of chasing away alien birds from post-fledging areas given little consideration up to now is the prevention of cleptoparasitism and adoption. The adult aggression against the conspecific juveniles allows to reduce substantially the success of procuring food from other adult birds. It is an essential factor that impedes the occurrence of widespread adoption and cleptoparasitism in the Montagu's Harrier populations (AMAR et al. 2000, KITOWSKI 2000a, KITOWSKI 2001).

Young Montagu's Harriers were fed by their parents every day as opposed to some other raptor bird species where whole days were recorded on which parents failed to supply any prey to their offspring (BROWN 1966, BUSTAMANTE & HIRALDO 1990). Fitted for all Montagu's Harrier families under consideration, exponential curves show the best fit in describing their pattern of variation in feeding rate and in the amount of time spent with the offspring. It means that the highest reduction in both took place at the beginning of the emancipation period. As the end of the emancipation period approached, the reduction rate of both forms of parental contribution slowed down. Such a parental care strategy seems to have an important adaptive value. The way in which the two forms of parental contribution change allows the offspring to be led into self-dependency slowly. In other species the parents of dependent birds of prey may steer the allocation of

their contribution to the offspring by making substantial reductions in feeding frequency over a short time interval that precedes the end of the emancipation period (ALONSO et al. 1987, BUSTAMANTE & HIRALDO 1990, CEBALLOS & DONAZAR 1990) or to terminate it abruptly (PALMER 1988, KOGA & SHIRAIISHI 1994). There is a high likelihood that a "severe" introduction of the offspring into independence might bring about a deterioration of juveniles' condition towards the end of the emancipation period which, in turn, may (PERRIS 1965, LACK 1966, MARTIN 1987) or may not (NEWTON & MOSS 1984) cause higher mortality among juveniles before or during the first autumn migration.

Every year the post-fledging period of Montagu's Harriers in South-east Poland coincided with mass appearances of *Tetrigonioidea*. Alongside with voles they provided an additional source of food for young and adult birds. HOUSTON (1976) observed the emancipation of the young of White backed *Pseudogyps africanus* and Ruppells' Griffon-Vulture *Gyps rueppelli* to coincide with the peak in the amount of carrion in the savannahs of east-central Africa. Also the post-fledging period of Bald Eagle *Haliaeetus leucocephalus* nesting in the north of Florida was linked with the highest abundance of food in the annual cycle (BOHALL-WOOD 1992). Likewise, young Short-toed Eagles *Circaetus gallicus* in north-eastern Greece (VLACHOS & PAPAGEORGIOU

1994) left nests during the mass appearance of snakes and lizards. The above data suggest that raptor species including Montagu's Harrier guide the course of their reproduction cycle in such a way that it coincides with the appearance of easily available food for adults and inexperienced juveniles. It allows inexperienced offspring to develop their feeding skills and is a source of additional quarry for adult birds. Data collected on the calcareous marshes of south-east Poland confirming the existence of parent-offspring conflict in Montagu's Harrier families (TRIVERS 1974) stem from conflicting interests in both generations. It is in the interest of the juveniles to extend the period of parental care as long as possible and, which is equally important, to maintain the care at an appropriately high level (even at the expense of the reproductive success of their parents in the breeding seasons to come). It is in the interest of the parents to have their young start flying as early as possible. It allows to discontinue parental care as soon as there is reasonable likelihood that the offspring will be able to survive up to breeding age. The difference in interests of both generations creates measurable aversive behaviour on parent individuals. As in other migratory raptors (BUSTAMANTE & HIRALDO 1990) the autumn migration puts an end to parent-offspring conflict in Montagu's Harrier through family break-up.

Abstract

The trend in post-fledging parental investment was studied in 14 families of Montagu's Harrier *Circus pygargus* with colour-marked juveniles. As the young grew older the parents spent less time with them, made fewer approaches towards them and fed them less frequently. The frequency of chasing away intrud-

ers by the adults and their aggressiveness towards them decreased as the young became more self-dependent. Collected data suggests that the major reduction of parental contribution took place at the beginning of the post-fledging period and that the juveniles are gradually introduced to independence. Recorded

cases of adults diving at their young and refusing to provision them with prey suggest the existence of parent-offspring tensions during

the post-fledging dependency period.

