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Prey selection in the common kestrel, *Falco tinnunculus* (Aves, Falconidae) in the Algiers suburbs (Algeria)

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A b s t r a c t . Birds comprised 51.9% of the diet of a pair of common kestrels *Falco tinnunculus* in 1997 in a suburb of Algiers. Insects were the most numerous prey type between 1998 to 2002 with a maximum of 67.5 % in 2001. Insect prey taken included coleoptera *Scaurus* sp. (E = 0.90) and the orthopterans *Pamphagus elephas* (E = 0.74) and *Eyprepocnemis plorans* (E = 0.09). At the species level, the hybrid sparrow (*Passer domesticus* x *Passer hispaniolensis*) was the commonest taken prey (47.2 %) and it had the highest density among the recorded birds. This prey species was the most prefered among the birds recorded (E = 0.35).

Key words: diet, common kestrel, Algiers, birds, insects, hybrid sparrow

Introduction

The common kestrel *Falco tinnunculus* has a wide distribution in Algeria and is found across all habitats (H e i m d e B a l s a c & M a y a u d 1962). The diet of common kestrel has been well studied in the Canary Islands (C a r i l l o et al. 1994), South Africa (V a n Z y l 1994), Algeria (B a z i z et al. 2001, S o u t t o u et al. 2006) and in Europe (T h i o l l a y 1963, 1968, Y a l d e n & W a r b u r t o n 1979, Q u e r e 1990, V i l l a g e 1990, V a l k a m a et al. 1995, R o m a n o w s k i 1996, R o u l i n 1996, F a t t o r i n i et al. 1999, S a l v a t i et al. 1999). However, there are fewer studies on the relationship between diet and food availability (K o r p i m ä k i 1985). In Algeria, B a z i z et al. (2001) analysed the diet of the common kestrel relative to prey availability but did not have data for the availability of all prey types such as Coleopterans and Orthopterans. In this paper, we analyzed diet composition in relation to prey availability in the common kestrel.

Study Area

This study was conducted in the Algiers suburbs at El Harrach located between Belfort (Hacen Badi) and the eastern part of Mitidja (3° 08' E, 36° 43' N) at 50 m a.s.l. with 10 ha of buildings, parks and lawns and 6 ha of agricultural plots. The average annual rainfall is 545 mm (E m b e r g e r 1955) ranged from a minimum of 272 mm in 2000 to a maximum of 807 mm in 1999. The daily temperature (measured at Dar El Beida, 5 km east of the study area) ranged from a mean minimum of 11.5°C in 1998 to a mean maximum of 26°C in 2000.

Material and Methods

Diet was determined by pellet analysis. A pair of kestrels has been known to breed and winter as this site since 1997. A total of 429 pellets were collected every 2–4 weeks between January 1997 to December 2002 on the flat roofs of four buildings, under a water tower, and a *Eucalyptus* sp. and *Quercus ilex* tree used as perches by the kestrels. Of these, 335 pellets were collected in the breeding period and 94 pellets collected during the non-breeding period.

Each pellet was dissected in water. Mammal prey items were identified from the skull and teeth or by mammal hair if no skeletal elements were present in the pellet (Debrot et al. 1982). Bird prey items were identified by beaks, bones (humerus, femur and tibia) and feathers against a reference collection. Arthropoda were identified from main body parts, including heads, mandibles, antennae, legs and especially elytrae (Hacini & Doumandji 1998).

The number of individual prey were calculated based on the different parts found. Paired anatomical parts with the same features were counted as belonging to the same individual (Piatella et al. 1999). The number of vertebrates were calculated separately for each pellet on the basis of the predominant bone elements, jaw bones or skulls for mammals, and beaks or humerus bones for birds. Arthropods were counted from the number of legs, heads, elytrae, mandibles and ovipositor valves.

Prey availability was estimated by pitfall traps for arthropods. Arthropod availability was estimated by means of 10 pitfall traps set every 2 weeks throughout the study period, collecting all specimens caught after 24 h (see Le Berre 1969 for greater detail). A total of 360 traps were installed between 2000 and 2002. Pitfalls are considered useful for estimating ground-dwelling prey (Le Berre 1969).

The census of grasshopper's species was conducted by quadrat method (Voisin 1986). The surface of the quadrat was 3 m x 3 m and with 9 quadrats per month a total of 324 quadrats were censussed between 2000 and 2002. Both adult and larvae individuals were recorded per quadrat.

The avifauna was sampled using the quadrat method during the spring from 1998 to 2002 (Blondel 1969). Bird pairs were recorded if both were seen or heard from the survey point during the 2 to 3 hours period. The quadrat surface was 50 m x 50 m and 40 quadrats were covered. The total area sampled was 10 ha. Censusses were conducted on 7 quadrats per year during the breeding season. A total of 35 quadrats were censussed between 1998 and 2002.

One ecological index was calculated; relative frequency – the number of individuals of a species to the total number of individuals of all species.

