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Source: Journal of Raptor Research, 42(2) : 110-118

Published By: Raptor Research Foundation

URL: https://doi.org/10.3356/JRR-07-09.1

*J. Raptor Res.* 42(2):110–118


# THE FEEDING BEHAVIOR OF THE BLACK KITE (*MILVUS MIGRANS*) IN THE RUBBISH DUMP OF ROME

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Abstract.—We studied the feeding behavior of Black Kites (*Milvus migrans*) in a rubbish dump in Rome, Italy, from April–September 2005. The earliest kites reached the rubbish dump at dawn and the last left just after dusk. The number of individuals foraging in the dump increased during the course of the day and also from April to August. The number of kites in the rubbish area of the dump was usually small and tended to show rapid increases and equally quick declines. Kites searched for food while directly standing on the rubbish or, more often, while flying low over the ground. The first strategy, which was never observed in April but was more common during the following months, was used when there were few foraging gulls or trucks in the dump. Cleptoparasitism was the technique most frequently used to acquire food (76% of all foraging events). It was directed toward conspecifics in 35% of the observed cases, toward Yellow-legged Gulls (*Larus cachinnans*) in 57% and toward Carrion Crows (*Corvus corone*) in 8%. The success rate of cleptoparasitic attempts was 32% against conspecifics, 73% against Yellow-legged Gulls and 66% against crows. The higher frequency of cleptoparasitic attempts against gulls may thus be explained by its higher success rate, although its efficiency declined with increasing gull numbers. The frequency of intraspecific cleptoparasitism paralleled variations in kite density and its effectiveness increased progressively from April–August.

Key Words: *Black Kite*; Milvus migrans; *cleptoparasitism*; *dump*; *feeding behavior*; *urban.*

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EL COMPORTAMIENTO ALIMENTICIO DE *MILVUS MIGRANS* EN EL VERTEDERO DE ROMA

Resumen.—El comportamiento alimenticio de *Milvus migrans* fue estudiado en un basural en Roma, entre abril y septiembre de 2005. Los primeros ejemplares llegaron al basural al amanecer, mientras que los últimos ejemplares se fueron justo antes de la puesta del sol. El número de ejemplares forrajeando en el basural aumentó desde abril hasta agosto y durante el transcurso del día. El número de individuos de *M. migrans* en el área del vertedero del basural fue usualmente reducido y tendió a mostrar rápidos aumentos y disminuciones igualmente rápidas. *Milvus migrans* buscó el alimento parado directamente sobre la basura o más a menudo volando muy bajo sobre el suelo. La primera estrategia, que no fue observada en abril pero que se hizo más común durante los meses siguientes, fue empleada cuando el número de gaviotas era bajo y cuando la actividad de los camiones disminuyó o cesó. El cleptoparasitismo fue la técnica más frecuentemente utilizada para la obtención de alimentos (76% de todos los eventos de forrajeo). Esta técnica estuvo dirigida a individuos coespecíficos en el 35% de los casos, en el 57% de los casos contra *Larus cachinnans* y en el 8% de los casos contra *Corvus corone.* El éxito del cleptoparatismo fue del 32% contra los individuos coespecíficos, del 73% contra *L. cachinnans* y del 66% contra *C. corone.* La alta frecuencia de los intentos de cleptoparasitismo puede, por lo tanto, ser explicada por su alta tasa de éxito, aunque su eficiencia disminuyó con el incremento del número de gaviotas. La frecuencia de cleptoparasitismo intra-específico se ajustó a las variaciones en la densidad de *M. migrans* y su eficacia aumentó progresivamente entre abril y agosto.

[Traducción editada por el equipo editorial]

The Black Kite (*Milvus migrans*) is a gregarious bird (Cramp and Simmons 1980, Donázar 1992) which frequently forms roosts and reproductive colonies where trophic resources are very abundant (Cramp and Simmons 1980, Viñuela 2000, Sergio et al. 2003b). However, because many individuals in this species typically gather over a spatially restricted amount of resources, the resulting high density of kites may exacerbate aggressiveness; thus, behavioral strategies to contend with this may be advantageous (Newton 1998, Donázar et al. 1999). Cleptoparasitism is a widespread aggressive strategy

