

## PAIR FORMATION IN THE MONTAGU'S HARRIER

Jarosław Wiącek

**Abstract.** Montagu's Harrier arrive to nesting territories in eastern Poland in the second decade of April. During the research males were more numerous. The arrival of females was more stretched in the time. The time of pair formation was an average 18 days. Monogamy was the dominating system of pair formation. The females spent more time inside the territory while the males hunted. The males performed 88.8 % of sky-dancing while females only 11.2 %. Flight play as ritualized form of aggression within pair was common behaviour. The males performed 1915 fake attacks on females. During pre-laying period 70 copulations were observed (0.22 copulations per hour of observation). Most of them (84 %) were successfully.

**Key words:** Poland, Montagu's Harrier, *Circus pygargus*, ethology, pair formation.

**Address:** J. Wiącek, Dept. of Nature Conservation, Curie-Skłodowska University, Akademicka 19 Street, 20-033 Lublin, Poland; e-mail: rjwiacek@poczta.onet.pl.

**Образование пар у лугового луня. - Я. Вёнецк. - Беркут. 15 (1-2). 2006.** - Исследования проводились в 1992–1995 гг. на известняковых болотах возле Хелма. Луговые луны появляются на гнездовых территориях в Восточной Польше во второй половине апреля. Во время исследования более многочисленными были самцы. Прилет самок более растянут во времени. Образование пар занимает в среднем 18 дней. Преобладающей системой была моногамия. Самки проводили больше времени на гнездовой территории, в то время как самцы охотились. Самцы выполняли 88,8 % воздушных демонстраций, а самки лишь 11,2 %. Воздушные игры как ритуализированная форма агрессии внутри пары были обычным поведением. Самцы проделали 1915 ложных атак на самок. Перед откладкой яиц наблюдалось 70 копуляций (0,22 копуляции за час наблюдений). Большинство из них (84 %) были успешными.

### Introduction

Pair formation in birds is non random process, based on many phenotypic and behavioural cues in mate choice. Sexual selection favours the evolution of costly phenotypic traits which reflect the high genetic quality of the partner (Kodrick-Brown, Brown, 1984). Males of many species perform vigorous displays to advertise their good condition. Other birds confirmed their the high genetic quality by specific phenotypic cues as long tails or long rectrices (Andersson, 1982; Moller, 1988).

Sky-dancing observed in Montagu's Harrier (*Circus pygargus*) is a really honest criterion of mate choice. Sky-dancing is made by both sexes, but males display more vigorously than females (Cramp, Simmons, 1980). These spectacular displays is difficult to fake because male in poor condition can't display frequently. The best "dancers" are chosen first by females (Wiącek, 2004).

Flight play is usually performed after sky-dancing. This behaviour contains repeated dives performed by male at perched female

(Clarke, 1996). These displays is a ritualized form of food pass (Pandolfi, Pino d'Astore, 1994) or form of aggressive behaviour, however males perform this display without talons presentation (Wiącek, 2006a).

The significant element of pair formation in many species of birds is courtship feeding. Males of many birds feed their females in the pre-laying period. Mating decision is controlled by females, therefore males try to induce them to start copulation and eggs laying earlier. Courtship feeding is direct, non genetics "benefits" for females (Moller, Jennions, 2001). This behaviour performed during the courtship period can directly increase female reproductive success. The females which are better fed by their mates start reproduction earlier (Wiącek, 1997). Food for female in the time of courtship feeding is transferred by two ways: on the ground or in the air (Pandolfi, Pino D'Astore, 1994). Aerial food transfer is a spectacular form of territorial behaviour. At the beginning of the pre-laying period ground transfer is the dominant form of courtship feeding, but the number of aerial food transfers in-



creases until the start of eggs-laying. In the later stages of the breeding season aerial food transfer is dominant form of food transfer (Wiącek, 2006b). Both ways of food transfer take place in the male territory, therefore they are significant for pair bond and pair formation. Courtship feeding is pre-copulatory behaviour in socially monogamous birds like Montagu's Harrier. However it can be an introduction to extra-pair copulation and extra-pair fertilization in the monogamous populations. Additional food is important element of mate choice in the polygynous populations of Montagu's Harrier (Cramp, Simmons, 1980).