The prey composition of the diet of the common kestrel is very diverse. In order to highlight the diet preferences of this small raptor compared with prey availability, we used Ivlev's (1961) formula:

$$E = (r - p) / (r + p)$$

Where *r* is the proportion of a prey species in the diet of the common kestrel and *p* is the proportion of same prey in the environment. Ivlev's index ranges from +1 to -1, with values close to +1 indicating consumption at much greater proportions than availability, those near -1 indicating prey taken considerably below availability. The Ivlev's index E is measure to quantify prey selection, but the values of this indice depend not only on the extent of selection but also on the relative abundance of the prey species in the environment (Jacobs 1974). Accidental items we omitted from the analysis following Johnson (1980).

The annual variations of frequencies between vertebrarte and invertebrate prey and between prey class were tested using a contingency table (Chi-square Test).

Results

Diet composition

The relative frequency of vertebrate and invertebrate prey varied significantly between years ($\chi 2$= 50.90, df = 5, p<0.00001). The diet of the common kestrel in 1997 was dominated by vertebrate prey (64.8 %) versus 35.2 % for invertebrate prey. Whereas, between 1998 and 2002 the proportion of invertebrate prey was higher than that of the vertebrate prey, varying between 65.5 % in 1999 and 73.0 % in 2001 for the invertebrate prey against 24.7 % in 2002 and 34.5 % in 1999 for the vertebrate prey, respectively.

The relative frequency of the prey class varied significantly between 1997 and 2002 ($\chi 2$ = 294.36, df = 45, p<0.00001). In 1997, birds and insects made up 51.9 % and 25.9 % of the diet, respectively. Myriapoda and reptilia with 5.6 % each made up most of the remainder of the diet. Consequently between 1998 and 2002, insects were the most important component with 38.4 % in 1998 and 67.5 % in 2001 (Table 1). Within Insecta, grasshoppers made up the most consumed prey varying between 12.4 % in 1999 to 30.3 % in 2001. Coleopterans (beetles) fluctuated between 3.7 % in 1997 to 36.7 % in 1999 and birds ranged from 20.7 % (2001) to 27.7% (1999).

In 1997, 108 prey items were identified comprising 30 species. The dominant species in the diet was the hybrid sparrow *Passer domesticus* x *P. hispaniolensis* making up 47.2 %. The remaining prey species made up less than 6.0 % of the diet (Table 1). In 1998, the diet was composed of 151 prey items of 30 species. The millipede *Lithobius forficatus* was the dominant species eaten (23.8 %), followed by *Passer domesticus* x *P. hispaniolensis* (19.9 %), *Lithobius* sp. (8.6%), *Silpha granulata* and *Pamphagus elephas* (6.0 % each). The analysis of the pellets collected in the same area in 1999 consisted of 354 preys items with 55 species, the hybrid sparrow *Passer domesticus* x *P. hispaniolensis* (24.6 %) was the most important prey species consumed by kestrels. This is followed by *Silpha opaca* (15.3 %), Chilopoda sp. (6.5 %), *Silpha granulata* and *Potosia cuprea* (5.1 % each). The 455 prey items identified from 127 pellets collected during 2000 comprised 70 species. The hybrid sparrow made up the most important prey species consumed (19.6 %), followed by *Polydesmus* sp. (5.7 %), *Silpha opaca* (5.3 %), *Potosia cuprea* (5.1 %) and *Mantis religiosa* (3.7 %). In 2001, 310 item preys were composed of 41 species. *Passer domesticus* x *P. hispaniolensis* (17.1 %) was the most numerous followed by *Silpha opaca* with 13.9 %, *Odontura algerica* (13.6%), *Messor barbara* (5.5 %), *Silpha granulata* (4.8 %) and *Polydesmus* sp. (4.5 %). During the 2002, 263 prey items, were composed of the ant *Messor barbara* (19.4 %), this is followed by *Passer domesticus* x *P. hispaniolensis* (14.1 %), *Aethiessa floralis barbara* (9.9 %) and *Calliptamus wattenwylianus* (8.4 %).

Comparison between diet and prey availability

The values of Ivlev's index E of orthopterans had *Pamphagus elephas* (0.60) as the most preferred species in the diet of common kestrel, and *Acrida turrita* (-0.82) and *Eyprepocnemis plorans* (-0.68) were the least selected prey (Table 2). The species present in the environment but

Table 1. Relative frequency (%) of prey's species of common kestrel *Falco tinnunculus* between 1997 to 2002 in suburbs Algiers.