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among birds, especially among predators/scavengers and has been frequently observed in Black Kites (Cramp and Simmons 1980, Davies and Cowlichaw 1996, Kabouche and Ventroux 1999). In Mediterranean areas, this species is attracted by the conspicuous availability of food at urban waste disposal sites as in Madrid or Marseilles, where it has established large breeding colonies (Blanco 1994, Blanco 1997, Kabouche and Ventroux 1999). The Black Kite population of Rome consists of 40–50 pairs, most of them feeding on the rubbish dump along with Yellow-legged Gulls (*Larus cachinnans*; approximately 10 000 individuals) and Carrion Crows (*Corvus corone*; 100–400 individuals; De Giacomo et al. 2004). We here examine the behavior of Black Kites foraging in the rubbish dump of Rome.

## STUDY AREA AND METHODS

**Study Area.** Kites were studied in a 190-ha rubbish dump, 12.5 km southwest of the urban center of Rome, Italy (41°51′N, 12°20′E). The area included two large pre-selection plants and a waste treatment area. The site supported a variety of patches of shrubs and trees, where several plant species (*Eucalyptus* sp., *Robinia pseudoacacia*, *Phoenix canariensis*, *Olea europaea*), mostly exotics, were planted in order to stabilize the slopes. Native plant communities (*Salix alba*, *Prunus spinosa*, *Phragmites australis*, *Arundo pliniana*, *Inula viscosa*) are developing on abandoned sites. Four thousand ± 158 tons of waste are deposited daily in the rubbish dump. The waste is transported in the treatment area with dump trucks and then levelled and compressed with compaction equipment. These activities begin at dawn and, after a break between 1200–1300 H, cease at approximately 1700 H. The compaction equipment works on a surface of 1000–3000 $m^2$ per day. In the afternoon, a portion of the compressed waste is covered with sand.

**Breeding Colonies.** The range of the Black Kite in the lower reaches of the Tiber River near Rome comprises a mosaic of residual woodland patches and agricultural fields (mostly wheat [*Triticum aestivum*], maize [*Zea mais*] and forage) scattered within an extensive matrix of urban and industrial landscapes, and includes two airports and numerous busy roads. Adult kites return to the area between 10 March and the end of April (De Giacomo et al. 2004). Nonbreeding kites arrive at the site between May and early June, and form night roosts along the river (De Giacomo et al. 2004, Blanco et al. 2007, Sergio et al. 2007). Breeding pairs are clustered in three main colonies: one in the south of Rome in the Presidential Estate of Castelporziano (28–36 pairs) and the others within woodland patches in the western suburbs (Castel di Guido, 7–9 pairs; Tenuta dei Massimi, 4 pairs). These breeding colonies are 11.5, 5.7, and 4 km, respectively, from the rubbish dump. By the end of August, the kites have mostly migrated from the region and very few individuals are detected in September.

**Data Collection.** From April–August 2005, the activity of Black Kites was observed for half a day, once a week. Every morning observation period (0400–1300 H) was followed by an afternoon observation (1300–2000 H) the following day and vice versa. Observations were made from elevated sites, 100 or 150 m from the waste treatment area using 8 × 30 and 10 × 42 binoculars. Individuals resting on perches were counted using a 20–60× spotting scope. We made observations only when visibility was good and wind speed did not exceed 4 m/s.

A timed-count method was employed to estimate kite abundance in various regions of the dump. Every 5 min a count was made of: (1) the number of individuals observed inside an area of one hectare (100 × 100 m) where the rubbish is being dumped (''rubbish area''); (2) the number of individuals flying outside the rubbish area, and (3) the number of individuals at rest, i.e., those perched on the pylons or trees located about 400 m from the rubbish area.

We distinguished food collecting strategies as follows: (1) food collected directly from the rubbish by an individual standing on the ground; (2) food collected while flying over the rubbish; (3) food obtained via intraspecific cleptoparasitism; (4) food obtained via interspecific cleptoparasitism. Because the kites could not be individually identified, we recorded all the observed feeding events. In case of cleptoparasitic events, kite activity was monitored until success or failure of the attempt. We also recorded the frequency and success of cleptoparasitic attempts by kites. Cleptoparasitic attempts that lasted for more than one minute were analysed separately.

