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SHORT REPORT

Winter diet of urban roosting Long-eared Owls *Asio otus* in northern Italy: the importance of the Brown Rat *Rattus norvegicus*

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The diet of Long-eared Owls *Asio otus* has been extensively reviewed[1–3] and is generally well studied in northern Europe,[4,5] Britain[6,7] and southern Europe.[3,8–10] Some indications of a winter dietary adaptation to man-made environments have been reported (e.g. a dominance of the House Mouse *Mus domesticus*[11] or an increase of birds in the diet[4]). Here we analyse the diet of urban roosting Long-eared Owls, to assess whether such adaptation to an urban environment occurs.

In the city of Milan, northern Italy (45°28′N 9°12′E), a large roost of Long-eared Owls (up to 76 birds) has occurred every winter (October–April), since at least 1988 (A. Pirovano, unpubl. data). The study site is located along a public footpath and in private gardens, with two sub-roosts 150 m apart. Data from both sites were pooled for most analyses. The owls hunt in the suburbs of the city and the adjoining farmland.[12]

Pellets were collected between October 1996 and April 1997, pooled by month for analyses and examined following standard techniques.[13] Although the pellets could belong to a non-independent sample, we have minimized bias by using an average value for every month.[14] Estimates of biomass were derived from the literature[3,15] and from specimens collected in the study area. As in other studies, birds were considered as a single category[3,5,9,10] and they were assigned an average mass of 20 g each.[3] The weight of predated Brown Rats *Rattus norvegicus*, the only rat species in our study area,[16] was estimated by measuring mandible length and using the regression equation given by Di Palma & Massa.[15] In biomass calculations, rats were assigned the average monthly weight.

A total of 2760 prey items was identified in 2054 pellets. Mammals accounted for 91.0% of the diet in number; the remaining 9.0% was birds (see Appendix). Diet composition varied significantly between months ($\chi^2 = 395$, df = 24, $P < 0.001$, computed on numbers of the five main prey categories, Fig. 1a). Brown Rat is very important in the diet of Long-eared Owl in this locality, as is clear from consumed biomass (overall 65.2%, range 54.4–76.5% per month, Fig. 1b). Rats are often represented in the diet of the Long-eared Owl (80% of 18 studies), but few studies show such a large presence both in terms of number (20.5%) and biomass (*%N*: median = 0.7, range 0.1–4.7%, $n = 14$ studies; *%B*: median = 4.8, range 0.5–17.5%, $n = 9$ studies).

Weight (mean ± sd) of rats eaten was 140.0 ± 30.2 g (range 89.8–224.5 g, $n = 260$), suggesting mainly young or subadults in a non-reproductive state.[17] Rats predated in autumn and spring months were lighter than those taken in winter months (quadratic regression of individual rat weights on month, $F_{257} = 37.33$, $P < 0.001$, $r^2 = 0.23$) and monthly proportion (*%N*) of rats in the diet was negatively correlated with monthly mean rat weight (data from both sub-roosts, $r_s = -0.73$, $n = 14$, $P = 0.003$). This is most probably explained by a decrease in availability of young rats in mid-winter months,[18] together with a selection of smaller individuals, that may be easier to capture compared with large and aggressive ones.

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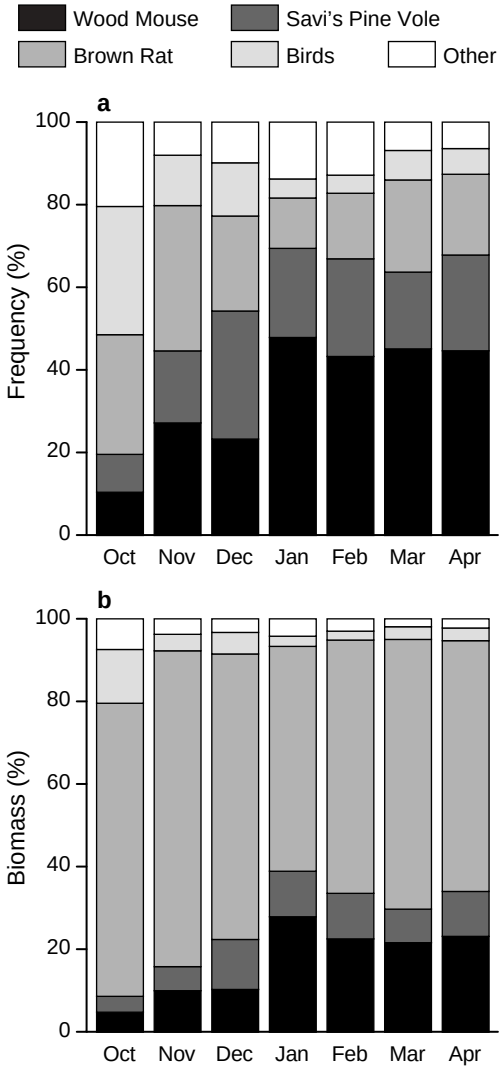

Figure 1. Monthly diet composition, October 1996 to April 1997: (a) number as a percentage of the diet for the five main prey categories; (b) biomass as a percentage of the diet. The category 'other' includes all mammal species with an overall frequency less than 5% in number. (Savi's Pine Vole *Pitymys savii*).