Years	1997	1998	1999	2000	2001	2002	**Mean**
Prey species	R.F.%	R.F.%	R.F.%	R.F.%	R.F.%	R.F.%	
Helicidae sp. und.	-	-	-	0.22	-	-	0.04
Otala sp.	0.93	-	-	-	-	-	0.16
Total Gastropoda	**0.93**	**-**	**-**	**0.22**	**-**	**-**	**0.19**
Isopoda sp. und.	-	-	-	-	-	0.38	0.06
Total Crustacea	**-**	**-**	**-**	**-**	**-**	**0.38**	**0.06**
Solifugea sp. und.	-	-	0.56	-	-	-	0.09
Araneidae sp. und.	2.78	-	-	-	0.32	0.76	0.64
Dysderidae sp. und.	-	-	0.85	0.66	0.32	4.56	1.07
Dysdera sp.	-	-	0.28	0.22	-	-	0.08
Total Arachnida	**2.78**	**-**	**1.13**	**0.88**	**0.64**	**5.32**	**1.89**
Myriapoda sp. und.	-	-	-	0.66	-	-	0.11
Chilopoda sp. und.	0.93	1.99	6.5	1.32	0.32	3.80	2.48
Lithobius sp.	-	8.61	-	2.42	-	-	1.84
Lithobius forficatus	4.63	23.84	-	-	-	-	4.75
Iulus sp. 1	-	-	-	0.22	-	-	0.04
Iulus sp. 2	-	-	-	0.22	-	-	0.04
Polydesmus sp.	-	-	1.70	5.71	4.52	-	1.99
Total Myriapoda	**5.56**	**34.4**	**8.76**	**10.6**	**4.84**	**3.80**	**11.23**
Lestes sp.	-	-	0.28	-	-	-	0.05
Periplaneta americana	-	-	1.13	0.88	-	-	0.34
Ameles sp.	-	-	-	-	-	0.38	0.06
Ameles abjecta	-	-	0.28	-	-	-	0.05
Mantoptera sp. und.	-	-	-	0.22	-	-	0.04
Mantis religiosa	-	0.66	0.85	3.74	1.29	-	1.09
Sphodromantis viridis	-	-	-	0.22	-	0.38	0.10
Ensifera sp. und.	-	0.66	-	-	-	0.76	0.24
Ephippigeridae sp. und.	-	-	-	0.22	-	-	0.04
Gryllidae sp. und.	0.93	-	-	0.66	0.65	0.38	0.44
Gryllulus sp.	-	-	-	0.22	-	0.38	0.10
Gryllus sp.	0.93	-	0.28	0.88	-	0.38	0.41
Gryllus bimaculatus	5.56	-	1.41	2.86	0.32	1.14	1.88
Odontura algerica	-	-	0.28	0.22	13.55	0.76	2.47
Acrididae sp. und.	-	-	-	-	0.32	2.66	0.50
Caelifera sp. und.	2.78	1.32	0.56	2.42	1.94	-	1.50
Oedipoda caerul. sulfurescens	-	-	0.85	-	-	-	0.14
Dociostaurus jagoï jagoï	0.93	-	-	-	-	-	0.16
Aiolopus strepens	0.93	4.64	-	0.66	1.29	0.38	1.32
Aiolopus thalassinus	-	0.66	-	0.44	0.65	-	0.29
Pamphagus elephas	1.85	5.96	1.98	2.86	0.97	1.90	2.59
Calliptamus sp.	-	-	0.56	-	-	-	0.09
Calliptamus barbarus	2.78	-	-	-	-	-	0.46
Calliptamus wattenwylianus	-	-	0.28	1.1	-	8.37	1.63
Anacridium aegyptium	-	2.65	2.54	1.76	4.19	-	1.86
Pezotettix giornai	0.93	0.66	-	0.22	0.32	-	0.36
Eyprepocnemis plorans	0.93	3.97	1.98	2.42	2.58	3.42	2.55

