

Black-shouldered Kite *Elanus caeruleus* diet in an area recently colonized in the north-east of the Iberian Peninsula

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The diet of the Black-shouldered Kite *Elanus caeruleus* is analysed in a recently colonized area in Catalonia, NE Spain. Results are based on the analysis of 342 pellets collected in the period after fledging at four nest sites in western Catalonia, in 1998, 1999, 2003 and 2004. Altogether 512 prey items were identified. The results show a diet based on small mammals, mainly voles and mice, which account for 64.4–95.3% of prey. Nonetheless, birds, mainly passeriformes, amount to as much as 4.8–30.3% of prey. The number of fledglings per nest was found to be positively correlated with the percentage of voles in the diet, supporting the idea of high vole specialization by this kite in southern Europe.

Key words: Black-shouldered Kite, *Elanus caeruleus*, feeding ecology, breeding success, diet, Catalonia, Spain.

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The Black-shouldered Kite *Elanus caeruleus* is a small raptor typical of open areas with scattered trees (Cramp & Simmons 1980, del Hoyo *et al.* 1994). The species has experienced a progressive expansion from its original range in Africa to the southern Iberian Peninsula, and is currently expanding northwards (del Hoyo *et al.* 1994), so that it now occupies most of the western Iberian Peninsula (Ferrero & Onrubia 2003). As part of this expansion, it has recently colonized Catalonia, NE Spain (Mañosa 2001, del Amo 2002, Bonfil & Mañosa 2004, Bota & Bonfil 2004). The Black-shouldered Kite is usually considered to be a rodent specialist (del Hoyo *et al.* 1994, Mendelsohn & Jaksic 1989, Leveau *et al.* 2002, Leveau & Leveau 2004, Scheibler 2004). The recent expansion of this bird may have been triggered by the species trying to use this food resource in new areas that were previously unoccupied, or may be the con-

sequence of dietary shift that enable the species to colonize new areas. The aim of this study was to see if the diet of these colonizing birds matched what was previously recorded for the species. We also investigated the relationship between diet composition and fledging success, with the aim of providing further insight as to the causes underlying the range expansion of the Black-shouldered Kite in southern Europe.

Study area and methods

Five Black-shouldered Kite breeding attempts were recorded in Catalonia in the period 1998–2004 (Mañosa 2001, del Amo 2002, Bonfil & Mañosa 2004, Bota & Bonfil 2004, Calvet *et al.* 2004). All the nests were in the province of Lleida, within the Ebro Valley, in western Catalonia (Fig. 1). The species was first mentioned



Figure 1. Study area and locations of the five nest sites in Catalonia in the period 1998–2004. 1 – 1998; 2 – 1998; 3 – 1999; 4 – 2003; 5 – 2004.
 Àrea d'estudi i ubicació dels cinc nius localitzats a Catalunya entre 1998-2004. 1 – 1998; 2 – 1998; 3 – 1999; 4 – 2003; 5 – 2004.

as a breeder in Catalonia in 1998 (Mañosa 2001, Bonfil & Mañosa 2004), when one nest was found in the county of El Urgell, near the village of Belianes (nest 1, 10x10 km UTM co-ordinates: 31T CG30, 350 m above sea level, unknown number of eggs, 2 fledglings), and another nest in La Segarra, near the village of Hostafranchs (nest 2, 10x10 km UTM co-ordinates: 31T CG52, 440 m above sea level, 4 eggs, 0 chicks). Approximate laying dates for these nests were the middle of March and May respectively. In 1999 only a single nest was found, just 3 km from the nest found in El Urgell the preceding year. This probably belonged to the same pair (nest 3, 10x10 km UTM co-ordinates: 31T CG30, 350 m above sea level, 3 eggs, 2 fledglings) (del Amo 2002, Bonfil & Mañosa 2004); the approximate laying date for this breeding attempt was early April. The species was not detected again in the following years. Then, in 2003, one nest was discovered in Castelló de Farfanya, in La Noguera county (nest 4, 10x10 km UTM co-ordinates: 31T CG13, 300 m above sea level, unknown number of eggs, 4 fledglings), with an approximate laying date in mid-April, and in 2004 another was found in Cabanabona, also in La Noguera (nest

5, 10x10 km UTM co-ordinates: 31T CG53, 440 m above sea level, unknown number of eggs, 3 fledglings), with an approximate laying date in mid-April.