We estimated the number of Yellow-legged Gulls and Carrion Crows feeding on 100 $m^2$ (10 × 10 m) of rubbish in front of compaction equipment from photographs (Bibby et al. 2000). Photographs were taken every 30 min with a 300 mm lens, from a position of known distance to the subject area. Every 30 min we counted the number of rubbish trucks and compaction equipment moving in the area in

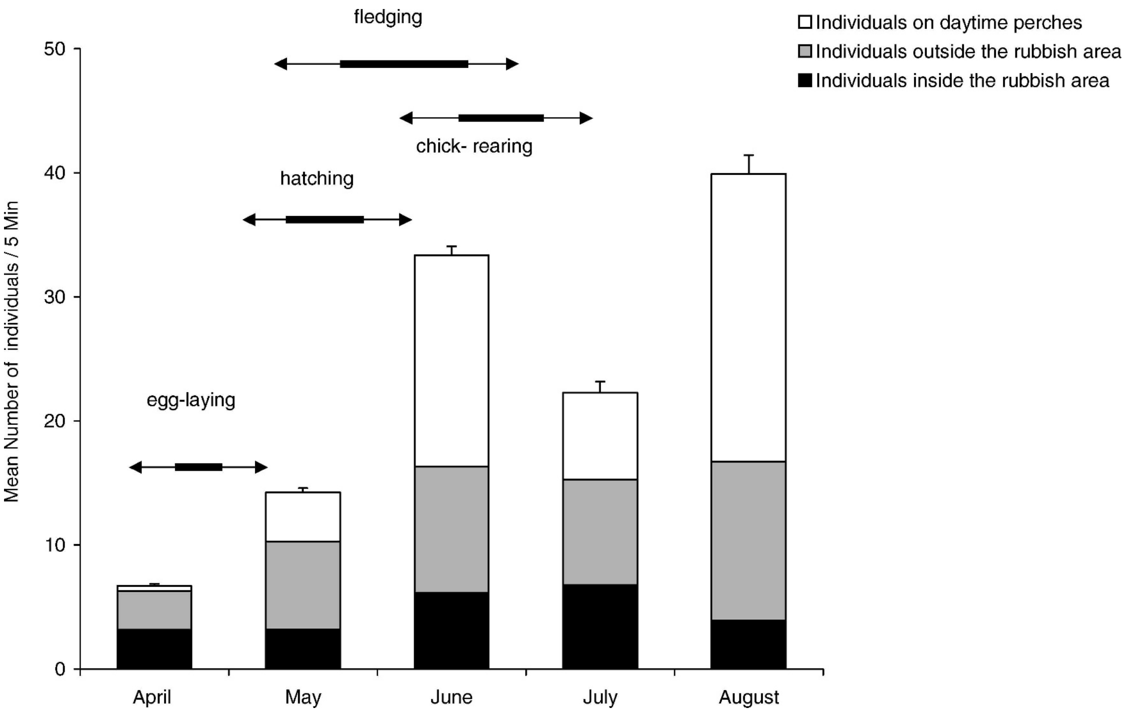


Figure 1. Mean number of individuals/5 min (±1 SE) observed in a rubbish dump of Rome in April–August 2005. The location of individuals was classified as: (1) near the main refuse-area, (2) within the rubbish dump but outside the immediate surroundings of the refuse-area, or (3) perched. Horizontal arrows indicate breeding stages. (Number of monthly observations = 384).

order to evaluate their potential effect on the feeding behavior of kites. We related the behavior within the rubbish dump to the potential breeding stage of the kites, based on local phenological data (De Giacomo et al. 1999, Battisti et al. 2003).

**Statistical Analysis.** To test for differences between mean values, we used one-way ANOVAs and subsequent Tukey tests on log-transformed or arcsin-square-root-transformed values of the data. A $\chi^2$ test was performed to test for differences among the frequencies of feeding strategies and success rates of cleptoparasitism, and Yates correction applied when necessary. Spearman's correlation and, when possible, Pearson's correlation coefficients were used to examine the relationship between mean kite abundance and time of the day. All analyses were performed with SPSS 12.0 software.