Semi-colonial breeding of Montagu's Harrier is associated with risk of extra-pair copulation. The first method of paternity assurance in birds is mate guarding (Birkhead, 1979). In birds of prey when mate guarding is prevented by courtship feeding, especially at the beginning of the breeding season, a good way of paternity assurance is frequent within pair copulations. This way males decrease the risk of cuckoldry (Birkhead, Lessells, 1988; Moller, Birkhead, 1992).

Simmons (1990) and Arroyo (1999) suggest that clumped pairs of African Marsh Harrier (*Circus ranivorus*) and Montagu's Harrier copulate more frequently than solitary ones. However some solitary nested raptors can copulate frequently than colonial ones (Kor-pimaki et al., 1996).

### Material and methods

The study was carried out from 1992 to 1995 on the calcareous marshes near Chełm in eastern Poland (51° 10' N, 23° 37' E) in Lublin region. The observations were performed on 29 pairs of birds in two nature reserves "Bagno Serebryskie" and "Roskosz" located near Polish-Ukrainian border. The marsh landscape of study area was dominated by sedge community *Cladietum marisci* where the harriers territories were occupied. The birds were caught in the special ornithological nets (Busse, 1991), ringed and individually marked by special colour wing tags (Kochert et al.,

1983). Unmarked birds were recognized by the individual differences in the plumage and moulting stage. The harriers were observed from arrival (end of April) until start incubation (June). Every day observations were started at 7 a.m. and lasted until sunset. The observations were performed near harrier territories from distance 100–200 m. by use of 10 x 50 binocular and KOVA scope 20–60 x 72.

The field observation was concentrated on the arrival both sexes, measuring of the time of pre-laying period (from first day in the couple to first egg laying). Additionally: the time budget and the courtship displays like sky-dancing and flight play were counted. The food transfers (on the ground and in the air) and copulations (successfully 6 s duration and unsuccessfully shorter or with no contact of the cloaca) were observed and time of these behaviour were measured with occurrence to 1 s. The aggressive behaviour within pairs was observed, and time of this behaviour was estimated.

All statistical analyses were performed with Statistica 6.1. The analyses of behaviour were made with Spearman correlation (r) and t-test. Data are presented as a mean.

### Results

Montagu's Harrier arrive to the nesting territories located in the eastern part of Poland in the second decade of April (between 12 and 20th of April). In each of the observed seasons males were more numerous. As a rule, the males arrived first and reached their maximum number on the nesting ground on the 18 day after the arrival of the first bird, while the arrival of females was more stretched in time, reaching their maximum number on the 29 day of the arrival of the first bird ( $t = 7,73$ ,  $p = 0.01$ ). The differences in the number of birds of both sexes were statistically significant.

The pair formation in the studied population started directly after the arrival at the nesting territories or with a few-day delay due to the uneven arrival of birds of both sexes. The