Table 1. continued

Acrida turrita	-	0.66	1.41	2.86	3.55	2.28	1.79
Locusta migratoria	-	-	0.28	0.66	-	-	0.16
Dermaptera sp. und.	-	-	1.13	-	-	-	0.19
Labidura riparia	-	-	0.85	-	-	-	0.14
Forficula auricularia	-	-	0.28	0.22	-	-	0.08
Anisolabis mauritanicus	-	1.32	0.85	2.2	1.94	1.14	1.24
Cicadetta montana	-	-	0.28	0.22	-	-	0.08
Carabidae sp. und.	-	-	-	0.22	-	-	0.04
Ocypus olens	-	-	0.28	0.22	-	-	0.08
Silpha sp.	-	-	-	-	-	1.52	0.25
Silpha opaca	-	0.66	15.26	5.27	13.87	1.52	6.10
Silpha granulata	-	5.96	5.09	1.1	4.84	0.76	2.96
Scarabeidae sp. 1	1.85	0.66	0.56	-	0.32	-	0.57
Scarabeidae sp. 2	-	-	-	-	0.32	-	0.05
Pentodon sp.	-	-	-	-	-	0.38	0.06
Geotrupes sp. 1	-	-	2.54	1.98	1.61	0.38	1.09
Geotrupes sp. 2	-	0.66	-	-	-	-	0.11
Geotrupes sp. 3	0.93	0.66	-	-	-	-	0.27
Phyllognathus silenus	-	-	0.56	0.44	-	-	0.17
Bubas sp.	-	-	-	-	-	0.38	0.06
Bubas bison	-	-	0.28	0.44	0.32	-	0.17
Rhizotrogus sp.	0.93	-	-	-	-	1.14	0.35
Amphimallon scutellare	-	-	0.28	-	-	-	0.05
Potosia cuprea	-	1.99	5.09	5.05	2.58	-	2.45
Cetonia aurata funeraria	-	0.66	1.41	-	2.26	-	0.72
Aethiessa floralis barbara	-	0.66	1.13	0.44	-	9.89	2.02
Pimelia sp.	-	-	-	-	-	0.76	0.13
Sepidium varigatum	-	-	-	-	-	0.38	0.06
Oxythyria squalida	-	-	-	1.54	-	-	0.26
Buprestidae sp. und.	-	-	1.41	-	-	-	0.24
Tenebrionidae sp. und.	-	-	0.28	-	-	-	0.05
Tentyria sp.	-	-	-	0.22	-	0.38	0.10
Lithoborus sp.	-	-	-	2.42	-	-	0.40
Scaurus sp.	-	-	-	0.88	-	1.14	0.34
Pachychila sp.	-	-	-	0.66	-	1.14	0.30
Aromia rosarum	-	-	-	0.22	-	-	0.04
Chalcophora mariana	-	-	-	-	0.32	-	0.05
Cerambycidae sp. und.	-	-	0.28	0.66	0.32	0.38	0.27
Hesperophanes sp.	-	-	0.28	-	-	-	0.05
Lixus sp.	-	-	-	0.44	-	-	0.07
Lixus algirus	-	-	1.98	0.22	0.32	-	0.42
Otiorhynchus sp.	-	0.66	-	-	-	-	0.11
Plagiographus sp.	-	-	-	0.22	-	-	0.04
Bothynoderes brevirostris	-	-	-	0.22	-	-	0.04
Lepidoptera sp. und.	0.93	1.99	-	-	-	0.38	0.55
Messor barbara	-	-	-	-	5.48	19.39	4.15
Ichneumonidae sp. und.	-	-	-	-	0.65	-	0.11
Sphecidae sp. und.	-	0.66	-	-	-	-	0.11

Table 1. continued

Apoidea sp. und.	1.85	-	0.56	0.22	-	-	0.44
Apis mellifera	-	-	-	-	-	0.76	0.13
Vespoïdea sp. und.	0.93	-	-	-	-	-	0.16
Vespa germanica	-	-	-	2.86	-	-	0.48
Polistes gallicus	-	-	-	-	-	0.76	0.13
Total Insecta	**25.93**	**38.4**	**55.65**	**54.07**	**67.54**	**66.14**	**51.04**
Hyla sp.	0.93	-	-	-	-	-	0.16
Total Batrachia	**0.93**	**-**	**-**	**-**	**-**	**-**	**0.16**
Tarentola mauritanica	5.56	2.65	2.26	1.54	0.97	0.76	2.29
Chalcides ocellatus	-	-	0.85	1.54	1.61	1.14	0.86
Total Reptilia	**5.56**	**2.65**	**3.11**	**3.08**	**2.58**	**1.90**	**3.15**
Aves sp. und.	0.93	-	0.28	0.44	0.65	0.76	0.51
Streptopelia sp.	-	-	-	0.66	-	0.38	0.17
Streptopelia senegalensis	-	-	-	0.44	-	-	0.07
Sturnus vulgaris	-	-	-	2.42	0.65	0.38	0.58
Pycnonotus barbatus	1.85	-	-	-	-	-	0.31
Erithacus rubecula	-	-	0.28	0.22	0.32	0.38	0.20
Turdus merula	-	-	0.28	0.22	-	-	0.08
Carduelis chloris	-	1.99	1.70	1.98	0.65	1.52	1.31
Serinus serinus	1.85	-	0.56	0.66	1.29	1.90	1.04
P. dom. x *P. hisp.*	47.22	19.87	24.58	19.56	17.10	14.07	23.73
Total Aves	**51.85**	**21.9**	**27.68**	**26.59**	**20.66**	**19.39**	**28.01**
Lemniscomys barbarus	-	-	0.56	-	-	-	0.09
Mus musculus	-	-	0.85	0.44	-	0.76	0.34
Mus spretus	2.78	1.99	0.85	1.98	1.94	0.76	1.72
Rattus norvegicus	0.93	-	-	0.44	-	0.38	0.29
Total Rodentia	**3.70**	**1.99**	**2.26**	**2.86**	**1.94**	**1.14**	**2.44**
Crocidura russula	1.85	0.66	-	0.44	-	0.38	0.56
Total Insectivora	**1.85**	**0.66**	**-**	**0.44**	**-**	**0.38**	**0.56**
Pipistrellus kuhli	0.93	-	1.41	1.32	2.58	1.90	1.36
Total Chiroptera	**0.93**	**-**	**1.41**	**1.32**	**2.58**	**1.90**	**1.36**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**