## RESULTS

**Activity Patterns.** We observed for a total of 160 hr. The mean number of kites per 5-min count for the whole study period, including individuals at rest, those present in the rubbish area, and those flying outside the rubbish area, was 24.1 ± 21.3 (SD; total number of 5-min counts = 1920), and varied significantly among months (ANOVA: $F_{4,1915}$ = 162.0, $P < 0.001$). Abundance was lowest in April (6.68 ± 3.54, number of 5-min counts in April = 384; *post hoc* Tukey test, $P < 0.05$) and increased during the summer (Fig. 1). The highest mean abundance per 5-min count was observed in August (42.90 ± 29.20, $N$ = 384), when we observed the highest mean abundance for any single hour (1600–1700 H: 90.1 ± 20.7, $N$ = 24) or for any single count (1700–1800 H; 108 individuals). A second abundance peak was also observed in June (mean abundance per 5-min count = 33.40 ± 14.30, $N$ = 384, with a maximum value recorded in a count of 71 individuals between 1000–1100 H). Daily, the first kite arrived at the rubbish dump 1–51 min before dawn (mean: 28.2 ± 17.9 min, $N$ = 6) in April, May and June. In July and August, the earliest kite reached the rubbish dump 1–22 min after dawn (mean: 11.5 ± 9.1 min, $N$ = 4). The last kite of the day to depart from the rubbish dump left 5–55 min after dusk (mean: 34.0 ± 17.5 min, $N$ = 6)