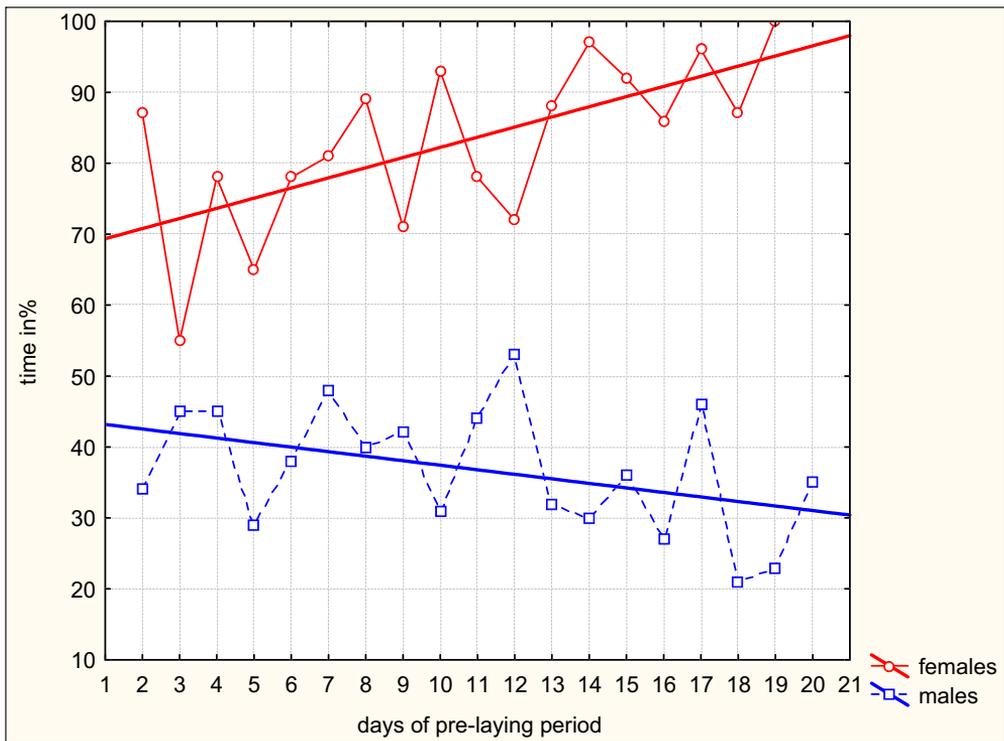


Fig. 1. The time spent inside territory by both sexes.

Рис. 1. Время, проведенное внутри территории птицами обоих полов.

duration of this stage of breeding was an average 18 days (n = 27). Monogamy was the dominating system of pair formation among birds on the calcareous marshes near Chelm. After arrival, the males occupied the territories which were actively defended against the intruders. All cases of courtship behaviour connected with pair formation took place within territories or in their closest proximity. The time spend by both sexes varied distinctively (Fig.1) because females spent their time in the breeding territory while males in the hunting territories situated to 5 kilometers away from the nest.

The basic element of the courtship behaviour in the harriers was sky-dancing, performed by both sexes but in females observed less frequently. The males performed 85.3 % sequences of displays while females only 14,7 %. Total number of U-shaped evolutions observed during the study was 2302. Most of them was

performed by males 88,8 %. Females performed only 11,2 % evolutions. Less frequent sky-dancing observed among the females was their behavioral response to male sky-dancing which has been proved by a strong correlation of their hour schedule ( $r = 0.8, p = 0.01, n = 12$ ).

The highest intensity of sky-dancing among both sexes occurred before midday with its peak at 9 a.m. (Fig. 2).

Each year, young dark-coloured birds took part in sky-dancing. Occasionally their activities exceeded the ones of older males. However no young males managed to form its pair or make the female copulate. This young birds were vigorously repelled by adult males or ignored by the females.

Ritualized form of aggression within the pair – flight play, is a very common courtship behaviour in harriers. This display was the most frequently observed after sky-dancing

