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Notes on the diet of successful and failed breeding Tawny Owls (*Strix aluco*) in urban Rome, Italy

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Abstract. The authors compared the breeding diet of successful and unsuccessful pairs of Tawny Owls in urban Rome to estimate the relative importance of different prey groups to owl reproduction. They identified a total of 3 089 prey items from 15 owl territories. Medium-sized passerines, rats, and Columbidae contributed more than 20% in number and 60% in biomass. Small-sized passerines and rodents were the taxa most preyed on by number (more than 40%), decreasing at the biomass level (less than 30%). Geckos, swifts, and bats made up a minor component of diets, both in number and biomass. Insects constituted more than 20% of diets by number, but their contribution was negligible at the biomass level. Among large-sized prey, both Columbidae and rats were taken more by successful pairs than by unsuccessful ones, but only percentage number and biomass of rats significantly differed among the diets of pairs with different breeding status. The number of prey per pellet and niche breadth showed no substantial difference between the diets of successful and unsuccessful pairs, while mean prey weight and prey biomass per pellet slightly increased in the diets of successful pairs. It is suggested that the relationship between Tawny Owl diet and reproduction may reflect both differences in prey availability and prey selection among territories.

Key words: Tawny Owl, *Strix aluco*, diet, breeding success, rats, *Rattus* sp.

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I. INTRODUCTION

The diet of Tawny Owls (*Strix aluco*) had been extensively studied in Northern Europe, where the main prey of this raptor is woodland rodents, such as *Apodemus flavicollis* and *Clethrionomys glareolus* (see RANAZZI et al. 2000). On the basis of fewer materials, in Mediterranean Europe a great predation on alternative prey, such as birds, geckos, and insects, was documented (e.g. GALEOTTI et al. 1991, MANGANARO et al. 1999, RANAZZI et al. 2000 and references therein). By contrast, the relationship between diet composition and reproduction has not been adequately studied, except by BAUDVIN (1990), who found a positive correlation between the breeding success and the percentage of woodland rodents in the diet of many pairs in Central France. In North America, previous dietary studies have suggested that in *Strix* owls changes in individual diet are linked to the reproductive output (SMITH et al. 1999). Breeding Spotted Owls (*Strix occidentalis*) preyed on larger prey than non breeding owls (BARROWS 1987, THRAILKILL & BIAS 1989, but see also SEAMANS & GUTIÉRREZ 1999). According to this, the present authors hypothesised that changes in individual diet composition according to the reproductive state also occurred in the Tawny Owl. To test this hypothesis, they provide a comparison of the breeding diet of successful and unsuccessful owls in an urban area of Central Italy.

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II. METHODS

The authors studied Tawny Owl diets in 15 territories settled in small and large parks in urban Rome, Italy. For details on the study area, census method, and territory features see MANGANARO et al. (1999) and RANAZZI et al. (2000). The diet was assessed by analysing pellets and prey remains collected from April to August 1998-99, which encompassed the breeding period from incubation to young fledging. A diet from a small park territory was studied during four consecutive breeding seasons, from 1995 to 1998. The analysis was supplemented with data gathered during the breeding period in a large urban park ("Villa D. Pamphili", see RANAZZI et al. 2000). Pellets were generally collected monthly in each territory studied, searching below nests and known roosting sites. Pellet analysis, prey identification, and biomass calculation followed PIATTELLA et al. (1999). Mean weights for each prey taxon were estimated using data from Mediterranean areas (see PIATTELLA et al. 1999). Small-sized passerines and large-sized passerines included birds with a weight less or more than 30 g, respectively. Small mammals included shrews and rodents with a weight less than 30 g. The number of individuals (scored as minimum value) was calculated taking into account all different kinds of prey items found. Paired anatomical parts were counted as belonging to the same individual. Overall, the number of prey per territory averaged 206±158 (range 41-455 prey), that were regard as a representative sample for the breeding period, when compared with previous works (e.g. WENDLAND 1984, KORPIMAKI 1986, PIATTELLA et al. 1999). For each diet, the following parameters were obtained: (i) mean prey weight (M.P.W.), calculated as the total biomass divided by the number of prey, (ii) mean prey biomass per pellet (P.B.P.), and (iii) mean number of prey per pellet (P.P), obtained as the total biomass or the number of prey (considering only items from pellets) divided by the number of pellets collected, and (iv) trophic niche breadth, calculated following LEVINS (1968) using taxa reported in Table 1.