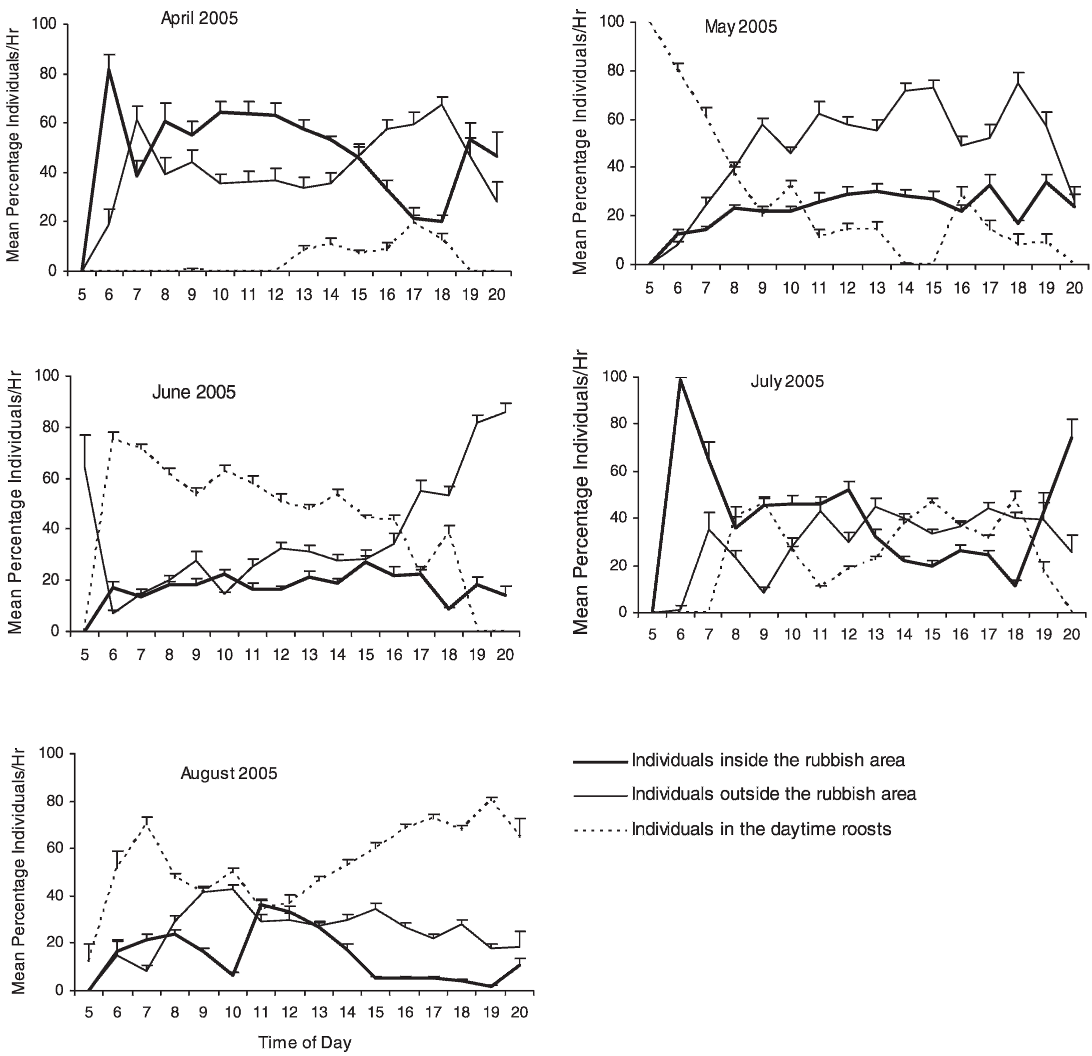


Figure 2. Mean percentage of individuals/hr (±1 SE) observed in the rubbish area, outside the rubbish area, and on daytime perches (Rome rubbish dump, April–August 2005).

in April, May, and June, and 5–15 min before dusk (mean: 10.5 ± 4.2 min, $N = 4$) in July and August. Kite abundance increased progressively until 1100 H ($r_s = 1.000$, $N = 7$ hr, $P < 0.01$), then remained stable until 1700 H, and after 1800 H, the birds progressively left the area.

The percentage of individuals at rest on perches differed over the months (8 ± 6% in April, 22 ± 23% in May, 43 ± 23% in June, 26 ± 17% in July, and 56 ± 14% in August; ANOVA: $F_{4,1915} = 133.0$, $P < 0.001$; Fig. 2). In particular, the percentage of individuals present in the rubbish area was not correlated with the percentage of individuals in flight outside the area ($r = 0.021$, $P = 0.85$, $N = 80$; 16 hourly counts per day over 5 mo), but increased as the percentage of individuals at rest diminished ($r = -0.573$, $N = 80$, $P = 0.01$). The activity in the rubbish area rose progressively during the day and was greatest around noon. The greatest number of individuals was observed during the time periods 1000–1100 H and 1100–1200 H in July and August, respectively. Crowding peaks normally lasted for 5–10 min and were followed by rapid, marked declines (Fig. 3). The mean percentage of individuals per 5-min count flying outside the rubbish area was 37 ± 27% ($N = 1920$); this varied over the months (AN-

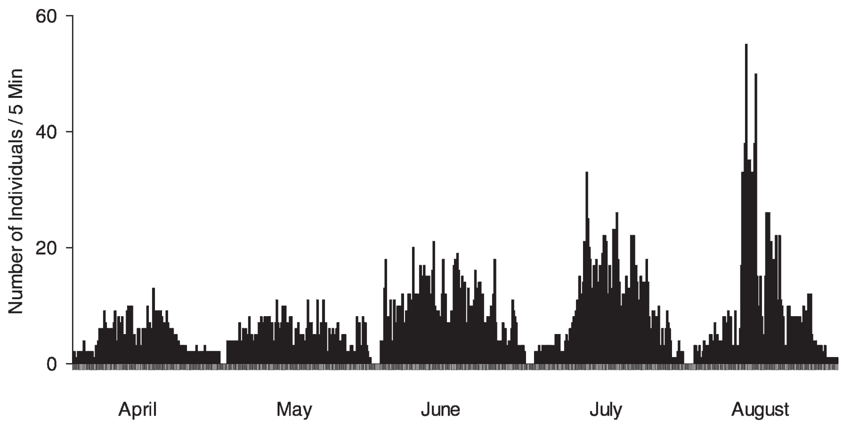


Figure 3. Number of individuals observed in the rubbish area during the whole study period during counts taken every 5 min from 0400–2000 H (total number of counts = 1920, Rome rubbish dump, April–August 2005).

OVA: $F_{4,1915}$ = 81.3, $P < 0.001$; Fig. 2), and was inversely correlated with the percentage of individuals on perches ($r = -0.474$, $N = 80$, $P < 0.01$). The first juveniles were observed in the dump during the last third of June and some of them were still being fed by parents.