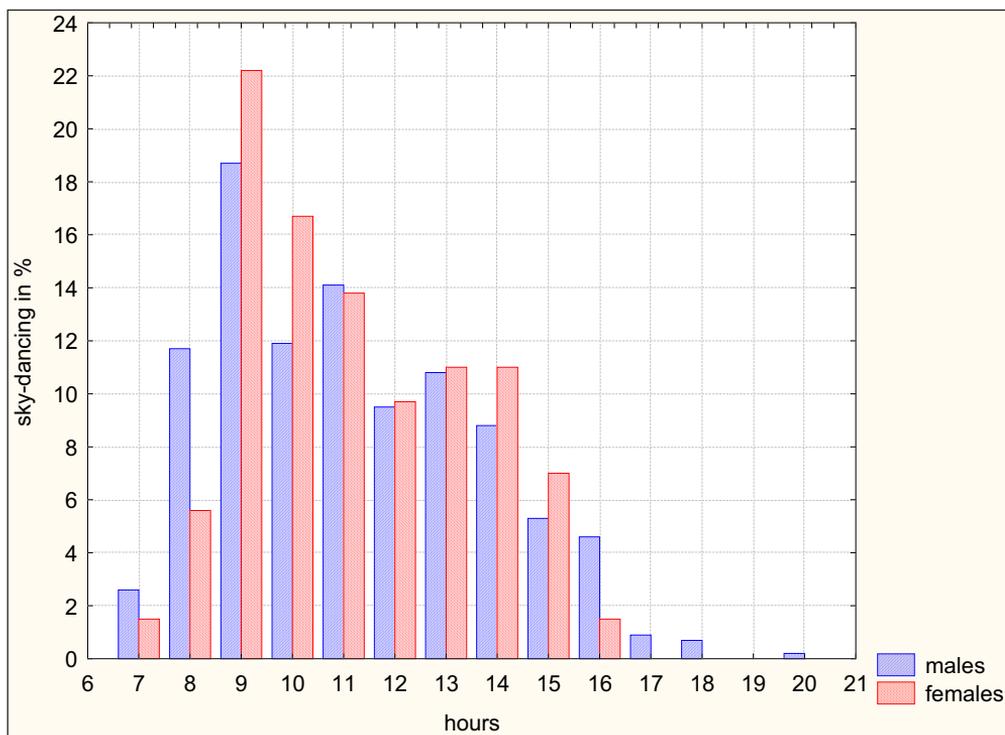


Fig. 2. The daily patterns of sky-dancing in both sexes.

Рис. 2. Суточные особенности воздушных демонстраций птицами обоих полов.

when the male finished sky-dancing in the proximity of the female. In this situation followed a series of fake attacks on the female sitting in the territory or circling around it. After male attacks the female usually landed in his territory. During these attacks the female frequently turned on its back while flying, presenting its talons. After landing the male faked attacks on already perched female. This behaviour gradually came to end. In the time of observations males performed 489 sequences contained 1915 attacks on the females. Each male performed an average 4 attacks per sequence. A daily pattern of flight play was correlated with sky-dancing ( $r = 0.7$ ,  $p = 0.01$ ,  $n = 12$ ).

During pre-laying period females were fed by their partners. Courtship feeding started from the first day of the observed period. From this moment till the second week after the hatching of fledglings, the females were food

depended from the males. The food was delivered by male in the air or in ground transfers. Frequently courtship feeding was an introduction to copulation. Most cases of copulations were preceded by courtship feeding. The daily pattern of these behaviour was strong correlated ( $r = 0.63$ ,  $p = 0.01$ ,  $n = 14$ ).

During the research, 70 copulations were observed, which results in 0.22 copulations per hour of observation. Successful copulations (84%) lasted more than 6 seconds, the remaining 16% of copulations probably did not end in passing of the sperm. The contact of partners was too short (1–2 seconds) or the female threw the male down and did not allow the cloacas to contact. The hour schedule of copulations shows two peaks. The first one between 9<sup>00</sup> and 10<sup>00</sup> and the second between 16<sup>00</sup> and 17<sup>00</sup> (Fig. 3). The daily pattern of copulation quite distinctively correlated with the females sky-dancing, which signaled their acceptance