The breeding success of each pair was assessed by broadcasting stranger male hoots within the nesting area and listening for adult and young responses (see WENDLAND 1984, RANAZZI et al. 2000 for details). The finding of other traces (e.g. young feathers) confirmed the breeding state of each pair. Pairs with males and females actively defending the territory and no young fledged were regarded as unsuccessful (i.e. non breeding or failed breeding). Diets from territories occupied by a single owl were not considered. A total of 9 diets from successful breeding territories and 6 diets from failed breeding territories were obtained.

A Mann-Whitney U-test was used to check differences in diet composition between successful and unsuccessful pairs. A minimum probability level of $P < 0.05$ was accepted (all tests were two-tailed). Statistical analyses were performed using STATISTICA software. Results are presented as mean ± SD.

III. RESULTS

The authors identified 3 089 prey items from 15 Tawny Owl territories, for a total biomass of 97 656 g (Table I). Small-sized passerines and rodents were the most common taxa by number, with a

Table I

Breeding diets of Tawny Owls in urban Rome (the Mann-Whitney test was performed among diets of successful and unsuccessful pairs, and the significance level of comparisons was marked with an asterisk when $P<0.05$). Minimum number of individuals was given as mean value

	Minimum number of individuals		Percent number		Percent biomass	
	Successful pairs	Failed pairs	Successful pairs	Failed pairs	Successful pairs	Failed pairs
Stylommatophora	9.3	3.0	0.7±1.3	1.0±1.6	0.1±0.2	0.1±0.2
Arachnida	1.5	0.0	0.1±0.3	0.0±0.0	0.0±0.0	0.0±0.0
Orthoptera	3.8	1.0	2.0±1.5	1.1±0.9	0.2±0.2	0.2±0.2
Dermaptera	9.0	2.5	1.4±3.4	0.6±1.3	0.0±0.0	0.0±0.0
Hemiptera	11.8	43.7	5.2±9.4	14.1±20.3	0.5±1.0	1.5±2.1
Coleoptera	28.4	5.5	9.3±5.5	6.9±6.1	0.5±0.3	0.4±0.6
Other insects	3.4	1.5	0.9±0.8	1.3±1.6	0.0±0.0	0.0±0.0
Anura	4.3	3.0	0.3±0.6	0.7±1.6	0.3±0.7	1.2±3.0
Sauria	29.0	8.3	13.2±12.7	5.9±5.0	1.5±1.5	0.8±0.5
Columbidae	3.6	1.3	1.3±0.9	0.6±0.6	8.9±4.9	6.7±6.4
Apodidae	2.2	4.0	1.1±1.9	1.0±2.0	1.4±2.5	1.1±2.0
Picidae	1.0	0.0	0.4±0.8	0.0±0.0	1.2±2.4	0.0±0.0
Small-sized passerines	102.4	37.5	31.0±15.2	28.4±16.6	19.8±7.9	19.6±10.0
Medium-sized passerines	28.0	14.7	9.5±3.8	10.8±7.8	23.1±6.9	29.7±19.4
Chiroptera	4.1	5.7	1.1±1.1	2.0±2.8	0.7±0.9	1.3±1.7
Small mammals	16.0	12.7	10.6±19.4	15.3±22.0	7.8±14.1	17.0±22.2
Rattus sp.	29.9	7.3	11.8±3.6	10.2±13.1*	33.7±10.2	20.3±10.9*
Total prey or biomass (g)	264.9	117.5	2 384	705	77 557	20 099

	Successful pairs	Failed pairs
Mean prey weight (g)	31.8±6.0	27.9±5.5
Prey biomass per pellet (g)	101.7±18.3	84.7±21.7
Number of prey per pellet	3.6±1.1	3.8±1.3
Niche breadth	2.4±0.3	2.2±0.3

similar proportion between diets of successful and unsuccessful pairs. Sauria, notably geckos, medium-sized passerines, notably *Turdus merula* and *Sturnus vulgaris*, and rats, including *Rattus rattus* and *Rattus norvegicus*, contributed more than 25% by number. Among invertebrates, only beetles and cicadas represented more than 5% by number, but contributed only 2% by biomass. No other taxa contributed more than 2% by number. Rats and medium-sized passerines contributed more than 20% by biomass, while small-sized passerines, rodents, and Columbidae, including *Columba livia* and *Streptopelia decaocto*, represented more than 15%. No other taxa contributed more than 2% to the total biomass consumed. Overall, few differences were observed between the diets of successful and unsuccessful pairs. Only rats were taken significantly more by successful pairs than by unsuccessful pairs both by number and by biomass. Prey biomass per pellet and mean prey weight slightly increased in successful pair diets, while number of prey per pellet and niche breadth showed a substantial similarity among diets. However, no diet parameters differed significantly between diets of successful and unsuccessful pairs.

