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Feeding of the barn owl, *Tyto alba* with first record of the European free-tailed bat, *Tadarida teniotis* on the island of Ibiza (Spain, Balearics)

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Abstract. In the abandoned quarry of San Carlos (Ibiza, Balearics) prey remains of the barn owl were collected. A total of 6,977 identifiable bone remains from 2,767 individuals of mammals, birds, reptiles and amphibians was found. The spectrum of mammals clearly shows two main prey groups: mice (*Mus domesticus*, *M. spretus*: 39.4%) and shrews (*Crocidura russula*, *C. suaveolens*: 38.4%). Voles, which in continental Europe are the owl's most numerous prey, are absent on Ibiza; these were replaced by mice and shrews. The record of the Pityusic wall lizard *Podarcis pityusensis* in the prey remains (0.5%) is remarkable. Obviously, the periods of activity of lizard and barn owl do not ordinarily overlap. One possible explanation might be that due to low prey density, *Tyto alba* probably starts hunting earlier during summer with its shorter nights. A skull of the European free-tailed bat (*Tadarida teniotis*) was recorded from the sediment, definitely confirming this species for the first time on Ibiza.

Key words: pellet-analysis, activity, vertebrate species diversity, island fauna

Introduction

Barn owls (*Tyto alba*) are night-active predators. Their food preferences in Europe are well documented from pellet-analysis (Uttendörfer 1952, Schmidt 1973, Görner 1973, 1978, Bunn et al. 1982, Henry 1982, Mikkola 1983, Alivizatos & Gounter 1999, Sans-Coma 1974, Sans-Coma & Kahmann 1976). The main prey of the barn owl are small mammals, especially voles (Arvicolidae).

Due to their geographic isolation, islands have different levels of prey availability than the mainland. The diversity of small mammal species on Ibiza is, as on other islands, much lower than in comparable regions at the European mainland. Because of this, taxa that represent the main part of the prey for *Tyto alba* at the mainland, may be represented in very low numbers or be completely absent.

The mammal fauna of the Pityusics have been investigated and documented previously by Barceló & Combis (1872, 1875), Koller (1931), König (1958), Vericad & Balcells (1965), Sart (1966), Mester (1971), Rey & Rey (1974), Alcover (1977, 1988) and Sara & Vogel (1996). The endemic subspecies of the barn owl at Ibiza is *Tyto alba kirchoffi* Brehm, 1858 (Sart 1966). Voles, which represent the main part of the barn owl's prey in Central Europe, are completely absent on Ibiza.

An analysis of prey remains of *Tyto alba* on Ibiza, and the utilisation of different small vertebrate species as food is discussed in more detail in this study.

Studied Area and Methods

During March and April of 2001 and 2002 in the abandoned quarry of San Carlos (Ibiza, 39 °01‘ N, 01°33’O, Balearics, Spain) prey remains of the barn owl were collected. The locality is situated in an area which is characterised by intensively-utilised agrarian landscape and pine forests (Fig. 1). The identification of the owl species *Tyto alba*, which produced the pellet assemblages, was by sightings, feather finds and the characteristic shape of the pellets. The collected pellets respectively prey remains derive from a decade of nearly one until three years. To also register smaller prey remains, for example, from decomposed pellets, we picked up the smaller prey parts at the pellet site using tweezers. All prey remains were investigated for identifiable fragments. In vertebrates, identifiable fragments include the skull, dentition and pelvic bones. In March 2002 an investigation of the sediment at the described pellet site was carried out; nearly 0.6 m^3 of the sediment, a mixture of earth and rock debris, was displaced and sieved. The aperture size of the sieve was 2.5 x 2.5 mm. All identifiable fragments of prey remains, discovered above and under the sieve, were collected and included in the investigation (Table 1). From the maximum number of identifiable prey fragments of each prey species, the minimum number of individuals was calculated on the basis of mandibles or upper jaws.