-: Species absent, sp. und.: species undertmined.
Oedipoda caerul. sulfurescens: *Oedipoda caerulescens sulfurescens*
P. dom. x *P. hisp.*: *Passer domesticus* x *Passer hispaniolensis*.

absent from the diet of the common kestrel had minimal extreme values (-1) such as *Oedipoda coerulescens sulfurescens* (-1), *Platypterna tibialis* (-1) and *Acrotylus patruelis* (-1) (Table 2). These values are discounted in further analysis. In 2001, the prey species *Aiolopus thalassinus* (-0.85), *Pamphagus elephas* (-0.67), *Acrida turrita* (-0.67) and *Eyprepocnemis plorans* (-0.31) were the least selected prey type. During 2002, *Pamphagus elephas* (0.74) was the most prefered orthopterans species in the diet, followed by *Eyprepocnemis plorans* (0.09).

In 2000, *Plagiographus* sp. (0.18) was the most preferred. In 2001, among the Coleopterans listed in the study area *Silpha opaca* (19.2 %) and *Silpha granulata* (6.7 %), were prey species with E equal to 0.45 and 0.46 and most preferred prey taken (Table 3). In 2002, prey type *Scaurus* sp. was most prefered (0.90) species taken by kestrels, followed by *Tentyria* sp. (0.34) and *Silpha opaca* (0.21).

Table 2. Ivlev's index E of Orthopteran prey of common kestrels in suburban Algiers between 2000 to 2002.

Years	2000			2001			2002		
Prey species	r	P	E	r	p	E	r	p	E
Oedipoda caerul. sulfurescens	-	3.4	-1	-	-	-	-	3.08	-1
Aiolopus strepens	1.00	12.45	-0.85	-	45.45	-1	0.51	32.69	-0.97
Aiolopus thalassinus	0.67	8.42	-0.85	0.89	11.36	-0.85	-	17.69	-1
Pamphagus elephas	4.35	1.10	0.60	1.34	6.82	-0.67	2.55	0.38	0.74
Pezotettix giornai	0.33	0.37	-0.06	1.22	-	+1	-	3.46	-1
Eyprepocnemis plorans	3.68	19.05	-0.68	3.57	6.82	-0.31	4.59	3.85	0.09
Acrida turrita	4.35	45.05	-0.82	4.91	25.00	-0.67	3.06	8.85	-0.49
Platypterna tibialis	-	4.03	-1	-	-	-	-	9.62	-1
Acrotylus patruelis	-	1.83	-1	-	2.27	-1	-	18.85	-1
Omocestus lucasi	-	-	-	-	2.27	-1	-	-	-
Conocephalus sp.	-	-	-	-	-	-	-	1.54	-1

r is the proportion of item in the diet of *Falco tinnunculus*.
p is the proportion of same item in environment.
E: Ivlev selection Index ; -: species absent.

Table 3. Ivlev's index E of Coleopteran (Beetls) prey of common kestrels in suburban Algiers between 2000 to 2002.

Years	2000			2001			2002		
Prey species	r	p	E	r	p	E	r	p	E
Silpha opaca	8.03	-	+1	19.20	7.20	0.45	2.04	1.33	0.21
Silpha granulata	1.67	-	+1	6.70	2.47	0.46	1.02	-	+1
Oxythyria squalida	2.34	-	+1	-	-	-	-	0.08	-1
Tentyria sp.	0.33	-	+1	-	-	-	0.51	0.25	0.34
Lithoborus sp.	3.68	-	+1	-	-	-	-	0.08	-1
Scaurus sp.	1.34	-	+1	-	-	-	1.53	0.08	0.90
Plagiographus sp.	0.33	0.23	0.18	-	-	-	-	-	-

r is the proportion of item in the diet of *Falco tinnunculus*.
p is the proportion of same item in environment.
E: Ivlev selection Index ; -: species absent.

The hybrid sparrow made up the most abundante species taken among the birds in the environment varyiing between 35.1 % in 2000 to 49.3 % in 1999 (Table 4). This prey species was the most prefered among the birds recorded in 1998 (0.32), in 1999 (0.29), in 2000 (0.35) and in 2001 (0.30), but in 2002, the serin *Serinus serinus* was the most preferred (0.49). The greenfinch *Carduelis chloris* was preferred in 2002 (0.20) and was least selected during the period from 1998 to 2001.

Discussion

In the suburbs Algiers at El Harrach, vertebrate prey made up the most consumed prey of common kestrels (64.8 %) during 1997 compared to 35.2 % of invertebrate prey. These results resemble those of Q u e r e (1990) in Paris, of R o m a n o w s k i (1996) in Poland and P i a t e l l a et al. (1999) in Rome (see Table 5). However the frequency of invertebrate prey was higher than that of the vertebrate prey between 1998 and 2002. Other studies also suggested the importance of invertebrate prey in the common kestrel diet (Y a l d e n

Table 4. Ivlev's index E of avian prey of common kestrels in suburban Algiers between 1998 to 2002.