Keywords: Montagu's Harrier, parental care, post-fledging period.

References

- ALONSO, C. J., GONZALES, L. M., HEREDIA, B. & GONZALES, J. L. (1987): Parental care and the transition to independence of Spanish Imperial Eagle *Aquila heliaca* in Donana National Park, southeast Spain. *Ibis* 129: 212-224.
- AMAR, A., ARROYO, B. E. & BRETAGNOLE, V. (2000): Post-fledging dependence and dispersal in hacked and wild Montagu's Harrier *Circus pygargus*. *Ibis* 142: 21-28.
- ARROYO, B. E., DE CORNULIER T. & BRETAGNOLE, V. (in press). Parental investment and parent-offspring conflict during the postfledging period in Montagu's Harriers. *Anim. Behav.*
- BOHALL-WOOD, P. (1992): Habitat use, movements, migration patterns, and survival rates of subadult Bald Eagle in north Florida. Ph.Diss. University of Florida. Gainesville.
- BUSTAMANTE, J. & HIRALDO, F. (1990): Factors influencing family rupture and parent – offspring conflict in the Black Kite *Milvus migrans*. *Ibis* 132: 58-67.
- BUSTAMANTE, J. & HIRALDO, F. (1993): The function of aggressive chases by breeding Black and Red Kites *Milvus migrans* and *Milvus milvus* during the post-fledging period. *Ibis* 135, 139-147
- BROWN, L. (1966): Observations of some Kenya eagles. *Ibis* 108: 531-572.
- CEBALLOS, O. & DONAZAR, J. A. (1990): Parent-offspring conflict during post-fledging period in Egyptian Vulture *Neophron percnopterus* (Aves, Accipitridae). *Ethology* 85: 225-235.
- DONAZAR, J. A. & CEBALLOS O. (1990): Post-fledging dependence period and development of flight and foraging behaviour in Egyptian Vulture *Neophron percnopterus*. *Ardea* 78: 378-394.
- DUNK, J., & COOPER, R. J. (1994): Territory size regulation in Black-shouldered Kites. *Auk* 111: 588-595.
- FOWLER, J. & COHEN, L. (1992): Statistics for Ornithologists. *BTO Guide* 22.
- HIRALDO, F., DELIBES, M. & ESTRELLA, R. R. (1989): Observations of Zone-tailed Hawk family during the post-fledging period. *J. Raptor Res.* 23: 103-106.
- HOUSTON, D. C. (1976): Breeding of White-backed and Rüppell's Griffon-Vultures *Gyps africanus* and *Gyps rueppelli*. *Ibis* 118: 14-40.
- IKEDA, Y. (1985): Ecological research on the Japanese Golden Eagle (*Aquila chrysaetos japonica*) during post-fledging period in the Haku-san Range. M.Sc. Thesis. Kanazawa University, Kanazawa.
- JUSZCZYK, W. (1974): [Amphibian and reptilian our country]. PWN. Warszawa
- KITOWSKI, I. (1994): [Post-fledging period ecology of Montagu's Harrier *Circus pygargus* on calcareous marshes near Chelm]. Ph.D Thesis, Univ. of Maria Curie-Sklodowska. Lublin [in Polish].
- KITOWSKI, I. (2000a): [A case of natural adoption in Montagu's Harrier *Circus pygargus* in the period of emancipation]. *Not. Orn.* 41: 86-88. [in Polish].
- KITOWSKI, I. (2000b): [The food of Montagu's Harrier *Circus pygargus* during post-fledging period on calcareous marshes near Chelm] – In: J. LETOWSKI. [Natural values of Chelm Landscape Park and the its surroundings]: 176-182 [in Polish].
- KITOWSKI, I. (2001): Intra-and inter specific kleptoparasitism in Montagu's Harrier *Circus pygargus* during the post-fledging period. *Biota* 2(2): 137-145.
- KOCHERT, M. N., STEENHOF, K. & M. Q. MORITSCH (1983): Evaluation of patagial markers for raptors and ravens. *Wildl. Soc. Bull.* 11: 271-281.
- KOGA, K. & SHIRAIISHI, S. (1994): Parent-offspring relations during the post-fledging dependency period in the Black Kite (*Milvus migrans*) in Japan. *J. Raptor Res.* 28: 171-177.
- KROGULEC, J. (1992): [Breeding ecology of Montagu's Harrier *Circus pygargus* on calcareous Marshes near Chelm.]. Ph.D Thesis, Univ. of Maria Curie - Sklodowska Lublin. [in Polish].