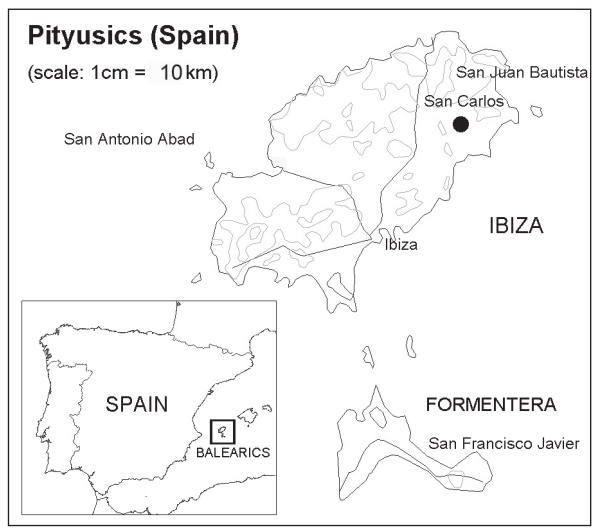

Fig. 1. Location of owl pellets sampling on Ibiza.

Results and Discussion

Altogether, a total of 6,977 identifiable bone fragments of 2,767 vertebrate individuals were discovered and identified among the prey remains of the barn owl. Among the bone fragments discovered in the sediment a nearly complete skull of the European Free-tailed bat *Tadarida teniotis* (Rafinesque, 1814) were identified.

The vertebrate fauna of Ibiza, relatively poor in terms of vertebrate species diversity and enormously impacted by anthropogenic activity, present the barn owl with only a very restricted spectrum of prey. Most of small mammals (*Crocidura russula*, *Rattus rattus*, *R. norvegicus*, *Mus domesticus, M. spretus*, *Apodemus sylvaticus*), living on the island and belonging to the potential prey of the barn owl, were recorded among

the prey remains, with the exception of *Atelerix algirus* and *Oryctolagus cuniculus*. The mammal prey of the barn owl (n=6,211 identifiable prey remains) clearly shows two main prey groups in this investigation: mice (*Mus domesticus*, *M. spretus*: 39.4 %) and shrews (*Crocidura russula*: 38.4 %).

On Ibiza pellets of *Tyto alba* were previously investigated for prey remains by B a r c e l ó y & C o m b i s (1875), K ö n i g (1958), V e r i c a d & B a l c e l l s (1965), S a r t (1966) and A l c o v e r (1977). None of the investigations present a prey analysis, including vertebrate taxa other than mammals. In terms of complexity only the investigation of A l c o v e r (1977), with a total of 4,507 identifiable prey remains, is comparable with our data.

In the investigation of A l c o v e r (1977) at St. Rafel and St. Joan, one main prey species (*Crocidura russula*: 55.9 %) and two secondary species (*Mus musculus*: 18.2 %, as well as *Apodemus sylvaticus*: 14.1 %) were clearly the dominant prey species. In contrast to our data, after the shrew, the long-tailed field mouse was more abundant. The proportions of bird-prey don't show visible differences.