**Feeding Behaviors.** During the study period we did not observe any predation on live animals. On the contrary, we observed 3214 episodes of food collection from the rubbish. Of these, 783 were autonomous food collection episodes and the other 2431 were cleptoparasitism acts. Of the overall 783 autonomous collection episodes, food items were collected by birds inspecting the waste on the ground on 298 occasions (38.1% of the episodes) and by individuals flying low over the rubbish mass in 485 instances (61.9%; Fig. 4). Food collection by birds standing on the ground was never observed

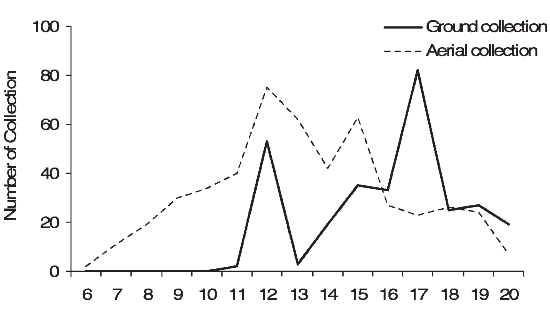


Figure 4. Number of observations/hr of birds collecting food while standing on the ground ($N$ = 298), or collecting food while flying low over the ground ($N$ = 485), Rome rubbish dump, April–August 2005.

before 1000 H and this behavior increased during the day (ground collection observations per hr vs. time of day: $r_s$ = 0.778, $N$ = 16, $P < 0.001$). This behavior was more often observed when gull densities were lower (ground collections per hr vs. mean number of gulls per hr: $r_s = -0.539$, $N$ = 16, $P <$ 0.031) and when the compaction equipment was inactive for the lunch period (1100–1200H), or ceased at the end of the daily work shift (ground collections per hr vs. mean number of compactors per hr: $r_s = -0.805$; $N$ = 16, $P < 0.001$). No relationship was observed between the time of the day and the number of episodes of food collection by flying kites (observations of collections per hr vs. time of day: $r_s$ = 0.238, $N$ = 16, $P$ = 0.37). The ground collection behavior, not observed in April, differed in frequency among the later study months ($\chi^2_3$ = 93.4, $P < 0.001$; Table 1).

The mean numbers of gulls and crows in the photographs of the rubbish in front of compaction equipment were, respectively, 425 ± 212 (range: 44–845) and 9 ± 4 (range: 2–15). However, there was no relationship between the number of gulls and the episodes of food collection by flying kites (observations of collections per hr vs. mean number of gulls per hr: $r_s$ = 0.071, $N$ = 16, $P$ = 0.80). Collection of food from the ground by kites was not correlated with the mean number of gulls or compactors ($P \geq 0.47$).

Of the 2431 cleptoparasitism events, 854 (35.1%) were intraspecific, 1379 (56.7%) were against Yellow-legged Gulls and 198 (8.1%) against Carrion Crows. The rate of success was 32.4% for intraspecific cleptoparasitism, but was significantly higher

Table 1. Number of cleptoparasitic attempts and frequency (%) of two food collection techniques used by Black Kites in a rubbish dump in Rome (April–August 2005).

| | MONTH | | | | |
|---|---|---|---|---|---|
| FORAGING METHOD | APRIL | MAY | JUNE | JULY | AUGUST |
| From the ground, *N* (%) | 0 | 16 (19.3%) | 12 (14.4%) | 97 (35.4%) | 173 (59.4%) |
| From the air, *N* (%) | 52 (100%) | 67 (80.7%) | 71 (85.6%) | 177 (64.6%) | 118 (40.6%) |
| Total observed, *N* | 52 | 83 | 83 | 274 | 291 |

for cleptoparasitism attempts against Yellow-legged Gulls (73.2%; $\chi^2_1 = 358$, $P < 0.001$) and against Carrion Crows (65.7%; $\chi^2_1 = 73.8$, $P < 0.001$). The effectiveness of intraspecific cleptoparasitism increased during the season, ranging from 21.4% success in April ($N = 70$ attempts) to 37.8% in August ($N = 196$; $\chi^2_4 = 13.10$, $P < 0.02$), and the frequency of intraspecific cleptoparasitism increased with the overall abundance of kites feeding in the rubbish area ($r_s = 0.834$, $N = 16$, $P < 0.01$; Fig. 5). Cleptoparasitic attempts lasting >1 min (maximum = 4.2 min) were less successful than shorter ones ($\chi^2_1 = 8.61$, $P < 0.01$).