The nests in Belianes and Hostafranch were built 3–5 m up, on top of almond trees *Prunus amygdalus* that stood on the edges of cereal fields. The nest in Castelló de Farfanya was built 2 m up, on top of an isolated oneseed hawthorn *Crataegus monogyna*, again along the edge of a cereal field. The nest in Cabanabona was built on an isolated holm oak *Quercus ilex*, similarly on the edge of a cereal field, also at a height of 3–5 m. Only breeding attempt 2 failed to raise any young, because the nest was blown down in a storm before the eggs hatched. The area where nests 1, 2, 3 and 4 were found is characterized by being very flat and dominated by dry cereal crops (mainly barley and some wheat) and a few almond trees, the latter mainly along the edges of the cereal fields, with virtually no forest or remains of any other natural vegetation at all. Nest 5 was in a more undulating area, also dominated by dry cereal fields, but with some remains of small holm oak woodland on the hills or alongside fields.

Pellet collection was carried out at the four nests where young were raised (nests 1, 3, 4 and 5). Pellets were collected around and on the nests after the chicks had fledged, as well as below roost sites and perches. After collection, the pellets were frozen for preservation until analysis. Small mammals were identified on the basis of skulls and teeth, while passerine remains were identified using bones and feathers. Dietary diversity was computed using the Shannon index based on five prey categories: voles; mice; shrews; birds; and reptiles. Pearson correlation coefficients were computed between variables. A forward multiple regression model was constructed to predict the number of fledglings in a nest on the basis of dietary composition parameters. All statistics were conducted using SPSS statistical software.

Results

We collected a total of 342 pellets, which yielded 512 prey items (Table 1). Only vertebrate prey items were consumed. Small mammals comprised 64.4–95.3% of prey items; birds com-

prised 4.7–30.3%; and reptiles 0.0–5.3%. Among mammals, field voles *Microtus duodecimcostatus* were the most frequently consumed prey (47.5–71.6%), followed by mice *Apodemus* or *Mus* (10.6–27.3%). Among birds, small passerines were virtually the only group consumed. Dietary diversity was inversely correlated to the percentage of voles in the diet ($r = -0.989$, $p = 0.011$, $n = 4$). The percentage of birds and the percentage of rodents in the diet were inversely correlated ($r = -0.997$, $p = 0.003$, $n = 4$). The number of fledged young was positively correlated to the percentage of voles in the diet ($r = 0.976$, $p = 0.024$, $n = 4$) and inversely correlated to diet diversity ($r = -0.967$, $p = 0.033$,

$n = 4$). However, it was best predicted by a regression model including only the percentage of voles as a predictive variable: *Number of fledged young* = $0.088 \times \text{Percentage of voles} - 2.424$ (Fig. 2).

Discussion

During the period 1998–2004, since the initial colonization of Catalonia by the Black-shouldered Kite, only five breeding attempts have been recorded, four of which were successful (Mañosa 2001, del Amo 2002, Bonfil & Mañosa 2004, Bota & Bonfil 2004). No breeding at

Table 1. Number of prey items in each category at the four study sites. Bold characters indicate percentages of higher categories. Indicative average weight (g) of each species is given. *Nombre de preses de cada categoria identificades en les quatre localitats d'estudi. Les xifres en negreta indiquen els percentatges de les categories superiors. S'indica el pes promig (g) de cada espècie.*

	Breeding attempt, site and year			
	Nest 1 Belianes 1998	Nest 3 Belianes 1999	Nest 4 Castelló de Farfanya 2003	Nest 5 Cabanabona 2004
Number of pellets	107	78	111	46
Number of prey items	151	132	169	60
RODENTIA	74.8%	63.6%	92.3%	83.3%
undetermined Rodentia	17	6	—	7
Microtidae	47.5%	53.0%	71.6%	62.0%
<i>Microtus duodecimcostatus</i> (27 g)	61	65	121	32
Muridae	27.3%	10.6%	20.7%	21.3%
<i>Mus spretus</i> (17 g)	—	—	8	4
<i>Mus musculus</i> (18 g)	—	—	11	—
<i>Apodemus sylvaticus</i> (30 g)	—	—	1	7
undetermined Muridae	35	13	15	—
INSECTIVORA	5.3%	0.8%	3.0%	0.0%
<i>Crocidura russula</i> (9 g)	8	1	5	—
BIRDS	18.5%	30.3%	4.7%	11.7%
<i>Galerida cristata</i> (43 g)	1	1	—	—
<i>Alaudidae</i> sp.	2	1	—	—
<i>Passer domesticus</i> (30 g)	1	6	—	—
<i>Miliaria calandra</i> (50 g)	1	1	—	1
<i>Emberiza</i> sp. (20 g)	—	—	—	1
<i>Coturnix coturnix</i> (100 g)	—	3	—	—
<i>Carduelis chloris</i> (27 g)	—	1	—	—
<i>Petronia petronia</i> (25 g)	—	1	—	—
<i>Delichon urbicum</i> (25 g)	—	1	—	—
<i>Upupa epops</i> (66 g)	—	1	—	—
undetermined Passeriformes	23	24	8	5
REPTILIA	1.3%	5.3%	0.0%	5.0%
<i>Psammmodromus algirus</i> (7 g)	2	7	—	3
<i>Shannon diversity index H'</i> ¹	1.79	1.63	1.17	1.49
<i>Prey items per pellet</i>	1.39	1.69	1.52	1.30
<i>Number of fledged young</i>	2	2	4	3

¹ H' computed on the basis of the following categories: *Microtidae*, *Muridae*, *Insectivora*, *birds* and *reptiles*.