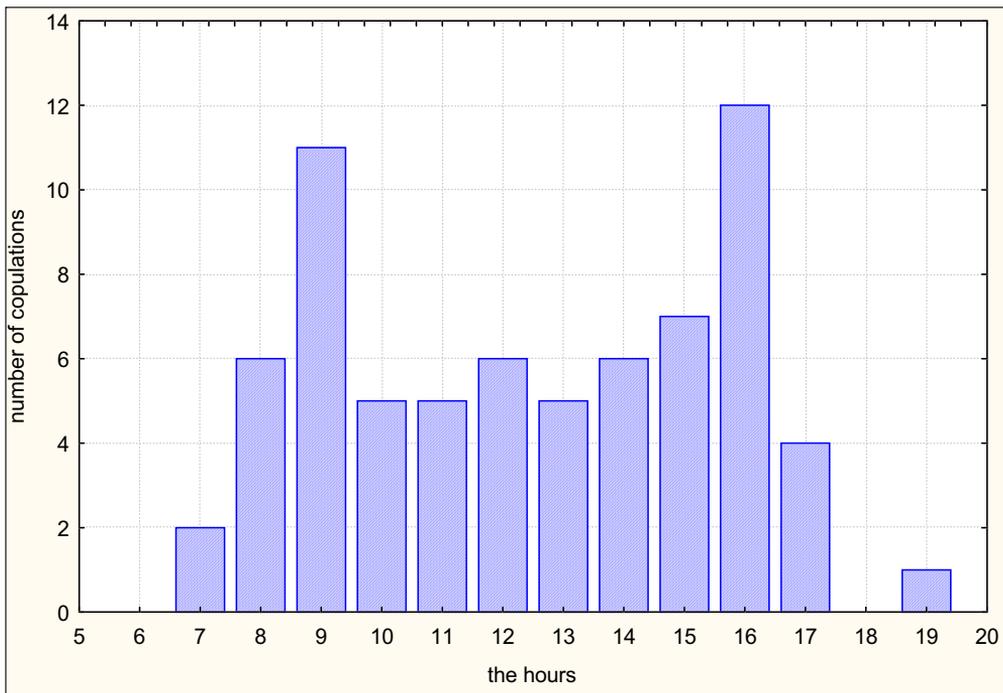


Fig. 3. The hour shedule of copulations in Montagu's Harrier.

Рис. 3. Частота копуляций у лугового луня по часам.

and readiness to copulate ( $r = 0.55$ ,  $p = 0.04$ ,  $n = 12$ ).

### Discussion

Montagu's Harrier as a middle-sized bird of prey, arriving at the breeding territories in Poland in the second part of April (Tomiałojć, Stawarczyk, 2003). The earliest arrival to the nesting territories is observed in Spain where Montagu's Harriers arrive at the end of March and the beginning of April (Arroyo, 1995) and almost simultaneously – in the Italian population of this species (Pandolfi, Pino d'Astore, 1992). At the beginning of April Montagu's Harriers appear in Hungary (Clarke, 1996) and in the second part of April – on the nesting territories in Germany (Looft, Busche, 1990). The phenomenon of males earlier arrival to the nesting territories is quite frequently observed among this species (Robinson, 1950, Perez Chiscano, Fernandez-Cruz, 1971) how-

ever in the large populations like in Spain, such differences have not been observed. The duration of pre-laying period lasted approximately 18 days. This period of time approximates the duration of this stage among other European populations of this species. In the English population this period lasted 19 days (Underhill-Day, 1993). If we compare the duration of this period with the one of other birds of prey, it has to be noticed that it is comparatively short. Among Ospreys (*Pandion haliaetus*) this period can last to 30 days (Poole, 1989). The canadian population of Gyrfalcon (*Falco rusticolus*) needs 4 weeks from the moment of pair formation till egg-laying (Platt, 1989), whilst among Finnish population of Kestrel (*Falco tinnunculus*) this period lasts up to 36 days (Hakkarainen et al., 1993).

Monogamy was the dominating system of pair formation on the study area but rare case of polygyny was observed in this population in earlier season (Wiącek, 2003). Several cases



of polygyny have been described in England (Underhill-Day, 1990) and a few single cases were notified in Spain (Arroyo, 1995) and Italy (Pandolfi et al., 1995). Polyandry is a rarer example of pair formation in this species. This way of pair formation has been described in France (Cormier, 1990), in Poland (Tryjanowski, Winiecki, 1995) and in Spain (Arroyo, 1996). What is worth emphasizing is the fact that extra pair copulation occur among this species quite infrequently (Arroyo, 1999) or in small populations it might not happen at all (Wiącek, Koziół 1997).

The males on calcareous marshes near Chełm occupied comparatively small nesting territories (Wiącek, 2006). Those territories were guarded against intruders while hunting territories are not guarded by birds. Their size, an average 1.1 ha, was relatively small in comparison with the ones of the Italian population of this species where territories covered on average 4 hectares (Pandolfi, Pino d'Astore, 1992). The size of nesting territories in Montagu's Harrier was relatively small in comparison to other species such as Marsh Harrier (*Circus aeruginosus*) where the size of the territory was on average 26.5 hectares (Witkowski, 1989) or the Australasian species *Circus approximans* with its districts of the size of 31 hectares (Baker-Gabb, 1981).

The females of Montagu's Harrier like most of the raptors species spent more time in the territory while the males hunted (Newton, 1979). The hunting areas of Montagu's Harrier were located within the distance of 5 kilometers from the nesting territories, although there have been examples in literature in which these areas were located several kilometers away from the nest in natural habitats (Schipper, 1977) even above 20 on the crops in Spain (Guixé, 2004).

