Етологія	Беркут	12	Вип. 1-2	2003	112 - 118

TRENDS ON PARENTAL CARE IN MONTAGU'S HARRIER DURING NESTLING PERIOD IN SOUTHEAST POLAND

Ignacy Kitowski

Abstract. Trends on parental care behaviour of Montagu's Harrier in 7 families with 18 nestlings were observed in SE Poland. The duration of the nestling period was estimated to be on average for M = 33,6 days. There was a distinct division of parental labour. Males were main providers of prey to the nest (70,1 %, n = 782 prey), females brooded and defended of nestlings (70,2 %, n = 582 defences). When nestlings were feathered females could get more involved in regular food provisioning: this happened on M = 15,6 days after hatching youngest nestling. Parents delivered increasing amounts of prey to their young as they were growing up. During the late nestling period food was carried close nest but not transferred to fledglings.

Key words: Montagu's Harrier, *Circus pygargus*, Poland, behaviour, parental care, nestling period.

Address: I. Kitowski, Dep. of Nature Conservation, University Maria Curie-Sklodowska, Akademicka 19, 20–033 Lublin, Poland; e-mail: kitowign@biotop.umcs.lublin.pl.

Тенденции в родительской заботе у лугового луня во время птенцового периода в Юго-Восточной Польше. - Китовский И. - Беркут. 12 (1-2). 2003. - Наблюдения проводились за 7 семьями с 18 птенцами. Средняя продолжительность птенцового периода составила 33,6 дня. Отмечены различия в родительском уходе за птенцами. Самец был основным поставщиком пищи (70,1 %, n = 782 случая), самка насиживала кладку и защищала птенцов (70,2 %, n =582 случая). Когда птенцы оперились, самец становился более вовлеченным в процесс регулярной доставки пищи. По мере роста птенцов количество приносимой родителями добычи увеличивалось. В конце птенцового периода пища оставлялась недалеко от гнезда, но не передавалась слеткам.

INTRODUCTION

Little is still known about parental care in birds of prey of medium size in the nestling period. This concerns also Montagu's Harrier (*Circus pygargus*), a raptor whose many aspects of breeding ecology have been relatively well known in Europe (Schipper, 1978; Leroux, Bretagnolle, 1996; Corbacho et al., 1997, Amar et al., 2000). Some theoretical models and field studies showed that there is conflict between parental sexes and between parents and theirs broods over parental care (time and size of parental investment). The parental care may increases the survival of offspring, but it may be costly to parent and can reduced future breeding successes (Trivers, 1974; Slagsvold et al., 1986; Barta et al., 2002). Study of parental investment on field conditions needs models with clear sex dimorphism in adults. Montagu's Harrier seems to be a good model for this type of behavioural studies, because of the distinct reversal sex dimorphism in adults and the openness of habitats occupied for breeding.

The purposes of these studies was to determine: 1) the exact duration of nestling period in Montagu's Harrier young of population nesting in SE Poland, 2) learn the extend and ratio of parental care over young. I tried to estimate trends in parental care such: nest defence, food provisioning, with progress of nestling period. In the paper also are given other little known details concerned to parental care considered species.

STUDY AREA AND METHODS

Studies were carried out in the area of calcareous marshes near Chelm (51°08' N, 23°37' E, SE Poland) in the years 2000–2001. Between 30–50 pairs of Montagu's Harrier traditionally nested there in Saw Sedge (*Cladium mariscus*) fields (Krogulec, 1992), but in the last years this number has distinctly decreased to approximately 20 pairs (Kitow-

ski, 2002). I observed 7 breeding pairs of Montagu's Harrier (3 and 4 pairs in each seasons). In all, n = 56, 8^{00}–20^{00} observational sessions were carried out. The pairs were observed every 3–5 days for a total 672 hours. Three broods with 2 nestlings and 4 broods with 3 nestlings were observed. Binocular 10 x 20 and telescope 60^{X} were used for observations. 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 of the fledglings was determined during nest examinations using the measurement of length of the first and fifth primaries. The fledglings sex was determined by colour of iris. The iris of females is chocolate and the iris of males is brown-grey (Krogulec, 1992).