IV. DISCUSSION

The breeding success of the Tawny Owl in Northern Europe is strictly linked with the abundance of small mammals (e.g. WENDLAND 1984). The number of young fledged increases linearly with the predation on woodland rodents (BAUDVIN 1990). The consumption of alternative prey (e.g. birds, frogs, and insects) increases in poor-rodent years and in urban habitats (MIKKOLA 1983, BOCHEŃSKI 1990, GALEOTTI et al 1991), with a remarkable reduction in the breeding success (see RANAZZI et al. 2000). In Southern Europe, alternative prey strongly increases in the diet probably owing to its greater availability (MANGANARO et al. 2000), while woodland rodents represent a minor component of the diet (MANGANARO et al. 1999, 2000). In Mediterranean urban habitats, the availability of woodland rodents further decreases along the urbanization gradient (GALEOTTI et al. 1991, PIATTELLA et al. 1999), therefore the breeding success should be less affected by the abundance of small rodents. In Rome, Tawny Owls caught prey ranging in size from 0.01 g to 300 g, but only three main prey groups showed a weight more than 50 g, including medium-sized passerines ($\bar{x}$ = 76.1 g), rats ($\bar{x}$ = 96.2 g), and Columbidae ($\bar{x}$ = 246.2 g). Rats were taken more by successful pairs, both by number and by biomass, and these prey groups contributed about 40% by biomass to the diets of successful pairs. Prey biomass per pellet was 17 g higher in diets of successful pairs than in diets of unsuccessful ones. Although differences in diet composition between Northern Europe and the Mediterranean basin are evident (e.g. MANGANARO et al. 2000), the prey biomass per pellet appears similar in the two habitats (see RANAZZI et al. 2000), therefore it may be used as a valuable predictor of the energy content of diets. Interestingly, the estimation of the mean daily food requirement for a Tawny Owl ($\bar{x}$ = 180 g) divided by the mean number of pellets regurgitated per day ($\bar{x}$ = 2) (MIKKOLA 1983) is similar to the mean value of prey biomass per pellet pooling all the diets ($\bar{x}$ = 94.9±20.8 g).

The predation on small-sized prey (e.g. land snails and insects) is rather low in urban Rome if compared with neighbouring woodlands. In lowland oak woods, invertebrates frequently contribute more than 60% by number and 10% by biomass, and the mean prey biomass per pellet falls to less than 50 g (MANGANARO et al. 2000). Consequently, the breeding success of Tawny Owls generally decreases in such habitat in comparison with urban areas (RANAZZI et al. in press), further confirming the importance of large-sized prey in rearing large broods.

The present authors agree with SMITH et al. (1999) that the relationship between the Tawny Owl diet and reproduction may reflect differences in prey availability and prey selection among territories. As the abundance of different prey groups (e.g. rodents, small birds, and frogs) affects the diet composition of Tawny Owls (BOCHEŃSKI 1990, JĘDRZEJEWSKI et al. 1996), the reduction in the energy content of woodland diets probably reflects both the decreased availability of large-sized prey, such as rats and pigeons, and the increase of easily-catchable alternative prey, such as invertebrates (see MANGANARO et al. 2000). As concerns prey selection, in cities pigeons are generally more common in built-up areas and small parks than in large parks, but Tawny Owls preyed on a comparable proportion of them in both habitats (RANAZZI et al. 2000). Further, the distribution of rats is usually affected by the availability of watercourses, increasing their abundance in the urban trait of rivers, near lakes and artificial ponds. However, rats were taken in similar proportion both in large parks with artificial lakes and in small gardens without ponds (RANAZZI et al. 2000).

Although the total amount of prey taken is difficult to assess because it is unlikely that all regurgitated pellets were collected, it clearly appears that a difference in diet, in terms of diet composition and prey size, exists between successfully breeding and failed Tawny Owl pairs. This pattern seem to be common in many raptors, both diurnal (e.g. KORPIMAKI 1986) and nocturnal (e.g. SMITH et al. 1999). In urban habitats, where the availability of optimal nest-sites, both tree cavities and holes in buildings, is generally high and the predation on young is reduced, owing to the scarcity of Mustelidae and snakes, trophic variables may be considered as the main factor affecting the reproduction of birds of prey.

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