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## Food transfer in Montagu's Harrier *Circus pygargus* during courtship

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**Abstract.** Male Montagu's Harriers delivered prey to their mates by ground and aerial transfer. Between 1992 and 1995, 365 cases of food pass behaviour were recorded (0.47 transfer per observation hour) on calcareous marshes near Chełm in eastern Poland. All of them were observed inside the territory. Ground transfer was dominant at the beginning of the pre-laying period during the time of pair formation. In the courtship season 107 ground transfers (29%) were observed (0.2 per hour). Aerial transfers were observed in 258 cases (71%, 0.41 per hour). The efficiency of aerial food pass was 98% (only five passes ended in the loss of food), that of ground transfer was 100%. Food transfer was strongly correlated with copulation, especially after ground transfer. The number of ground transfers of food was correlated with average time of sky-dancing in males.

**Key words:** Montagu's Harrier, *Circus pygargus*, aerial and ground food pass

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Among raptors, mate choice and pair formation is based on the number of prey that males deliver to females, therefore delivery of food is a main male behaviour in the courtship and nesting period (Newton 1979, Simmons 2000). In harriers, courtship feeding constitutes an important cue for female decision making (Pandolfi & Barocci 1994, Arroyo 1995, Simmons 2000, Wiącek 2004). Most harriers are ground nesting, therefore, they are under serious risk of attack by mammalian predators (Baker-Gabb 1984); hence the method of food transfer is important to avoid nest detection by predators. Harriers transfer prey in two ways: on the ground and in the air. Aerial food transfer is safer because it leaves no scent or remains for ground predators to find (Simmons 2000). Different habitat conditions may influence the method of food transfer. It seems that wet territories are less accessible for mammalian predators (Simmons 1991). The number of aerial transfers in Hen Harrier *Circus cyaneus*, breeding in medium wet habitat, is higher than in the African Marsh Harrier *Circus ranivorus* breeding in wet habitats (Simmons 1991). A high level of aerial food pass was also described for the Italian

population of Montagu's Harrier inhabiting dry Mediterranean habitats (Pandolfi & Pino D'Astore 1994). The breeding habitat of the Montagu's Harrier population in Eastern Poland is more wet in comparison with the Italian population (Pandolfi & Pino D'Astore 1994) as well as with the West European population nesting in crops (Arroyo 1995, Clarke 1996). Therefore, the influence of terrestrial predators on harriers in eastern Poland is probably lower than in the dry habitat in Italy. It may be expected that in the studied population near Chełm there will be more ground pass than in the Italian population (Pandolfi & Pino D'Astore 1994).

Efficiency of aerial food transfer depends on partners' movement coordination in the time of transfer and in all species of harriers it is high. The efficiency of aerial food transfer in several species — the Australasian Swamp Harrier *Circus approximans* (Baker-Gabb 1982), the African Marsh Harrier (Simmons 1991), the European Marsh Harrier *Circus aeruginosus* (Fernandez & Azkona 1994) or the South American Cinereous Harrier *Circus cinereus* (Jimenez & Jaksic 1988) — varied from 96 to 100% regardless of habitat wetness.

Therefore, we may expect that efficiency of aerial food transfer in Montagu's Harriers in the study population will be similar. The aim of this work was to describe the way of food transfer in wetter habitat after longer migration from wintering areas in comparison with other European populations of this species.

Field observations were conducted on 27 pairs of birds from 1992 to 1995 in two nature reserves: "Roskosz" and "Bagno Serebryskie" on calcareous marshes near Chelm in eastern Poland (51°10'N, 23°37'E). The sedge community *Cladietum marisci* was dominant in both areas (*Cladium mariscus* dominant). Marshes were surrounded by agricultural landscape.

The study was carried out from the end of April to late May. Birds arrived to the breeding place from the 16–20 of April. Harriers were observed every day from 7 a.m. till sunset. Total time observation in the 4 years was 768 hours. The field observations were performed near the territories from a distance of 100–150 meters, using 10x50 binoculars. The day, time and way of transfer were noted. Harriers' courtship behaviour (sky-dancing and copulations) just before and after food transfer was observed and by stopper measured with accuracy to 1 second. The first day after pair formation and day of laying of the first egg, was recorded. The sizes of the territories were estimated by the minimum convex polygon method (Kenward 1987). At the beginning of the pre-laying period most of the

birds were caught in special ornithological nets using the Eagle Owl *Bubo bubo* as a decoy (Kochert et al. 1983). All were ringed and individually marked using special wing tags in many colours. Some unmarked birds were recognized by individual differences in their plumage and the moulting stage (gapes in primaries, secondaries or rectrices).

All statistical analyses were performed with Statistica 6.1. Analyses of behaviour were made with nonparametric tests (Spearman correlation).