The success rate of cleptoparasitism against Yellow-legged Gulls and Carrion Crows did not differ among the months ($P > 0.05$). When directed against the Yellow-legged Gull, the effectiveness of cleptoparasitism increased with the time of day ($r_s = 0.944$, $N = 16$, $P < 0.001$; Fig. 6) and declined with the number of gulls present on the rubbish ($r_s = -0.615$, $N = 16$, $P < 0.05$). Against Carrion Crows, the efficiency of cleptoparasitism increased progressively throughout the day ($r_s = 0.811$, $N = 16$, $P < 0.001$), but was not related to the local abundance of crows ($r_s = 0.362$, $N = 16$, $P < 0.17$; Fig. 6). Cleptoparasitism against Yellow-legged Gulls was significantly more successful than that against Carrion Crows ($\chi^2_1 = 4.50$, $P < 0.03$). Cleptoparasitism attempts by Yellow-legged Gulls against Black Kites were never successful ($N = 47$), whereas Carrion Crows succeeded on 2 of 196 attempts (1.0%).

## DISCUSSION

The Black Kite population of Rome regularly visits the refuse dump that we studied (De Giacomo et al. 2004). Some individuals in this population are known to feed also elsewhere, and the exploitation of such alternative food sources seems to have a seasonal character (Castaldi and Guerrieri 2006). In contrast to observations from Madrid (Blanco

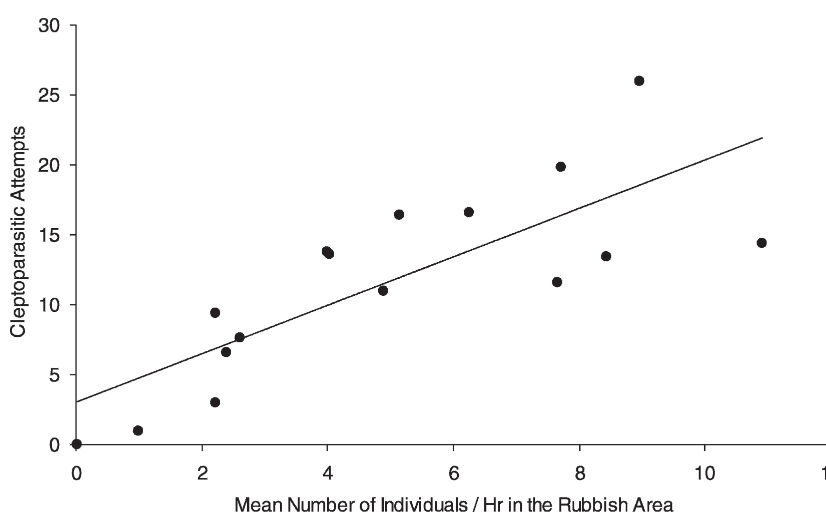


Figure 5. Mean hourly increase in intraspecific cleptoparasitic attempts in relation to the mean number of kite individuals in the rubbish area of the Rome rubbish dump, April–August 2005 (mean number of observations per hr = 160; line: y = 1.7303 x + 3.0317, $r^2 = 0.6281$).

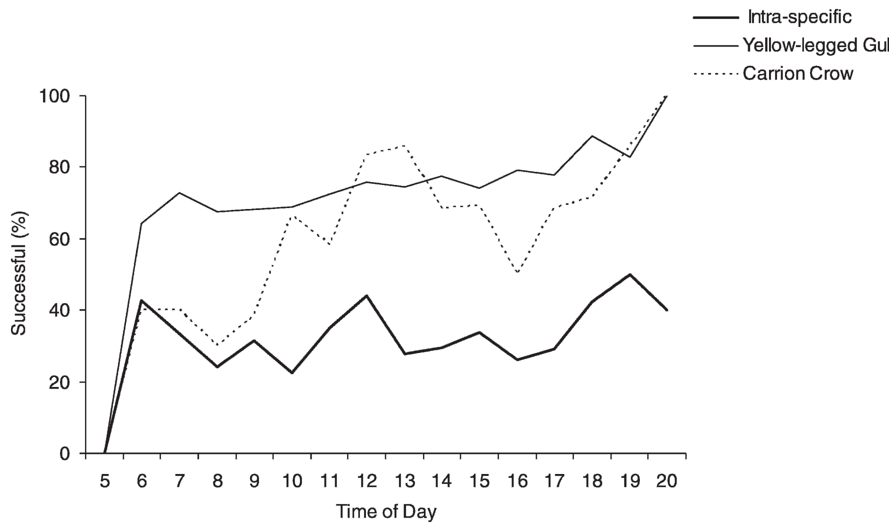


Figure 6. Success rate of intraspecific ($N = 854$) and of interspecific cleptoparasitic attempts against Yellow-legged Gulls ($N = 1379$) and Carrion Crows ($N = 198$). Success rate is expressed as the percentage of the attempts which were successful (Rome rubbish dump, April–August 2005).