Because of fast prey transfers between mates or adults and nest the kinds of prey were not determined into species for many preys, but only included into definite classes. As the defences was considered: active attacks with dives, flights to intruder, escorting flights accompanied or not by alarm calls. To estimate the vertebrate prey biomass, the data for amphibians and reptilians presented by Juszczyk (1974), for passerines by Busse (1990) and for mammals by Pucek (1984) were used. Previous analyses of pellets collected from nests of Montagu's Harrier during nestling period (Karwat, 1990) indicated that *Microtus* sp. distinctly predominate in their number among identified small mammals, the mass of which was calculated to be 20 g. Also the biomass passerines was calculated to be 20 g. Following Romanowski (1988) 0,5 g. biomass was assumed for all invertebrates. Variables describing parental investment of adults Montagu's Harrier seemed not to reflect normal distribution, therefor non parametric analyses were used. Frequencies were compared using the χ^2 test with Yates correction as necessary. All means are given ± sd (Sokal, Rohlf, 1981; Flower, Cohen, 1992). Spearman rank correlation presented in this paper concerns the age of the latest hatched nestling in the brood and variables describing parental care.

RESULTS

Duration of nestling period

In the 7 nests the observed Montagu's Harrier chicks stayed on the nest 30–36 days (33,6 ± 1,68; n = 18). Young males (n = 8) were able to fly at an earlier age M = 32,1 ± 1,25), range 30–34 days after hatching, compared with young females (M = 34,7 ± 0,95; n = 10; range 33–36 days after hatching). The differences in the age of first flights between sex were significant (Whitney – Mann U test: U =1, n_1 = 8, n_2 = 10, P < 0,05.). There is evidence that forced flight of fledglings can take place earlier. Such a case was observed in a nest, when Roe-deer (*Capreolus capreolus*) impelled all 3 fledglings to fly, including one 29 days of age.

Time spent in the vicinity of nests by adults

During the first part of the nestling period (up to 16 day of latest young) Montagu's Harrier females spent almost all time in nests (94 %, N = 18 120 min.) brood. However, when considering the whole nestling period, the time spent by females in the nest decreased significantly as the young were growing up (Spearman r = –0,949, n = 56, P < 0,001) (Table 1). Females when staying in the vicinity of nests (up to 200 m.), were usually perched on near bushes or hunted on meadows or xerotermic islets of marshes and harassed other birds. Cases of males staying in nests were extremely rare. Only 22 cases totalling 24 min. were recorded during studies,

Table 1

Spearman rang correlation coefficients (*r*) between young age and variables selected to describe parental investment
Коэффициенты корреляции рангов Спирмена (*r*) между возрастом молодых и переменными, избранными для описания вклада родителей
Variables: TNF – Time spend by females in the nest as percent of time observation, TVN – time of stay of at least one adult in vicinity of the nest, as percent of time observation. PFD – Percentage of harassing when females dived on intruders at least once, PMD – percentage of harassing when males dived on intruders at least once. NPBN – number of prey brought by adults to the nest, BBN – prey biomass brought by adults to the nest.

Nest	n	TNF	TVN	PFD	PMD	NPB	BBN
N1	8	–0,877**	–0,904**	0,907**	0,690	0,879**	0,842**
N2	6	–0,841*	–0,857*	0,622	0,475	0,844*	0,337
N3	10	–0,779**	–0,801**	0, 956***	0,572*	0,931***	0,890***
N4	10	–0,894***	–0,888***	0,962***	0,602*	0,902***	0,900***
N5	7	–0,752*	–0,700	0,721*	0,493	0,393	0,847*
N6	7	–0,664	–0,887*	0,542	0,909**	0,939**	0,893*
N7	8	–0,800**	–0,774**	0,906**	0,864**	0,884*	0,844*
Total	56	–0,949***	–0,881***	0,628***	0,398**	0,650***	0,477***

* $p < 0,05$, ** $p < 0,01$, *** $p < 0,001$.

including one case of a male staying for 8 min. to cover young (4–8 old) during heavy rainfall. With progressing nestling period the time of staying of at least one adult in vicinity of the nest (up to 200 m.) also decreased (Spearman $r = –0,882$, n = 56, P < 0,001) (Table 1).