The size of the harrier territories were estimated from 0.42 to 2.25 ha (mean =  $1.1 \pm 0.5$  ha,  $n = 27$ ). The water depth at nests varied from 0 to 12 cm. All ground transfers recorded during the pre-laying period were observed within the territory, on the meadows inside territory or in the nest. The ground transfers dominated in the first week after pair formation (Fig. 1). In the courtship period, 107 ground transfers (29% of all cases) were observed. In the later stages of the courtship season, this kind of behaviour occurred rarely. Males with prey waited for females on the false nest (platform built by the male) or the meadow in the territory. All ground passes ended successfully.

A few cases of unsuccessful courtship feeding were recorded in young dark males. These inexperienced birds brought food for paired females. Young males landed with prey near the border of the territory and waited for females. Only one food transfer was successful. Young males tried to feed females only by ground pass.

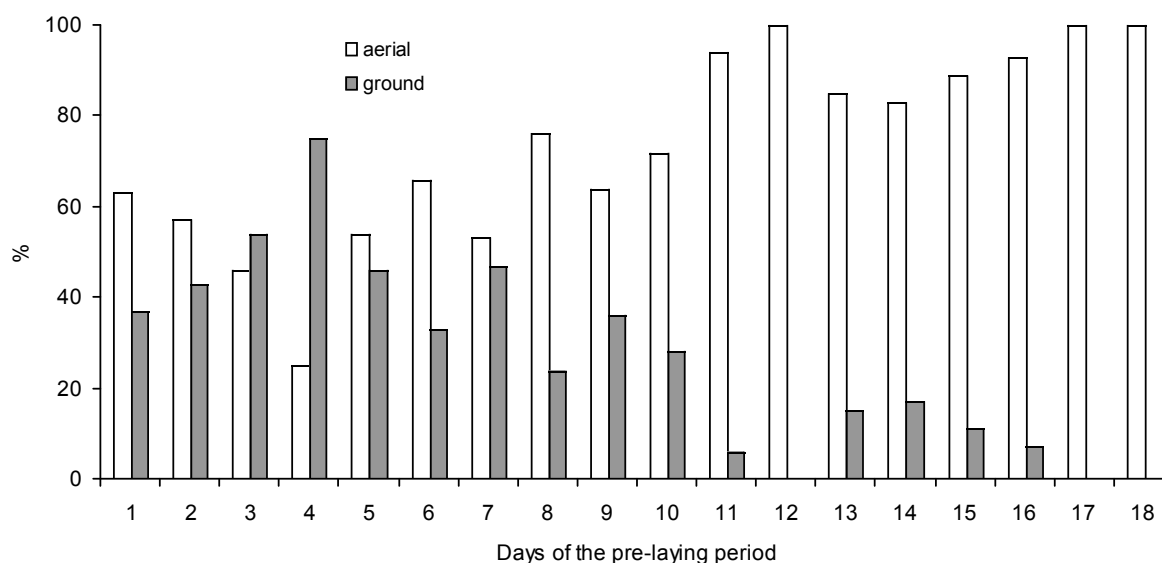


Fig. 1. Food transfers in Montagu's Harrier.

The aerial food transfer was the dominant form of prey delivery in the courtship period except for the first week of the described period. The aerial food pass was observed in 258 cases (71% of all cases). All aerial food passes were recorded inside the territory or in its neighbourhood. After transfer, females immediately landed on the nest or platform inside the territory to consume prey. Only five observations of food loss were recorded: 3 cases in April and 2 in May. All cases were observed in the first week after pair-formation in the pre-laying period. These cases occurred in the time of aerial food pass in the territories of Montagu's harriers. Females tried to regain the lost prey but they failed on the wet marshes. However, efficiency of the aerial food transfer was high — 98%. The total delivery of food in the pre-laying period expressed as the number of courtship feedings per observation hour by both methods of food pass was 0.47/h. For the ground pass it was 0.2/h while for the aerial pass — 0.41/h.

More than half of all copulations (62%) were observed immediately after courtship feeding. The food transfer in the studied population of Montagu's Harriers is strongly correlated with copulations for both the ground ( $r = 0.72$ ,  $t = 3.58$ ,  $n = 24$ ,  $p = 0.003$ ) and aerial food pass ( $r = 0.6$ ,  $t = 2.61$ ,  $n = 24$ ,  $p = 0.02$ ).

There was a strong relationship between the mean duration of male sky-dancing behaviour and the number of ground food transfers ( $r = 0.48$ ,  $n = 23$ ,  $p = 0.019$ ).