Voles, which are on the European mainland are the main prey of the barn owl in most cases, were replaced by mice and shrews on Ibiza. *Tyto alba* obviously hunted in the surroundings of human settlements. This assumption is based on the large number of house mice, but also the numerous house sparrows (*Passer domesticus*) and a small parakeetspecies, which probably was an escaped pet (Table 1). Furthermore, the proportion of long-tailed field mouse is very low, even though it represented the dominant small mammal species in the pine forests on Ibiza. Besides mammals and passerine birds, 244 remains of reptiles and amphibians were recorded (Table 1). Previously, reptilian remains from pellets of *Tyto alba* were only mentioned by S a r t (1966), R e y & R e y (1974) and A l c o v e r (1977). An examination of the reptilian bones was only carried out by S a r t (1966); he identified *Hemidactylus turcicus*, *Tarentola mauritanica*, *Lacerta* [= *Podarcis*] *pityusensis* as well as *Acanthodactylus erythrurus*. The relatively frequent appearance of the wall gecko *Tarentola mauritanica*, as a night-active species (R i e p p e l 1981) in the prey of the barn owl (1.7 %) is not a new occurrence. The record of the Pityusic wall lizard *Podarcis pityusensis* among the prey (0.5 %) of *Tyto alba* is more remarkable. In terms of its diurnal activity *P. pityusensis* is not well investigated. However, its close relative *P. lilfordi*, is also active at dawn and dusk (S a l v a d o r 1986). This behaviour may also apply to *P. pityusensis*. The obvious overlapping of the activity periods of lizard and owl could be caused by the behaviour of *Tyto alba*, which probably starts its hunting flights earlier during shorter nights in the summer or at times of low prey-density.

As the only shrew species, *Crocidura russula* is known from Ibiza since K o l l e r (1931) and was described later as an endemic subspecies *Crocidura russula ibicensis* V e r i c a d & B a l c e l l s 1965. This species was numerous in the pellet and sediment samples analysed (Table 1). *Crocidura russula* is characterised by the morphology of its upper PM4/ (protocone situated lingually), proportions of the unicuspids, the shape of the molars (M2: lingually narrow, M3: lingually short), as well as by size (upper toothrow I-M3= 8.85-9.18). Its endo- and ectoparasite fauna suggest a relationship of *C. russula* on Ibiza with populations of Northern Africa (C a t a l a n et al. 1988), well proven by recent genetic investigations (C o s s o n et al. 2005), an indication of a possible introduction from Maghreb. Among the skull fragments of shrews also two rostra were present (adult and senile), being of a smaller size (upper toothrow I-M3=8.05-8.35). By their short toothrows, these fragments (SMF 92461-2) show similarities with *Crocidura suaveolens*. Unfortunately, missing teeth and heavy abrasion of those being present prevent a reliable identification (for characters of upper teeth s. P o i t e v i n et al. 1986). Previous examinations of *Crocidura*-skulls from Ibiza (V e r i c a d &

Table. 1. Results of the prey analysis of *Tyto alba* from the quarry near San Carlos (Ibiza). Of prey remains from the sediment, *Mus spretus* and *M. domesticus* as well as *Crocidura russula* and *C. suaveolens* were not identified to species.

prey species	total number of identifiable bone remains		minimum number of individuals	total of prey individuals (vertebrates)	biomass of the vertebrate prey
	pellets	sediment	n	%	g
Mammalia					
Rattus rattus	41	94	60	2.1	5,040
Rattus norvegicus	40	76	43	1.5	4,300
Rattus sp.	217	313	142	5.1	ca. 7,100
Apodemus sylvaticus	150	260	139	5.0	4,587
Mus spretus	395	–	146	5.3	2,817
Mus domesticus	164	–	46	1.6	887
Mus spretus et *M. domesticus*	65	2032	890	32.5	17,177
Crocidura russula	430	1931	1049	38.4	10,940
Tadarida teniotis	–	3	1	0.03	30
total	1502	4709	2516	91.8	52,878
Aves					
Passer domesticus	57	120	94	3.4	2,679
Carduelis chloris	6	20	16	0.6	451
Carduelis carduelis	5	10	9	0.3	143
Erithacus rubecula	2	–	1	0.0	15,5
Fringilla coelebs	–	3	2	0.1	43,4
Serinus serinus	32	15	16	0.0	184
Sylvia sp.	–	11	5	0.2	ca. 75
Fringillidae indet.	–	6	4	0.1	ca. 100
Passeriformes indet.	10	109	29	1.1	ca. 435
Psittaciformes indet.	–	1	1	0.03	ca. 25
Total	112	295	177	6.0	4,150
Reptilia					
Tarentola mauritanica	30	178	47	1.7	
Podarcis pityusensis	8	27	14	0.5	
total	38	205	61	2.2	
Amphibia					
Rana perezi	1	–	1	0.03	
total	1		1	0.03	
Insecta					
Coleoptera/Scarabaeidae	100	14	11		
Saltatoria	1	–	1		
total	101	14	12		
total number	1754	5223	2767		