Nest attendance and defence

During the presence in the nesting area adults performed flights not connected with feeding towards the nest, however, the total daily number of flights of adults towards to the nest was not correlated with age of young (Spearman $r = 0,221$, n = 56, n. s), like the total daily number of flights of females (Spearman $r = 0,103$, n = 56, n. s). A significant increase in the number of flights towards the nest was shown only for males (Spearman $r = 0,288$, n = 56, P < 0,031). When staying in the nesting area parents (both mates or singly) harassed intruders from the surroundings of their nests. There were n = 582 cases of harassing intruders by adults from studied families (Table 2). Females engaged in n = 409 (70,2 %) of those cases, whereas males only in n = 173 (29,8 %) cases. The differences in the frequencies between the sexes were highly significant ($\chi^2 = 95,7$, $df = 1$, P < 0,001). The progress of the nestling period didn't cause any significant changes in total daily time spent in harassing intruders by adults (Spearman $r = –0,054$, n = 56, n.s), neither in the total number of events of harassing cases of avian (Spearman $r = –0,226$, n = 56, n. s). Only for males the number of harassing intruders decreased significantly with the development of young (Spearman $r = –0,279$, n = 56, P < 0,04). Such relations were not found for Montagu's Harrier females (Spearman $r = –0,22$, n = 56, n. s). However, aggressiveness of adults was growing distinctly as the nestling period proceed. With the age of the youngest nestlings the percentage of harassing events in which adults dived on intruders at least once increased. This took place

both with males (Spearman $r = 0{,}398$, n = 56, $p < 0{,}002$) and females (Spearman $r = 0{,}628$, n = 56, $P < 0{,}001$) (Table 1). These cases included the participation of females in n = 2 communal defences against foxes (*Vulpes vulpes*) and n = 2 against Goshawks (*Accipiter gentilis*).

In close relation with the variables describing defensive behaviours of adult females were those variables describing the number of flights towards the nest. There was a significant correlation between the number of flights to the nest and the cases of harassing intruders from nesting area by females (Spearman $r = 0{,}522$, n = 56, $P < 0{,}001$). However, such correlation were not found for males (Spearman $r = 0{,}096$, n = 56, n. s).

Prey delivery

Progress of nestling period was accompanied both with strong increase of the number of prey (Spearman $r = 0{,}650$, n = 56, $P < 0{,}001$) and their biomass (Spearman $r = 0{,}477$, n = 56, $P < 0{,}001$) (Table 1) brought by adults to the nest. During the studies n = 782 prey delivered to the nest were observed, to which largely males contributed. Males caught 548 (70,1 %) prey delivered to the nest. Females caught only 234 (29,9 %) prey. The differences between males and females were statistically significant ($\chi^2 = 126{,}1$, $df = 1$, $P < 0{,}001$), but the percentage of prey delivered by each sex varied among nests (Table 3). Females started regularly to participate in food provisioning from M = 15,6 ± 0,97, n = 7, range: 14–17 days after hatching. Only two incidental hunting cases were observed before that on 12 day after hatching the youngest nestling in the brood.

With progress of the nestling period the rate of prey transferred between mates in the air was decreased (Spearman $r = -0{,}551$, n = 56, $p < 0{,}001$). This was strongly connected with the decreasing number of prey caught by males among all delivered ones to the nest (Spearman $r = -0{,}906$, n = 56, $p < 0{,}001$). With progress of the breeding season a clear increase in the rate of feedings consisting in direct prey drops onto the nest was observed (Spearman $r = 0{,}494$, n = 56, $p < 0{,}001$).

Small mammals (75,9 %, n = 782 prey) predominated among the identified delivered

Table 2

Intruders harassed by adults of Montagu's Harrier
Чужаки, отогнанные взрослыми луговыми лунями

Harassed intruders	n	%
Circus pygargus males	279	47,9
Circus pygargus females	64	11,0
Circus aeruginosus males	147	25,3
Circus aeruginosus females	52	8,9
Accipiter gentilis males	4	0,7
Accipiter nisus males	11	1,9
Accipiter nisus females	4	0,7
Aquila pomarina adults	1	0,2
Corvus cornix adults	9	1,5
Vanelus vanelus adults	7	1,2
Vulpes vulpes	4	0,7
Total	582	100

Table 3

The number delivered prey by males and females into studied nest
Количество добычи, доставленной самцами и самками в исследуемые гнезда

Nest	Males		Females		
	n	%	n	%	χ^2 $df = 1$
N1	109	72,7	41	27,3	30,83**
N2	79	88,8	10	11,2	53,49**
N3	69	54,3	58	45,7	0,95, n. s
N4	36	66,7	18	33,3	6,0*
N5	67	53,6	58	46,4	0,65, n. s
N6	108	73,0	40	27,0	31,2**
N7	80	89,9	9	10,1	56,6**
Total	548	70,1	234	29,9	126,1**

* $p < 0{,}02$, ** $p < 0{,}001$.