- LACK, D. (1966): Population Studies of Birds. Oxford Univ. Press. Oxford.
- LETT, D. W. & BIRD, D. M. (1987): Post-fledging behavior of American Kestrel in southwestern Quebec. *Wilson Bull.* 99: 77-82.
- MARTIN, T. (1987): Food as limit on breeding birds: a life history perspective. *Ann. Rev. Ecol. Syst.* 18: 453-487.
- MENDELSON, J. M. (1983): Social behaviour and dispersion of Blackshouldered Kite. *Ostrich* 60: 1-12.
- MONTGOMERIE, R. D. & P. J. WEATHERHEAD (1988): Risks and rewards of nest defence by parent birds. *Quart. Rev. Biol.* 63: 167-187.
- NEWTON, I. (1979): Population ecology of raptors. T. & A. D. Poyser. Berkhamstad.
- NEWTON, I. & D. MOSS (1984): Post-fledging survival of Sparrowhawks (*Accipiter nisus*) in relation to mass, brood size, and brood composition at fledging. *Ibis* 128: 73-80.
- PALMER, R. S. (1988): Hand Book of North American Birds. Vol. 4. Diurnal raptors (Part 1). Yale Univ. Press. New York.
- PANDOLFI, M. (1996): Play activity in young Montagu's Harriers (*Circus pygargus*). *Auk* 113: 935-938.
- PERRINS, C. M. (1965): Population fluctuation and clutch size in the Great Tit (*Parus major* L.). *J. Anim. Ecol.* 34: 601-647.
- PUCEK, Z. (1984): [Key to the identification of Polish mammals]. PWN. Warszawa.
- RATCLIFFE, D. (1980): The Peregrine Falcon. Poyser. Berkhamsted.
- ROMANOWSKI, J. (1988) Trophic ecology of *Asio otus* (L.) and *Athene noctua* (Scop.) in the suburbs of Warsaw. *Polish Ecol. Stud.* 14(1-2): 223-234.
- ROSENFELD, R. N. & A. KANVICK (1983): Precious nest defence behavior by a Sharpshinned Hawk. *Raptor. Res.* 17: 62-63.
- RYVES, B. H. (1948): Birds life in Cornwall. Collins. London.
- SIMMONS, R. (1988): Honest advertising, sexual selection, courtship displays and body condition of polygynous male harriers. *Auk* 105: 303-307.
- SOKAL, R. R. & ROHLF, F. J. (1981): Biometry. Freeman. San Francisco.
- TRIVERS, B. L. (1974): Parent-offspring conflict. *Amer. Zool.* 14: 249-264.
- UNDERHILL-DAY, J. C. (1993): The foods and feeding rates of Montagu's Harriers in arable farmland. *Bird Study* 40: 74-80.
- VLACHOS, C. G. & N. K. PAPAGEORGIOU (1994): Diet, breeding success and nest site selection of the Short-toed Eagle in northeastern Greece. *J. Raptor Res.* 28: 39-42.
- WIKLUND, C. G. (1990): Offspring protection by Merlin *Falco columbarius* females: the importance of brood size and expected survival for defence of young. *Behav. Ecol. Sociobiol.* 26: 217-223.

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