¹ H' calculat en base a les següents categories: *Microtidae*, *Muridae*, *Insectivora*, *ocells* i *reptils*.

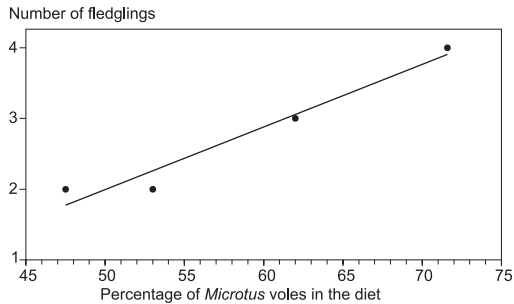


Figure 2. Relationship between the percentage of voles in the diet and the number of fledglings.
Relació entre el percentatge de talpons a la dieta i el nombre de polls volanders.

tempts were recorded in 2000, 2001 and 2002, but observations of kites in spring 2000 and 2002 suggest that, at least in these two years, the nests might have been overlooked (Calvet *et al.* 2004). Black-shouldered Kites may shift breeding sites from one year to the next, tracking prey availability (del Hoyo *et al.* 1994), so some of the breeding attempts recorded here might well correspond to the same pair moving between sites. Although the maximum number of nests recorded in a single year was only two (in 1998), according to their distribution in the plain the recorded breeding attempts might well correspond to three different pairs (attempts 1 and 3, attempts 2 and 5, and attempt 4). Observations of Black-shouldered Kites in areas of the plain apart from those considered here (Calvet *et al.* 2004) also suggest that one or two pairs might have been undetected in some years. The habitats occupied by the species in this recently colonized area perfectly fit the requirements described for the species, which in the Iberian Peninsula are associated with the presence of dry cereal crops with scattered trees (Ferrero & Onrubia 2003).

Black-shouldered Kites are usually considered to be rodent specialists, with a diet based almost exclusively on small mammals (Mendelsohn & Jaksic 1989, del Hoyo *et al.* 1994, Leveau *et al.* 2002, Leveau & Leveau 2004). However, in some Mediterranean areas in Morocco and Spain where the diet of the species has previously been analysed (Pérez Chiscano 1973, Garzón 1974, Suetens & van Groenendel 1975, Amat 1979, Aguilar *et al.* 1980, Bergier 1987), it seems capable of con-

suming relatively large quantities of other small vertebrates, notably passerines. The diet of Black-shouldered Kites in the recently colonized Mediterranean area covered in our study also follows this pattern, as it is more diverse and incorporates relatively larger amounts of passerines than are traditionally assumed for the species. This suggests the possibility that in Mediterranean areas Black-shouldered Kites take advantage of different sorts of prey and use different foraging techniques as compared with other parts of the species' range, which may allow them to colonize areas with lower rodent availability. In all the areas where Black-shouldered Kites have been reported to consume relatively larger amounts of prey other than rodents, breeding success has been reported to be very low (Suetens & van Groenendel 1975, Bergier 1987). In our study area, the close relationship between the amount of voles in the diet and fledging success indicates that dietary plasticity affects reproductive output, and shows that Black-shouldered Kites in these new colonized areas behave as real vole specialists, breeding more prolifically where these rodents are abundant (Newton 1979, Ferrero 1996). In some areas, the kite may consume prey other than voles, but breeding success is higher where voles can be consumed as the main prey. The first breeding record of Black-shouldered Kites in the neighbouring region of Aragón also took place in 1998, and the diet of that breeding pair included 88% voles (Canudo 2001). According to Serrano (1999), 1998 was a very good vole year in the Ebro Valley, supporting the view that the expansion is favoured by years in which vole populations are high. All this evidence suggests that the range expansion of the Black-shouldered Kite within the Mediterranean region is not the consequence of a dietary shift allowing the colonization of new areas where food other than voles occur, but rather the result of other processes that allow the species to invade previously unoccupied areas where and when it can find its preferred food. Further studies on the ranging behaviour of kites, and vole availability, may help us to understand if this extraordinary new case of range expansion is the consequence of some landscape or climatic change promoting the expansion of Black-shouldered Kite habitats (i.e. promoting vole availability in formerly vole-free areas) or simply the result of

a demographic process that allows the Black-shouldered Kite to colonize areas which were already suitable.