Table 4

Category of prey delivered to the studied nest – number and biomass
Категории добычи, доставленной к исследуемым гнездам – количество и биомасса

Prey category	Mass, g.	n	% n	m, g.	% m
Small mammals	20	594	75,9	11 880	86,0
Lepus capensis juv.	150	1	0,16	150	1,1
Arvicola terrestris	100	1	0,16	100	0,7
Bit of carrion	100	1	0,16	100	0,7
Lacerta sp.	15	2	0,32	30	0,2
Passerine birds	20	72	9,2	1440	10,4
Rana sp.	20	4	0,5	80	0,6
Tettigonioidea	0,5	71	9,0	35,5	0,3
Unidentified prey	–	36	4,6	–	–
Total	–	782	100	13 815,5	100 %

prey with regard to their number (Table 4). They also constituted the highest percentage of biomass (86 %, N =13 815,5 g.) delivered to the nest. Adults were found to bring to the nest considerable number of passerines (9,2 %), which made (10,4 %) of the biomass consumed by young. However, Grasshoppers (*Tettigonioidea*), despite the nearly the same percentage (9,0 %) in the numbers as passerines, made a small percentage (0,3 %) of the prey biomass.

Males caught 68,3 % of total prey biomass of total amount (3 815,5 g) delivered to nests (Table 5). They were also main providers of biomass of small mammal prey. There differences of frequency of biomass small mammal prey between males and females ($\chi^2 = 165{,}3$, $df = 1$, $P < 0{,}001$). If we consider inter-sexual differences of prey category, we also should note that females were exclusive providers big size prey category (European Hares (*Lepus capensis*), European Water Voles (*Arvicola terrestris*), the bit of carrion) (Table 5). In n = 9 cases prey (small mammals) hunted by adults was not delivered to the nest after being presented to the young through extended (M = 99,3 ± 10,8 sec., range: 86–114 sec.) flights over the nest. As a rule the prey was

Table 5

Category of prey caught by males and females presented by number and biomass
Категории добычи, пойманной самцами и самками, по количеству и биомассе

Prey category	Mass, g.	Prey caught by males				Prey caught by females			
		n	% n	m, g.	%m	n	% n	m, g.	% m
Small mammals	20	418	76,3	8360	88,6	176	75,2	3520	80,4
Lepus capensis juv.	150	–	–	–	–	1	0,4	150	3,4
Arvicola terrestris	100	–	–	–	–	1	0,4	100	2,3
Bit of carrion	100	–	–	–	–	1	0,4	100	2,3
Lacerta sp.	15	2	0,4	30	0,3	–	–	–	–
Passerine birds	20	49	8,9	980	10,4	23	9,8	460	10,5
Rana sp.	20	2	0,4	40	0,4	2	0,9	40	0,9
Tettigonioidea	0,5	54	9,8	27	0,3	17	7,3	8,5	0,2
Unidentified prey	–	23	4,2	–	–	13	5,6	–	–
Total	–	548	100	9437	100	234	100	4378,5	100

consumed by adult birds on the ground nearby the nest. These flights were performed when the average age oldest young was: M = 33,3 ± 1,4, range: 31–35 days since hatching.

DISCUSSION

Results concerning duration of the nestling period of Montagu's Harrier confirm the findings of other authors studying raptors with reversed sex dimorphism (RSD), pointing to the fact that young males are capable to flight at an earlier age than young females (Fischer, 1980; Newton, 1986; Witkowski, 1989). During the study up to one week difference was observed between the earliest and latest date in which Montagu's Harrier fledglings of a brood leaving the nest the earliest and the latest. Besides hatching asynchrony this might have been affected also by differential the growth rate of individual young. This allows lighter males fledglings to avoid sibling aggression of heavier females once.