Within territories or in their close proximity various examples of behaviour with mating or territorial context took place. Montagu's Harrier like all European birds of prey perform various kinds of flights connected with pair formation. The most substantial show of air evolution is sky-dancing observed among

all species of harriers (Simmons, 1988; Pandolfi, Barocci, 1994). This behaviour is important for pair formation and is the basic criterion in choosing a partner among Montagu's Harrier. Vigorously displaying males were chosen by the females as the first ones (Wiącek, 2004). Males sky-dancing is difficult to fake signal and it proves a good physical condition of the partner and its high genetic quality (Simmons, 1988). It is proved by the fact that primaries of the offspring of the best displaying males growing faster than other young birds (Wiącek, 2004). It enables them to start first flights faster and to leave the nesting territories earlier starting their autumn migration.

Flight play behaviour was observed directly after sky-dancing. In the literature flight play is described as ritualized food-pass practice (Pandolfi & Pino d'Astore, 1994). In the Montagu's Harrier monography (Clarke, 1996), emphasizes the direct connection of this kind of behaviour with the examples of sky-dancing. The observations carried out in the east of Poland clearly show that this behaviour includes repeated "power dives" by the male on perched or flied female. Summarized observation in my study of flight play is ritualized form of aggressive behaviour within pair was strongly connected with courtship displays. The main objective of this behaviour seems to be forcing the female to land in the territory of the male or not leaving his territory. Summarizing, the ultimate objective is keeping the female within the males territory.

The second substantial criterion (after sky-dancing) important for pair formation process is courtship feeding. After the long migration from the winter areas, the females are rather exhausted and they need rapid regeneration for produce gametes which are energetically expensive. Additional food in the early stage of the reproductive cycle speeds up readiness to produce and lay eggs and the start of incubation. Courtship feeding among all species of raptors influences on laying success (Newton, 1979; Simmons, 1988). The number of courtship feeding influences on the female's breeding decision (Village, 1990; Bortolotti, Iko,



1992). Among all birds, including birds of prey, there is a correlation between the day of laying the first egg and the quantity and size of the prey delivered by males during the period preceding egg-laying (Newton, Marquiss, 1981; Meijer et al., 1989). Among the examined population of Montagu's Harrier, there was a distinct correlation between the number of feeding and the length of the pre-laying period. Better fed females started egg-laying earlier and at the same time the period of pair formation lasted shorter (Wiacek, 1997). Courtship feedings were the introduction to the copulation. Similar correlation of those two elements of behaviour was also described by Arroyo (1999). Her research in the Spanish population of Montagu's Harrier near Madrid shows that copulations occurred more frequently after the food transfer than without it. The analogical relation between courtship feeding and copulation was emphasized by Simmons (1988) in two other species of harrier: Hen Harrier (*Circus cyaneus*) and Australian Swamp Harrier (*C. approximans*). However in African Marsh Harrier the relation between feeding and copulation was less importance (Simmons, 2000).

The number of copulations (0.22 per hour) observed in Montagu's Harrier inside territory, enables to classify this species as a frequently copulating species (Birkhead, Moller, 1992). This can indicate the occurrence of sperm competition among this species of raptor. Male's prolonging absences in the district and semi-colonial character of nesting is conducive to extra-pair copulation. The males' response to this situation is frequent copulation within pair, meant to prevent extra-pair fertilization and cuckoldry in its final effect.

A similar phenomenon is described by Arroyo (1999) in the Spanish population of this species. The duration of successful copulations (on average 6 s.) did not differ from data published by Mougeot et al. (2001) in French and Spanish populations of Montagu's Harrier. All observed copulations, which lasted at least 5 seconds were successful and ended in passing of the sperm. Copulation behaviour

is harmonized with the daily schedule of sky-dancing and courtship feeding, described above. It indicates that the main elements of courtship behaviour like sky-dancing and courtship feeding directly influence on the copulations (Simmons, 1988; Clarke, 1996; Wiacek, 1997, 2004).

The participation in copulation is limited by the age of birds. Young, dark-coloured males, despite their temporary superiority in sky-dancing and courtship feeding, were ignored by settled females and not allowed to copulate in the absence of mature male. A similar position of young males is emphasized by Arroyo (1995) and Clarke (1996).