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Sumari

Dieta de l'Esparver d'espatlles negres *Elanus caeruleus* en una regió de recent colonització al nord-est de la península Ibèrica

L'Esparver d'espatlles negres *Elanus caeruleus* ha colonitzat recentment Catalunya (Bota & Bonfil 2004), on s'ha localitzat un total de cinc nius al 1998, 1999, 2003 i 2004. L'Esparver d'espatlles negres és considerat un especialista en petits mamífers (del Hoyo *et al.* 1994). Per aquest motiu, l'expansió que experimenta pot ser resultat d'un canvi en les seves preferències tròfiques o bé degut a la colonització de zones on el seu recurs preferit ja era o s'ha tornat abundant. L'objectiu d'aquest treball ha estat estudiar la composició de la dieta de les primeres parelles d'Esparver d'espatlles negres que han ocupat Catalunya per veure si coincideix o no amb el que es coneix tradicionalment per a l'espècie i, per altra banda, contrastar si la composició de la dieta determina l'èxit reproductor, per tal d'esbrinar quins poden ser els mecanismes subjacents a l'expansió d'aquest ocell. Un cop finalitzada la cria, es van recollir 342 egagròpils en quatre nius localitzats a Catalunya entre 1998 i 2004, tots ells situats a la depressió de l'Ebre catalana (Fig. 1). Es van identificar 512 preses (Taula 1), totes elles petits vertebrats: petits mamífers (64,4 – 95,3%), ocells (4,7–30,3%, principalment passeriformes) i rèptils (0,0–5,3%). El talpó *Microtus duodecimcostatus* va ser la presa més freqüentment consumida (47,5 – 71,6%), seguida dels ratolins *Apodemus* o *Mus* (10,6 – 27,3%). L'índex de Shannon de diversitat tròfica es correlacionà negativament amb el percentatge de talpó a la dieta ($r = -0,989$; $p = 0,011$; $n = 4$). El percentatge d'ocells i el percentatge de rosegadors foren inversament proporcionals ($r = -0,997$; $p = 0,003$; $n = 4$). El nombre de polls volanders es correlacionà positivament amb el percentatge de

talpons a la dieta ($r = 0,976$; $p = 0,024$; $n = 4$) i negativament amb la diversitat tròfica ($r = -0,967$; $p = 0,033$; $n = 4$). El millor model predictiu pel nombre de polls volanders considera únicament el percentatge de talpó a la dieta com a variable predictora: $\text{Nombre de polls volanders} = 0,088 \times \text{Percentatge de talpó} - 2,424$ (Fig. 2). Podem concloure que la dieta de les parelles d'Esparver d'espatlles negres que colonitzen Catalunya es basa fonamentalment en petits rosegadors, principalment talpons. Si bé aquest petit rapinyaire és capaç de consumir altres petits vertebrats, principalment ocells, en freqüències relativament elevades, l'estreta relació que s'observa entre el consum de talpons i la producció de polls indica que la plasticitat tròfica es fa a costa d'un descens en l'èxit reproductor, indicant el caràcter especialista de l'Esparver d'espatlles negres. Cal suposar, doncs, que l'expansió de l'Esparver d'espatlles negres és més el resultat de l'ocupació d'àrees amb elevada disponibilitat de talpons que no pas d'un canvi en les preferències tròfiques de l'espècie. Caldria més estudis per saber si aquesta expansió és resultat d'algun canvi d'hàbitat o climàtic que afavoreix l'aparició de noves àrees adequades per a l'espècie o bé si és simplement el resultat d'un procés demogràfic que permet a l'Esparver d'espatlles negres l'ocupació de zones que ja eren bones anteriorment.

Resumen

Dieta del Elanio Azul *Elanus caeruleus* en una regió de reciente colonización en el noreste de la península Ibérica.

Se estudia la dieta del Elanio Azul *Elanus caeruleus* en una zona recientemente colonizada de Cataluña (NE de España). Los resultados se basan en el análisis de 342 egagròpils recolectadas tras la reproducción en cuatro de los cinco nidos conocidos en Cataluña entre 1998, 1999, 2003 y 2004. Se identificaron un total de 512 presas, todas ellas pequeños vertebrados, principalmente topillos y ratones, que alcanzan entre un 64,4 – 95,3 % de las presas. Sin embargo, las aves, principalmente passeriformes, pueden representar entre 4,7 – 30,3 % del total de presas consumidas. El número de pollos volantones se correlaciona positivamente con el porcentaje de topillos en la dieta, apoyando la visión del Elanio Azul como un verdadero especialista en el consumo de topillos en el sur de Europa.

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