1997), where kites also hunted for live food items, kites in the Rome dump collected food primarily from the refuse, which may not meet all the nutrients needs of the young (Veiga and Hiraldo 1990, Viñuela 1991).

In April, the number of kites in the rubbish area was high. In May and June, the percentage of kites present in the refuse processing area tended to decline. In May, individuals that probably were nonbreeders or had arrived at the area later in the season (Blanco et al. 2007, Sergio et al. 2007) remained on perches longer. In June, the first juveniles were observed at the dump-site (Glutz von Blotzheim et al. 1971, Newton 1979, Blanco 1994, Ortlieb 1998); in this month, most kites arrived at the dump at dawn and likely remained on perches until they were successful at feeding. In August, kites spent most of the day resting (i.e., perching) within the rubbish dump. At dusk, they moved some kilometers from the rubbish dump to form night roosts, whereas in Marseilles they stayed near the rubbish dump overnight (Kabouche and Ventroux 1999). This suggests that locations of roosting sites were likely determined by woodland availability and structure as reported elsewhere (Sergio and Boto 1999, Sergio et al. 2003c, Sergio et al. 2003a, Battisti and Zocchi 2004).

At the Rome dump, the concentrations of individuals were lower than those recorded in Madrid and Marseilles dumps (Blanco 1994, Kabouche and Ventroux 1999). Given the fact that the number of individuals present in the rubbish area usually remained low and that high concentrations occurred only for brief periods, it is possible that coexistence of a relatively large number of individuals was promoted by temporal segregation and consequently lower aggression rates, as previously reported for other carrion- and refuse-feeders (Wallace and Temple 1987, Gómez-Tejedor 1998, Newton 1998). The same mechanism, working on a seasonal basis, has been proposed for Red Kites (*Milvus milvus*) and Black Kites in Spanish rubbish dumps (Donázar 1992). In this scenario, the observed increase in intraspecific cleptoparasitism rates associated with increasing kite density might cause some kites to refrain from feeding on the refuse until the abundance of potential cleptoparasites declines. The progressive increase in the efficiency of intraspecific cleptoparasitism observed from April to August might be influenced by (1) the progressively higher conspecific density within the rubbish dump, (2) a progressively higher proportion of young birds employing or suffering cleptoparasitic attempts, and/or (3) the increasing motivation by breeders later in the season when the energy demands of feeding nestlings are higher.

Kites seemed to prefer finding food while flying low over the ground to foraging from the ground. Food collection from the ground was observed only in the late morning, after the searching activity of gulls made food more readily available. Kites locate food by sight and apparently are not able to break through plastic seals. Searching for food on the ground was the technique used more often when the number of gulls was low and the opportunities for cleptoparasitism more limited. The same behavior was observed when compaction equipment activity was low or absent. This strategy was more frequent in July and August, and may have been associated with the appearance of recently fledged young at the rubbish dump.

Finally, Yellow-legged Gulls were the most frequent victims of cleptoparasitic attempts by kites. This was expected and probably adaptive because gulls were more abundant than crows and cleptoparasitised more efficiently. The increase in success rate during the day was probably associated with a progressive decline in gull abundance. In fact, large gull flocks seemed to disorient the kites when gull numbers were extremely high.

ACKNOWLEDGMENTS

We thank G. Blanco, F. Sergio, J. Viñuela, and an anonymous referee for their criticism and constructive suggestions. We are also very grateful to Manlio Cerroni, Piero Giovi, and Francesco Rando, who gave us permission to work at the rubbish dump, and to all the dump personnel for their collaboration during fieldwork.

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Received 13 February 2007; accepted 22 January 2008
Associate Editor: Fabrizio Sergio