Summarizing:

- pair-formation process in the Montagu's Harrier is placed inside the male territory;
- the basic element of courtship behaviour is sky-dancing perform by both sexes;
- flight-play is a very important behaviour which influences for pair bond;
- courtship feeding stimulate to start copulations and egg-laying;
- second-year, dark colored males, despite their good physical condition are ignored by females in the courtship time.

## REFERENCES

- Andersson M. (1982): Female choice selects for extreme tail length in a widowbird. - *Nature*. 299: 818-820.
- Arroyo B. (1995): Breeding ecology and nest dispersion of Montagu's Harrier *Circus pygargus* in central Spain. - Ph.D Thesis. University of Oxford.
- Arroyo B. (1996): A possible case of polyandry in Montagu's Harrier. - *J. Raptor. Res.* 30 (2): 100-102.
- Arroyo B. (1999): Copulatory behaviour of semi-colonial Montagu's Harrier. - *Condor*. 101: 340-346.
- Baker-Gabb D.J. (1981): Breeding behaviour and ecology of the australasian harrier *Circus approximans* in the Manawatu-Ringitikei Sand Country, New Zealand. - *Notornis*. 28: 103-119.
- Birkhead T.R. (1979): Mate guarding in the Magpie *Pica pica*. - *Anim. Behav.* 27: 866-874.
- Birkhead T.R., Lessells C.M. (1988): Copulation behaviour of the Osprey *Pandion haliaetus*. - *Anim. Behav.* 36: 1672-1682.
- Bortolotti G.R., Iko W.M. (1992): Non random pairing in American Kestrels: mate choice versus intra-sexual competition. - *Anim. Behav.* 44: 811-821.