The studies fully confirm the observed distinct division of parental labour in raptors with strongly expressed RSD during the nestling period. The female spent more time in proximity of nest, brooding and defending it, while the male is the chief deliverer of prey (Fischer, 1980; Newton, 1986; Martin, 1987). Nevertheless, it should be noted that this general rule can undergo some modification in the calcareous marshes of SE Poland due to massive appearing of Grasshoppers (*Tettigonioidea*) in the late nestling period (Table 4), which can be hunted by females in the nest proximity. It increase thereby considerably the number (but not biomass) of prey delivered by females. The behaviour of Montagu's Harrier females is similar to that of Hen Harrier (*Circus cyaneus*) and Marsh Harrier (*C. aeruginosus*) ones which, begin to hunt only after feathering of nestling. This is of course connected with decrease of the time spent in the nests (Watson, 1977; Martin, 1987; Witkowski, 1989; Fernandez, Azkona, 1994).

In many raptors this points to adaptive value of adult behaviour by the end of nestling period, inducing abandonment of the nest by fledging, which is induced by extended flights with prey together with its presentation to fledglings and reduction of feeding frequencies (Ikeda, 1985; Bustamante, Hiraldo, 1990). In the calcareous marshes of SE Poland decrease in feeding frequency was recorded by the end of nestling period, but extended prey presentations were noted. The ability to leave the nest as early as possible seems to be basic importance for Montagu's Harrier nesting on ground, particularly in view of the strong risk of carnivore predation especially by foxes (Kitowski, 1998, 2002).

Development of young of Montagu's Harrier resulted in an increased frequency of feeding by direct drops to the nest without landing on it. The above seems to be the adaptation allowing adults to avoid injures during sibling rivalry in late nestling period when fledglings are characterised by a high mobility and sibling conflict is intensified. The way of feeding young "beak to beak", to limit sibling competition in Montagu's Harrier broods appears only in the first part of the nesting period (Krogulec, 1992). Older young are able to tear up prey. Direct feeding of young disappears with their development also in other species of raptors, except in Ospreys (*Pandion haliaetus*) and Bonelli's Eagle (*Hieraaetus fasciatus*) where "beak to beak" feeding is observed even in the post-fledging dependency period (Newton,1979; Bustamante, 1995; Real et al., 1998). The above indicated need to avoid injures by adults during prey transfers to fledglings and the decreasing role of males in prey delivery to the nest caused a significant rate decrease of prey transfers between mates with progressing nestling period. The above results are in contrast to those obtained by Fernandez and Azkona (1994) in studies of Marsh Harriers, where with progress of the nestling period the frequency of aerial prey transfers between mates increased.

Although semicolonial breeding favours communal defence against predators threatening broods, during field study, only a small

number of mobbing events was recorded. Their frequency increased in the post-fledgling period when the value of fledglings for the parents is high (Kitowski, 1998, 2003). Progress of the nesting period was accompanied with significant increase of parent's aggressiveness. This seem to be adaptation to the conditions occurring in the post-fledging period in which fledglings will be conspicuous (by sitting in shrubs or by flying) and also the increased value of young after all the previous investment. It undoubtedly exposes them to attacks of predators. Increasing aggressiveness of adults over the nestling period can limit predation of birds of prey and carnivores in the next stage of breeding.

Acknowledgments. I am greatly indebted to: J. Raczkiewicz and M. Kitowska for field assistance and an anonymous referee for critical comments on the manuscript.

REFERENCES

Amar A., Arroyo B.E., Bretagnolle V. (2000): Post-fledging dependence and dispersal in hacked and wild Montagu's Harrier *Circus pygargus*. - Ibis.142: 21-28

Barta Z.N., Houston A.I., McNamara J.M., Szekely T. (2002): Sexual conflict about parental care: The role of reserves. - Am. Nat. 159: 687-705.

Busse P.(1990): [Small zoological dictionary. Birds.]. Wiedza Powszechna. Warsaw. (in Polish).

Bustamante J. (1995): The duration of the post-fledging dependence period of Osprey *Pandion haliaetus* at Loch Garden, Scotland. - Bird Study. 42: 31-36.

Bustamante H., Hiraldo F. (1990): Factors influencing family rupture and parent offspring conflict in the Black Kite *Milvus migrans*. - Ibis. 132: 58-67.