Yeras	1998			1999			2000			2001			2002		
Prey species	r	p	E	r	p	E	r	p	E	r	p	E	r	p	E
Columba livia	-	7.64	-1	-	5.04	-1	-	4.35	-1	-	7.76	-1	-	5.88	-1
Columba palumbus	-	4.01	-1	-	11.94	-1	-	5.44	-1	-	7.35	-1	-	15.84	-1
Streptopelia turtur	-	-	-	-	2.39	-1	-	4.35	-1	-	1.23	-1	-	5.88	-1
Streptopelia senegalensis	-	2.08	-1	-	0.80	-1	1.65	2.18	-0.14	-	1.63	-1	-	3.10	-1
Streptopelia decaocto	-	-	-	-	-	-	-	0.31	-1	-	0.92	-1	-	1.88	-1
Upupa epops	-	-	-	-	-	-	-	0.31	-1	-	-	-	-	0.33	-1
Jynx torquilla	-	0.45	-1	-	0.86	-1	-	2.64	-1	-	1.23	-1	-	1.96	-1
Pycnonotus barbatus	-	4.90	-1	-	1.33	-1	-	3.03	-1	-	2.04	-1	-	2.29	-1
Sylvia atricapilla	-	2.67	-1	-	1.59	-1	-	3.89	-1	-	2.66	-1	-	2.61	-1
Cisticola juncidis	-	-	-	-	0.40	-1	-	0.62	-1	-	0.61	-1	-	0.65	-1
Hyppolaïs pallida	-	1.04	-1	-	-	-	-	-	-	-	0.82	-1	-	1.39	-1
Muscicapa striata	-	1.19	-1	-	1.99	-1	-	2.18	-1	-	-	-	-	-	-
Turdus merula	-	2.45	-1	1.02	3.05	-0.50	0.83	5.28	-0.73	-	6.33	-1	0.37	4.08	-0.83
Erithacus rubecula	-	2.08	-1	1.02	1.59	-0.22	0.83	1.86	-0.38	-	2.66	-1	0.37	2.29	-0.72
Parus caeruleus	-	2.97	-1	-	2.06	-1	-	4.20	-1	-	2.66	-1	-	1.96	-1
Parus major	-	0.30	-1	-	0.93	-1	-	0.93	-1	-	0.41	-1	-	0.82	-1
Certhia brachydactyla	-	1.04	-1	-	0.86	-1	-	2.18	-1	-	1.23	-1	-	1.63	-1
Fringilla coelebs	-	1.34	-1	-	0.93	-1	-	1.55	-1	-	1.84	-1	-	1.31	-1
Passer dom. x *P. hisp.*	90.91	47.18	0.32	88,78	49.34	0.29	73.55	35.12	0.35	84.21	45.35	0.30	72.55	37.55	0.32
Carduelis chloris	9.09	14.84	-0.24	6,12	10.61	-0.27	7.44	13.05	-0.27	5.26	7.15	-0.15	7.84	5.22	0.20
Serinus serinus	-	3.86	-1	2,04	4.31	-0.36	2.48	6.53	-0.45	5.26	6.13	-0.08	9.80	3.35	0.49

r is the proportion of item in the diet of *Falco tinnunculus*.
p is the proportion of same item in environment.
E: Ivlev selection Index ; -: species absent.
Passer dom. x *P. hisp.*: *Passer domesticus* x *Passer hispaniolensis.*

Table 5. Percentage of the vertebrate and invertebrate prey in the diet of common kestrel in different regions.

Country	City	Vertebrate prey	Invertebrate prey	Source
France	Paris	97 %	3 %	Quere 1990
Warsaw	Ochota	94.6 %	5.4 %	Romanowski 1996
Warsaw	City	90.7 %	9.3 %	Romanowski 1996
Italy	Rome	64.0 %	36.0 %	Piatella et al. 1999
England	Lake District	6.1 %	83.9 %	Yalden & Warburton 1979
Canary Islands	El Hierro	4.7 %	95.3 %	Carillo et al. 1990
Canary Islands	Fuerteventura	7.7 %	92.3 %	Carillo et al. 1990