- Busse P. (1991): Mały słownik zoologiczny. Ptaki, vol. II. Warszawa: Wiedza Powszechna.
- Clarke R. (1996): Montagu's Harrier. - Chelmsford: Arlequin Press.
- Cormier J.P. (1990): Un case d'aide à l'elavage des jeunes de la part d'un male de deux ans chez le Busard cendré *Circus pygargus*. - *Alauda*. 58: 203-204.
- Cramp S., Simmons K.E.L. (Eds.) (1980): The birds of the Western Palearctic. Oxford University Press. 2.
- Guixé D. (2004): Territory characteristic, home range size, habitat and prey selection of the Montagu's Harrier in NE Spain. - Intern. Symp. on Ecology and Conservation of Steppe-Land Birds, Abstract Volume. Lleida. Spain.
- Hakkarainen H., Korpimäki E., Huhta E., Palokangas P. (1993): Delayed maturation in plumage colour: evidence for the female mimicry hypothesis in the kestrel. - *Behav. Ecol. Sociobiol.* 33: 247-251.
- Kochert M.N., Steenhof K., Mortisch M. (1983): Evaluation of patagial markers for raptors and ravens. - *Bull. Wild. Soc.* 11: 271-281.
- Kodrick-Brown A., Brown J.H. (1984): Thuth in advertising: the kinds of traits favored by sexual selection. - *Am. Nat.* 124: 309-323.
- Korpimäki E.L., Katrina C.A., May D.T., Parkin G.B., Powell P., Wetton J.H. (1996): Copulatory behaviour and paternity determined by DNA fingerprinting in kestrels: effects of cyclic food abundance. - *Anim. Behav.* 51: 945-955.
- Looft V., Busche G. (1990): Vogelwelt Schleswig-Holstein. Band II: Greifvögel. Wachholtz. Neumünster.
- Meijer T., Masman D., Daan S. (1989): Energetics of reproduction in female kestrel. - *Auk*. 106: 549-559.
- Moller A.P. (1988): Female choice selects for male sexual tail ornaments in the monogamous swallow. - *Nature* 332: 640-642.
- Moller A.P., Birkhead T.R. (1992): Sperm competition in birds. London: Academic press.
- Moller A.P., Jennions M.D. (2001): How important are direct fitness benefits of sexual selection. - *Naturwissenschaften*. 88: 401-415.
- Mougeot F., Arroyo B., Bretagnolle V. (2001): Decoy presentation as a means to manipulate the risk of extra-pair copulation: an experimental study in a semi-colonial raptor, the Montagu's Harrier. - *Behav. Ecol.* 12: 1-7.
- Newton I. (1979): Population Ecology of Raptors. Calton: T. & A.D. Poyser.
- Newton I., Marquiss M. (1981): Effect of additional food on laying dates and clutch sizes of Sparrowhawks. - *Ornis Scand.* 12: 224-229.
- Pandolfi M., Barocci A. (1994): Description of courtship patterns in Montagu's Harriers *Circus pygargus*. - *Ethol. Ecol. & Evol.* 6: 439-440.
- Pandolfi M., Pino D'Astore P.R. (1992): Aggressive behaviour in Montagu's Harrier during the breeding season. - *Boll. Zool.* 59: 57-61.
- Pandolfi M., Pino D'Astore P.R. (1994): Analysis of food pass behaviour in Montagu's Harrier during the breeding period. - *Ethol. Ecol. & Evol.* 6: 285-292.
- Pandolfi M., Savelli F., Fucili E. (1995): Analisi di uno caso di bigamia in Albanello minore *Circus pygargus*. - *Atti VII Conv. Naz. Ornitologia. Suppl. Ric. Biol. Selv.* 22: 155-157.
- Perez Chiscano J.L., Fernandez Cruz M. (1971): Sobre *Grus grus* y *Circus pygargus* en Extremadura. - *Ardeola*. Vol. Especial: 508-574.
- Platt J.B. (1989): Gyrfalcon Courtship and Early Breeding Behaviour on the Yukon North Slope. - *Sociobiology*. 15 (1): 43-69.
- Poole A.F. (1989): Ospreys. A Natural and Unnatural History. Cambridge: Cambridge University Press.
- Robinson W. (1950): Montagu's Harrier. - *Bird Notes*. 24: 103-114.
- Schipper W.J.A. (1977): A comparison of prey selection in sympatric harriers in Western Europe. - *Gerfaut*. 63: 117-120.
- Simmons R. (1988): Honest advertising, sexual selection, courtship displays and body condition of polygynous male harriers. - *Auk*. 105: 303-307.
- Simmons R. (2000): Harriers of the World. New York: Oxford University Press.
- Tomiałojć L., Stawarczyk T. (2003): Awifauna Polski. Rozmieszczenie, liczebność i zmiany. Wrocław: PTPP "pro Natura".
- Tryjanowski P., Winiecki A. (1995): Polyandrie bei Weihen. - *Orn. Mitteilungen* 47 (3): 75.
- Underhill-Day J.C. (1990): The status and breeding biology of Marsh Harrier and Montagu's Harrier in Britain since 1900. - National Council for Academic Awards.
- Underhill-Day J.C. (1993): Badge size, phenotypic quality and reproductive success in the house sparrow: a study on honest advertisement. - *Evolution* 47 (4): 1161-1170.
- Village A. (1990): The Kestrel. London: T. & A.D. Poyser.
- Wiącek J. (1997): The effect of courtship feeding on the duration of pre-laying period in Montagu's Harrier. - Present Perspectives of Ecology. Lublin: University of Maria Curie-Skłodowska.
- Wiącek J. (1998): Ecology of the pre-laying period in the Montagu's Harrier on the calcareous marshes near Chełm. - Ph.D. Thesis. Lublin: Curie Skłodowska University.
- Wiącek J. (2003): A rare case of polygyny in Montagu's Harrier in Poland. - *Vogelwarte*. 42 (1-2): 129.
- Wiącek J. (2004): Sky-dancing as an honest criterion of mate choice in Montagu's Harrier. - *Raptors Worldwide*. Budapest. 845-848.
- Wiącek J. (2006a): Aggressive behaviour in Montagu's Harrier during courtship period. - *Biologia*. Bratislava 61 (5): 1-3.
- Wiącek J. (2006b): Food transfer in Montagu's Harrier during courtship. - *Acta Orn.* 41 (1): 88-91.
- Wiącek J., Koziół P. (1997): An attempt at verification of partners fidelity in the Montagu's Harrier with use of DNA Fingerprinting. - *Not. Orn.* 38 (3): 173-182.
- Witkowski J. (1989): Breeding biology and ecology of the Marsh Harrier in Barych Valley, Poland. - *Acta Orn.* 25: 223-320.