Corbacho C., Sanchez J.M., Sanchez A.(1997): Breeding biology of Montagu's Harrier *Circus pygargus* L. in agricultural enviroments of southwest Spain; comparison with other populations in the western Palearctic. - Bird Study. 44: 166-175.

Fernandez C., Azkona P. (1994): Aerial food transfers as a demand behaviour in the Marsh Harrier. - J. Field Ornithol. 65: 109-114.

Fischer W. (1980): Die Habichte. Wittenberg Lutherstadt. Brehm.

Flower J.,Cohen L. (1992): Statistics for Ornithologist. BTO Guide 22.

Ikeda Y. (1985): Ecological research on the Japanese Golden Eagle *Aquila chrysaetos japonica* during post-fledging period in the Hakusukan range. - Ms. thesis. Univ. of Kanazawa. Kanazawa. (in Japanese).

Juszczyk W. (1974): [Amphibian and reptilian our country]. PWN. Warsaw. (in Polish).

Karwat M. (1990): [Food composition of Montagu's Harrier *Circus pygargus* during breeding on calcareous marshes near Chelm]. - Ms. thesis. Univ. of Maria Curie-Sklodowska. Lublin. (in Polish).

Kitowski I.(1998): [Group mobbing on birds and foxes by Montagu's Harrier *Circus pygargus* in the period of fledglings emancipation]. - Not. Ornitol. 39: 211-217. (in Polish).

Kitowski I. (2003): Inter-specific and temporal differences in brood defence of adult Montagu's Harriers C*ircus pygargus* and Marsh Harriers C*ircus aeruginosus* against foxes *Vulpes vulpes* and avian intruders during the post-fledging dependency period. - Biota. 4: 33-42.

Krogulec J. (1992): [Breeding ecology of Montagu's Harrier *Circus pygargus* on calcareous marshes near Chelm.] - Unpublished Ph. D Thesis. Univ. of Maria Curie-Sklodowska Lublin. (in Polish).

Krogulec J., Wiacek J., Sniezko S.(2000): [Montagu's Harrier (*Circus pygargus*) population dynamics on the calcareous marshes near Chelm in 1985–1998.]. - Letowski J. [Natural values of Chelm Landscape Park and the its surroundings.]. Univ. of Maria Curie-Sklodowska Lublin. 183-188. (in Polish).

Leroux A., Bretagnolle V.(1996): Sex ratio variations in broods of Montagu's Harriers *Circus pygargus*. - J. Avian Biol. 27: 63-69.

Martin J.W.(1987): Behavior and habitat use of breeding Northern Harriers in southwestern Idaho. - J. Rapt. Res. 21: 57- 66.

Newton I. (1979): Population Ecology of Raptors. Poyser. Berkhamsted.

Newton I. (1986): The Sparrowhawk. T.& A.D. Poyser. Calton.

Pandolfi M. (1996): Play Activity in young Montagu's Harrier (*Circus pygargus*). - Auk. 113: 935-938.

Pucek Z. (1984): [Key to the identification of Polish mammals]. PWN. Warsaw. (In Polish).

Real J., Manosa S., Codina J. (1998): Post-nestling dependence period in the Bonelli's Eagle *Hieraaetus fasciatus*. - Ornis Fennica. 75: 129-137.

Romanowski J. (1988): Trophic ecology of *Asio otus* (L.) and *Athene noctua* (Scop.) in the suburbs of Warsaw. - Pol. Ecol Stud. 14: 223-234.

Schipper W. (1978): A comparison of breeding ecology in three European Harriers (*Circus*). - Ardea. 66: 77-102.

Slagsvold T., Roskaft E., Engen S.(1986): Sex ratio, differential cost of rearing young, and differential mortality between the sexes during the period of parental care: Fisher's theory applied to birds. - Orn. Scand. 17: 117-125.

Sokal R., Rohlf F.J. (1981): Biometry. Freeman. 2nd ed. San Francisco.

Trivers R. L. (1974): Parent-offspring conflict. - Amer. Zool. 14: 249 -264.

Watson D. (1977): The Hen Harrier. T. & A.D. Poyser. Berkhamsted.

Witkowski J. (1989): Breeding biology and ecology of the Marsh Harrier *Circus aeruginosus* in the Barycz valley, Poland. - Acta Ornit. 25: 223-320.