& Warburton 1979, Carillo et al. 1994) (Table 5). In these studies insects made up the most important class among invertebrate prey. In the Sansouïres and the Camargue marshes, common kestrels ate mostly insects (76.0 %) (Thiollay 1968). In a suburban area in Rome, Italy Fattorini et al. (1999), had 1,108 insects prey items on a total of 2,361 preys (46.9 %) in the pellets of common kestrel. The importance of insects in the diet of this raptor was also confirmed by Salvati et al. (1999) in Rome in an urban area (37.7 %), in a suburban area (41.1 %) and in a farmland area (50.4 %). In the same area Piatella et al. (1999) found insects were the most consumed prey by common kestrels in summer (35.3 %) and winter (57 %) in an urban environment. The increase predation on insects (especially beetles and grasshoppers) is probably due to the high availability of these prey types in the Mediterranean (Thiollay 1968). In the Lake District, similar results recorded by Yalden & Warburton (1979) for the importance of invertebrate (83.9 %) of which 43.6 % were caterpillars of Lepidoptera, 17.8 % Geotrupidae, 10.6 % Acrididae and 9.7% Carabidae. In this study, Orthopteran and Coleopteran were most commonly eaten by this Falconidae. Other diet studies also suggested the importance of Orthopterans and Coleopterans prey. Thiollay (1968) reported that 62.8 % of Orthopterans and 13.0 % of Coleopterans were consumed by common kestrel in the Sansouïres and the Camargue marshes. Also Yalden & Warburton (1979) in the Lake District, indicate that among the insects, Coleopterans formed the highest proportion (56.1 %), followed by Orthopterans (31.6 %) and Hymenopterans (5.0 %). In the Canary Islands, Carillo et al. (1994) showed that Coleoptera (40.8 %), Hymenoptera (25.9 %) and Orthoptera (22.9 %) represent the most common insect prey. Salvati et al. (1999) in Rome reported that Coleopterans were consumed in urban areas (31.7 %), suburbans (31.6 %) and farmland areas (45.4 %). Predators opted for these invertebrates because the time taken hunting for prey can be reduced (Salvati et al. 1999). However, kestrels living primarily on invertebrates have to catch many small items to equal the energetic content of a single vertebrate prey (Van Zyl 1994).

From 1997 to 2001 the common eat species in the pellets of the common kestrels was the hybrid sparrow *Passer domesticus* x *P. hispaniolensis*. The same was found in urban Paris (Quere 1990) while the domestic sparrow *Passer domesticus* was most frequent (48.2%) in Poland (Romanowski 1996). The kestrel is adapted to hunt terrestrial prey (Korpimäki 1986) and is not efficient in aerial pursuit of birds. Prey in towns consists mainly of young birds which are caught on the ground and in buildings (Pikula et al. 1984). It is also possible that prey species are more susceptible to predation during the breeding period when increased time spent foraging reduces it vigilance of predators (Quere 1990). The optimal strategy is for kestrels to fully exploit seasonal resources (Korpimäki 1985) such as *Messor barbara* (19.0 % in 2002) which swarm or have irruptive populations (Nogales 1990 cited by Carillo et al. 1994). During this

study, the frequency of rodents consumed by common kestrel was low. This is in contrast to other studies in Europe where small mammals form the dominant component of the kestrel diet (Thiollay 1963, Cramp & Simmon 1994, Romanowski 1996). Voles are the dominant component in studies in France (Bonin & Strenna 1986) and Switzerland (Roulin 1996). Thus the low abundance of the rodents prey populations and their nocturnal activity in Algeria limited the inavailability to diurnal predators, and possibly explaining the in poor representation in the pellets of common kestrel.

For invertebrates, the most recorded prey species were *Pamphagus elephas*, *Eyprepocnemis plorans*, *Silpha* opaca, *Silpha granulata*, *Scaurus* sp., *Plagiographus* sp. and *Tentyria* sp. *Pamphagus elephas* is most probably an important insect prey item compared to the other insects because of its size (female weight 25 g) and its habit of climbing trees may increase its availability. The hybrid sparrow was the most frequent prey recorded among the vertebrate prey (Baziz et al. 2001). The high density of the hybrid sparrow could explain its high predation by kestrels. The diet composition of common kestrel is dependant on the availability of prey in the environment, and they are opportunistic hunters as reflected in its diet and its high adaptability to rural and suburban areas.

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LITERATURE

Baziz B., Souttou K., Doumandji S. & Denys C. 2001: Quelques aspects sur le régime alimentaire du Faucon crécerelle *Falco tinnunculus* (Aves, Falconidae) en Algérie. *Alauda 69 (3): 413–418.*

Blondel J. 1969: Méthodes de dénombrement des populations d'oiseaux. In: Lamotte M. & Bourliere F. (eds), Problème d'écologie 1969. *Masson et Cie, Paris: 97–151.*

Bonin B. & Strenna L. 1986: La biologie du Faucon crécerelle *Falco tinnunculus* en Auxois. *Alauda 54 (4): 242–262.*

Carillo J., Hernandez E. C. Nogales M., Delgado G., Garcia R. & Amos T. 1994: Geographic variation in the spring diet of *Falco tinnunculus* L. on the islands of Fuerteventura and El-Hierro (Canary Islands). *Bonn. Zool. Beitr. 45 (1): 39–48.*

Cramp S. & Simmon K.E.L. 1994: Handbook of the birds of Europe, the Middle East and North Africa. Vol. 2. Hawks to bustards. *London: Oxford University Press.*