Balcells 1965, Sart 1966, Mester 1971, Rey & Rey 1974, Alcover 1977, Poitevin et al. 1986, Catalan et al. 1988, Sara & Vogel 1996) failed to discover comparable variations in upper tooth row length. Furthermore, with exception of the Greek islands Crete and Lesbos (Vogel et al. 1986) as well as the Adriatic island Krk (Vogel & Sofianidou 1996), all other Mediterranean islands seems to be populated by only one species of the genus *Crocidura*.

In view of the mammalogical investigation on Ibiza, the investigated prey remains contain one important additions to the mammal fauna of Ibiza.

The occurrence of the European free-tailed bat (*Tadarida teniotis*) was suspected by Sart (1966) and Quetglas (1997) previously. From the presence of a skull including the lower jaw (Table 1) *Tadarida teniotis* is documented on Ibiza for the first time (SMF 92298). The shacked occiput of the skull earmarks it as a typical prey of *Tyto alba*. The absence of further parts of the skeleton excludesthe possibility that the skull and lower jaw were only found in the sediment by chance. *T. teniotis* was repeatedly recorded in owl-pellets (Pieper (1966): Rhodes, Niethammer (1971): Kythera, Pieper (1977): Crete, Brunet-Lecomte & Delibes (1982): Northern Portugal, Gonzaleź-Prieto et al. (1986): Spain). Kock & Nader (1984) prove *T. teniotis* as prey of the tawny owl (*Strix aluco*) in southern France. The finding by Hutterer (1979) on the Canary Islands is possibly remains of an owl prey. It seems to be improbable that the pellet assemblage from San Carlos comprises pellets that include prey species from the distant Iberian mainland and were transported by the owl in its craw. With that in mind, *T. teniotis* in the Balearics is also recorded on Menorca, Mallorca and Cabrera (Quetglas 1997). Thus the record on Ibiza proves an autochthonous occurrence and remarks the importance of *T. alba* for recording of small mammals (cf. Davis 1959).

Furthermore, another remarkable record is the skull of *Plecotus austriacus* (Fischer, 1829) (SMF 92339), discovered in April 2003 in a pellet of a barn owl in the mine of Can Sopes (39°02'N – 01°27'O) near San Miquel (not included in Table 1). The early records of *P. austriacus* on Ibiza were described as *P. auritus* (Barceló & Combis 1872), but König (1958) revised this and identified *P. austriacus* (Sart 1966). *P. austriacus* is also recorded on the island of Formentera, near Cala Pujols (Mester 1971). Both records on Formentera and Ibiza were not considered in the "Atlas of European Mammals" (Bogdanowicz 1999).

The identity of the available example of *P. austriacus* is confirmed by a comparison with other Mediterranean *Plecotus* species respectively subspecies: cf. *teneriffae* Barrett-Hamilton, 1907, *austriacus hispanicus* Bauer, 1957, *kolombatovici* Dulic, 1980, *auritus begognae* de Paz, 1994, *alpinus* Kiefer & Veith, 2002 and *sardus* Mucedda, Kiefer, Pidinchedda et Veith, 2002).

Species of the genus *Plecotus* are relatively rarely recorded as prey of owls; only one record is available from the Spanish mainland (Sans-Coma & Kahmann 1976). On Mallorca and the smaller neighbouring islands *Plecotus* is also rarely documented. Records are only available from Mallorca and Menorca (Ibanez & Fernandez 1989) as well as by Quetglas (1997) for Cabrera and Dragonera.

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