These results showed that food transfer on the ground is more frequent at the beginning of the pre-laying period. In the first days after the pair formation, ground food pass was a dominant way of food transfer. Similar trends were described by Pandolfi & Pino d'Astore (1994) in an Italian population of Montagu's Harriers. Their data suggested that ground transfers were preferred, because the mutual motor coordination between mates was not good enough after the spring migration. However, the frequency of ground transfers in the Italian population was smaller than in the Polish population (13.1% vs. 29%). The Italian population of Montagu's Harriers nested in dryer habitat, where predator risk was high. Therefore, in the Italian population there were more aerial food transfers (86.9%) as a method of avoiding the ground predators. The higher level of ground pass observed in Poland probably depends on the wetter habitat of calcareous marshes. Several

aerial transfers that resulted in the loss of food at the beginning of the courtship period suggest that birds had some problems with motor coordination at the time. These rare cases depend on the seasonal pair bond in this species. However, efficiency of aerial food pass in the Polish population was very high (98%) and similar to other species of harriers (Simmons 2000). Therefore, loss of food is probably not significant in harrier populations.

The difference in the distance from wintering areas in Africa to breeding places in Italy and Poland is nearly 1500 km. It is possible that females from the Polish population after longer migration are in poorer condition than the Italian ones. Therefore, the ground transfer supports pair bond success at the beginning of the pre-laying period. Aerial food transfers were more common in the later stages of the courtship period.

Food transfers in the air was important for ritualized courtship behaviour. The influence of courtship feeding on pair formation and the time of the pre-laying period in Montagu's Harriers were described in many European populations (Clarke 1996). Better fed females of Montagu's and Hen Harriers start egg laying earlier (Simmons 1988a, Pandolfi & Barocci 1994, Wiącek 1997). The correlation between the duration of male sky-dancing and food transfers underlines that courtship feeding and sky-dancing as components of mate choice are very important in pair formation in harriers (Simmons 1988b, Wiącek 2004).

The strong connection with sexual behaviour shows a high frequency of courtship feeding before mating. The rates observed for the Italian population by Pandolfi & Pino d'Astore (1992) were higher (77.5%) than in the studied population (62%). The strong relationship between the ground pass and copulations showed that males through offering of food on the ground induce females to start copulating. A similar conclusion, that the ground pass is a prelude to copulation, was reported by Pandolfi & Pino D'Astore (1994) (but see Simmons 1991 for the African Marsh Harrier). From the second week of the pre-laying period, aerial food pass was the main method of food transfer. The majority of aerial food transfers (0.2 for ground pass and 0.41 for aerial pass) were observed in the Spanish population of Marsh Harriers (Fernandez & Azkona 1994) or the North American population of Hen Harriers (Simmons 1991) throughout the entire breeding cycle.

Ground and aerial food transfers together are important for female physical condition and breeding success. At the beginning of the courtship

period, the ground pass is easier for birds in poor condition after long migration. Therefore, harriers from the Polish population more frequently transfer food on the ground than harriers in Italy, because the distance from wintering areas is much longer for the studied population. In later stages of the pre-laying period, the aerial food pass was used to avoid ground predators. The frequency of aerial food pass depends on the wetness of the habitat. In a dry habitat, like in Italy, harriers prefer aerial food pass because the possibility of predator attack is higher than in a wet habitat. Therefore, aerial food pass behaviour in the Polish population (71%) nesting in wet conditions in comparison with Italian harriers (86.9%) was lower.

Summarizing, it is not clear which factor, longer migration or wetness of habitat, has a stronger influence on the method of food transfer. Therefore, more observations from the same areas in different wetness conditions are needed.

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## STRESZCZENIE

### [Transfery pokarmu u błotniaka łąkowego w okresie godowym]

W trakcie okresu przedlęgowego samice błotniaków łąkowych są dokarmiane przez swoich partnerów. Dodatkowy pokarm dostarczany im przez samce pozwala zrehabilitować kondycję fizyczną po migracji i szybciej przystąpić do składania jaj. Badania terenowe dotyczące transferów pokarmu w czasie formowania par były prowadzone na obszarze torfowisk węglanowych pod Chełmem w latach 1992–1995. Obserwacjami objęto 27 par ptaków. W trakcie obserwacji zanotowano 365 przypadków przekazania pokarmu przez samce. Większość karmień odbyło się poprzez przekazanie ofiary w powietrzu (71%), podczas gdy karmienia na ziemi stanowiły 29% wszystkich obserwowanych przypadków. Transfery naziemne dominowały w pierwszym tygodniu okresu godowego, kiedy ptaki po migracji były w słabszej kondycji fizycznej. Karmienia na ziemi były silnie związane z zachowaniami godowymi takimi jak kopulacje oraz tańce powietrzne (sky-dancing).

W późniejszym okresie zalotów dominowały transfery w powietrzu. Ich efektywność ich wynosiła 98%. Przekazywanie pokarmu w powietrzu pozwalało uniknąć możliwych ataków ze strony drapieżników lądowych, głównie lisów. Poprzez wyraźny związek z zachowaniami seksualnymi stanowiły ważny element zachowania godowego. Głównym czynnikiem decydującym o sposobie transferów pokarmu jest najprawdopodobniej wilgotność siedliska, w którym gnieździły się błotniaki łąkowe.