Debrot S., Fivaz G., Mermod C. & Werber J.M. 1982: Atlas des poils de mammifères d'Europe. *Publ. Inst. Zool., Univ. Neuchâtel.*

Emberger L. 1955: Afrique du Nord-Ouest. In: Anonyme (ed.), Plant ecology reviews of research. *United nations educational scientific and cultural organization: Paris: 219–279.*

Fattorini S., Manganaro A., Piatella E. & Salvati L. 1990: Role of the beetles in raptor diets from a mediterranean urban area (Coleoptera). *Fragmenta entomologica Roma Vol. 31 (1): 57–69.*

Hacini S. & Doumandji S. 1998: Places des insectes dans le régime alimentaire de l'Hirondelle de cheminée *Hirundo rustica* Linné, 1758 (Aves, Hirundinidae) dans un milieu agricole à Bordj-El Kiffan région du littoral algérois. *L'Entomologist 54 (3) : 105–111.*

Heim de Balsac H. & Mayaud N. 1962: Les oiseaux du Nord-Ouest de l'Afrique. X, *Ed. Paul Lechevalier, Paris.*

Ivlev V. S. 1961: Experimental ecology of the feeding of fishes. *New Haven, Connecticut, Yale Univ. Press.*

Jacobs J. 1974: Quantitative measurement of food selection. A modification of the forage ratio and Ivlev's electivity index. *Ecologia 14: 413–417.*

Johnson D. H. 1980: The comparison of usage and availability measurements for evaluating resource preference. *Ecology 61 (1): 65–71.*

Korpimäki E. 1985: Prey choice strategies of the kestrel *Falco tinnunculus* in relation to available small mammals and other Finnish birds of prey. *Ann. Zool. Fennici 22: 91–104.*

Korpimäki E. 1986: Diet variation, hunting habitat and reproductive output of the kestrel *Falco tinnunculus* in the light of the optimal theory. *Ornis Fennica 63: 84–90.*

Le Berre J.R. 1969: Les méthodes de piégeage des invertébrés. In: Lamotte M. & Bourliere F. (eds), Problème d'écologie: L'échantillonnage des peuplements animaux des milieux terrestres 1969. *Masson et cie, Paris: 55–96.*

Piatella E., Salvati L., Manganaro A. & Fattorini S. 1999: Spatial and temporal variations in the diet of the common kestrel (*Falco tinnunculus*) in urban Rome, Italy. *J. Raptor. Research 33 (2): 172–175.*

Pikula J., Beklová M. & Kubík V. 1984: The nidobiology of *Falco tinnunculus. Acta Sc. Nat. Brno 18(4): 1–55.*

Quere P. 1990: Approche du régime alimentaire du Faucon crécerelle (*Falco tinnuculus* L. 1758) en milieu urbain (Paris) et durant la période de reproduction. *Le Passer 27 (1–2): 92–107.*

Romanowski J. 1996: On the diet of urban kestrels (*Falco tinnunculus)* in Warsaw. *Buteo 8: 123–130.*

Roulin A. 1996: Alimentation hivernale de la chouette effraie (*Tyto alba)*, du hibou moyen duc (*Asio otus)*, du busard Saint–Martin (*Circus cyaneus)* et du faucon crécerelle (*Falco tinnunculus)*. *Bull. Soc. Vaud. sc. nat. 84 (1): 19–32.*

Salvati L., Manganaro A., Fattorini S. & Piatella E. 1999: Density, nest spacing, breeding success and diet of a kestrel *Falco tinnunculus* urban population. *Alauda 67 (1): 47–52.*

Souttou K., Baziz B., Doumandji S., Denys C. & Brahimi R. 2006: Analysis of pellets from a suburban common kestrel *Falco tinnunculus* nest in El harrach, Algiers, Algeria. *Ostrich 77 (3 & 4) : 175–178.*

Thiollay J.M. 1963: Notes sur le régime alimentaire du Faucon crécerelle *Falco tinnunculus* en hiver. *Nos Oiseaux (27): 71–73.*

Thiollay J.M. 1968: Le régime alimentaire de nos rapaces: quelques analyses Françaises. *Nos Oiseaux 29 (319): 249–266.*

Valkama J., Korpimäki E. & Tolonen P. 1995: Habitat utilization, diet and reproductive success in the kestrel in a temporally and spatially heterogeneous environment. *Ornis. Fenn. 72: 49–61.*

Van Zyl A. J. 1994: A comparison of the diet of the common kestrel *Falco tinnunculus* in South Africa and Europe. *Bird Study 41: 124–130.*

Village A. 1990: The kestrel. *T. and A.D. Poyser, London.*

Voisin J.F. 1986: Evolution des peuplements d'orthoptères dans le canton d'Aime (Savoie). *Trav. Sci. Parc nat. Vanoise XV: 229–254.*

Yalden D.W. & Warburton A. B. 1979: The diet of the kestrel in the lake district. *Bird Study 26: 163–170.*