The presence of the Wood Mouse *Apodemus sylvaticus* in the diet is negatively correlated with that of the Brown Rat (monthly $\%N$: $r_s = -0.75$, $n = 7$, $P = 0.052$; monthly $\%B$: $r_s = -0.96$, $n = 7$, $P < 0.001$). Despite being numerically most abundant (37.8%), the Wood Mouse seems to be an alternative prey to the Brown Rat, given the dominance of rats by biomass.

The low value of the prey/pellet ratio and the high value of the average meal (see Appendix) compared with the literature (mean ± sd, prey/pellet = 2.1 ± 0.3, $n = 7$ studies; average meal = 45.9 ± 6.9 g, $n = 8$ studies) may be an index of the energetic advantage of eating rats: because they are heavier than other prey, owls need to hunt less often and can obtain a larger amount of food per hunting trip. This may explain the choice of an urban winter roost site.

In conclusion, we confirm the trophic plasticity of Long-eared Owls in their Italian wintering range[3–9] and highlight their ability to adapt to an urban environment.

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APPENDIX

Monthly diet composition, October 1996 to April 1997, number of prey items (*n*), percentage of prey in number (%*N*) and biomas (%*B*) according to prey species.

	Oct		Nov		Dec		Jan		Feb		Mar		Apr		Total		
Prey species	%*N*	%*B*	%*N*	%*B*	%*N*	%*B*	%*N*	%*B*	%*N*	%*B*	%*N*	%*B*	%*N*	%*B*	*n*	%*N*	%*B*
Rodentia																	
Apodemus sylvaticus	10.4	4.6	27.2	9.9	23.1	10.0	47.9	27.5	43.2	22.4	45.1	21.3	44.6	23.0	1043	37.8	18.0
Micromys minutus	0.5	0.1	2.2	0.2	3.1	0.3	9.0	1.3	6.7	0.9	3.0	0.4	1.3	0.2	132	4.8	0.6
Mus domesticus	2.7	0.7	1.9	0.4	2.4	0.6	1.9	0.6	2.4	0.7	1.6	0.4	0.6	0.2	56	2.0	0.6
Rattus norvegicus	29.0	71.4	35.0	76.5	23.1	69.3	12.0	54.4	16.1	61.2	22.2	65.6	19.8	60.8	567	20.5	65.1
Muridae spp.	0.9	0.4	1.3	0.5	0.7	0.3	1.3	0.8	2.0	1.1	1.4	0.7	3.8	2.0	43	1.6	0.8
Pitymys savii	9.1	3.7	17.5	5.8	31.0	12.2	21.6	11.3	23.4	11.0	18.6	8.0	22.9	10.7	587	21.2	9.2
Microtus arvalis	–	–	0.6	0.2	1.4	0.6	0.6	0.4	0.7	0.4	0.2	0.1	–	–	16	0.6	0.3
Arvicola terrestris	2.3	4.1	1.6	2.3	0.7	1.2	0.4	1.0	0	0	0.2	0.4	–	–	15	0.5	1.1
Muscardinus avellanarius	–	–	–	–	–	0	0.2	0.2	–	–	–	–	–	0	1	0.0	0.0
Insectivora																	
Crocidura leucodon	0.9	0.1	–	–	–	–	–	–	–	–	–	–	–	–	2	0.1	0.0
Crocidura suaveolens	–	–	–	–	–	–	0.2	0.0	–	–	–	–	–	–	1	0.0	0.0
Crocidura sp.	1.4	0.2	–	–	–	–	–	–	0.8	0.1	0.5	0.1	0.6	0.1	13	0.5	0.1
Sorex araneus	0.5	0.1	–	–	–	–	–	–	0.1	0.0	–	–	–	0	2	0.1	0.0
Chiroptera																	
Pipistrellus kuhlii	10.9	1.5	0.3	0.0	1.7	0.2	–	–	–	–	0.2	0.0	–	–	31	1.1	0.2
Chiroptera spp.	0.5	0.1	–	–	–	–	–	–	0.1	0.0	–	–	–	–	2	0.1	0.0
Aves	31.2	13.1	12.5	4.3	12.9	5.3	4.8	2.6	4.5	2.2	7.0	3.1	6.4	3.1	249	9.0	4.0
Pellet number	133		296		251		465		471		320		118		2054		
Prey number	221		320		294		476		851		441		157		2760		
Prey/pellet	1.66		1.08		1.17		1.02		1.81		1.38		1.33		1.34		
Average meal[a]	79.19		63.19		57.31		37.75		73.87		61.94		54.74		59.52		
Diet breadth[b]	4.67		4.09		4.51		3.31		3.63		3.40		3.37		4.14		

[a]Average meal is defined as: (mean prey weight) × (prey/pellet). [b]Diet breadth according to Levins' index, NB = $1/\Sigma p_i^2$, where p_i is the proportion of the prey.