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THE BREEDING SUCCESS OF TAWNY OWLS (*STRIX ALUCO*) IN A MEDITERRANEAN AREA: A LONG-TERM STUDY IN URBAN ROME

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The breeding biology of the Tawny Owl (*Strix aluco*) was studied in northern and central Europe specifically focusing on the influence of food abundance on clutch size and productivity of young (Southern 1970, Wendland 1984). Baudvin (1990) found a remarkable positive correlation between the reproductive output of Tawny Owls and the percentage of woodland rodents in the diet of pairs in central France. Annual fluctuations in Tawny Owl breeding success were directly linked to the abundance of woodland rodents, especially the yellow-necked mouse (*Apodemus flavicollis*), the main prey of this owl in woods and mixed farmlands (Wendland 1984, Baudvin 1990, Jedrzejewski et al. 1994). Moreover, alternative prey (e.g., birds and amphibians) increased in diet in low mouse years (Plesnik and Dusik 1994). Cyclic fluctuations in populations of rodent prey is probably the main factor affecting Tawny Owl productivity, but other factors, such as weather conditions, could be also involved (Kostrzewa and Kostrzewa 1990, Gil-Delgado et al. 1995, Penteriani 1997).

In Mediterranean areas, very few studies have focused on the study the annual variations in the breeding success of any raptor (Gil-Delgado et al. 1995). The aim of this study was to assess the long-term breeding success of Tawny Owls in a Mediterranean urban area, checking for variations, if any, in productivity of young, and comparing them to the breeding performance of other areas in Europe.

METHODS

The study was carried out from 1984–99 in five urban census plots, including developed areas, small gardens, and city parks (mean density of Tawny Owl territories = 3.0/km^2) and from 1989–99 in three suburban plots of Rome, including open land and deciduous woodland patches (mean density of Tawny Owl territories = 5.6/km^2, Ranazzi et al. 2000). Vegetation in small gardens included pines (*Pinus pinea*), cypresses (*Cupressus sempervirens*), cedars (*Cedrus* spp.), as well as isolated oaks (*Quercus* spp.). Vegetation of city parks as well as suburban woodlands was generally composed of strands of mixed deciduous wood predominated by oaks (e.g., *Quercus ilex*). Nests were generally located in natural cavities of old oaks and pines. The rate of territory occupation was remarkably high in both habitats, so the population density did not show significant variations among years (Ranazzi et al. 2000).

Procedures for mapping territories and locating nesting sites followed Ranazzi et al. (2000). Although the bulk of the data on breeding success were obtained from pairs consecutively studied throughout the census period, some pairs, especially those of urban parks, were not continuously censused due to the impossibility to visit their territories in some breeding seasons (e.g., occurrence of summer events or public works in parks and gardens and Tawny Owls nesting sometimes on private property). Data for 1984–85 seasons were not considered due to the small number of records available. The number of occupied territories censused each year was 14.3 ± 5.9 (N = 200) from 1986–99 in urban plots, and 10.1 ± 5.8 (N = 111) from 1989–99 in suburban plots.

Estimates of the number of young in nests were made by broadcasting calls of male Tawny Owls on a SANYO portable stereo with 6 W loudspeakers within the nesting area at a distance of about 50 m from known nest sites (see Ranazzi et al. 2000 for details) and listening for responses. Generally all young responded to calls with their persistent 'ptziè' begging calls, so this method was used to evaluate the number of successful pairs and fledgling production (Wendland 1984). Nest site disturbance was reduced by limiting visits to each territory to only two in May–August. This period was chosen to census young based on a preliminary assessment in 1984–85 of young vocal activity at eight known nests. All fledglings began to utter the 'ptziè' call in May and they remained in their parents' territories at least until early August, continuously uttering their begging calls. These data were consistent to those in non-Mediterranean zones (Southern 1970, Wendland 1984). Data gathered in early May or in August were included only if a control visit was made in June or July. When we were uncertain of the exact number of young that begged due to the many calls contemporaneously uttered, we omitted them from analyses.

We agree with Wendland (1984) that this method can

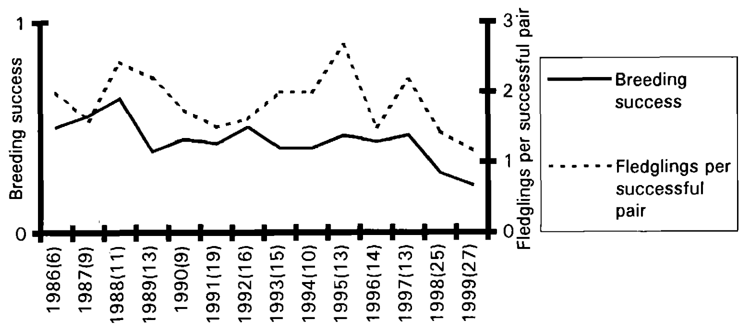

Figure 1. Annual variations in the rate of breeding success and mean number of fledglings per successful pair in urban Rome. Number of breeding attempts studied are given in parentheses.

result in small errors, but it allows checking of young in many natural cavity nests in a relatively short time. The breeding success was assessed using the following indexes: (1) breeding success (at least one young fledged); (2) number of fledglings per successful pair; and (3) number of fledglings per breeding pair. All data are presented as mean ±SD. Meteorological data were acquired from a weather station within the study area. The rate of breeding success was compared by χ^2 contingency tables including numbers of successful and failed pairs. Parametric tests were used when data showed a normal frequency distribution. Comparisons between different habitats or study areas were generally performed by Student's *t*-tests and one-way ANOVAs using yearly means and SDs. For some bibliographic data sets, only means were available, so we could not test for differences among years. A minimum probability level of $P < 0.05$ was accepted and all tests were two-tailed. Statistical analyses were performed by STATISTICA 4.5 and PRIMER 1.0 PC packages.

RESULTS

Out of a total of 311 breeding attempts studied from 1986–99, in urban plots 119 (59.5%, $N = 200$) failed, 37 (18.5%) produced 1 fledgling, 24 (12.0%) produced 2 fledglings, 16 (8.0%) produced 3 fledglings, and 4 (2.0%) produced 4 fledglings. In suburban plots, 57 breeding attempts (51.3%, $N = 111$) failed, 26 (23.4%) produced 1 fledgling, 20 (18.0%) produced 2 fledglings, and 8 (7.2%) produced 3 fledglings. No significant differences in any breeding parameters were found among years in both urban (breeding success: $\chi^2 = 9.9$, df = 13, $P = 0.703$; mean number of fledglings per successful pair: $F_{13,67} = 1.4$, $P = 0.177$; and mean number of fledglings per breeding pair: $F_{13,186} = 1.5$, $P = 0.126$; Fig. 1) and suburban plots (breeding success: $\chi^2 = 9.3$, df = 10, $P = 0.501$; mean number of fledglings per successful pair: $F_{10,43} = 1.4$, $P = 0.177$; and mean number of fledglings per breeding pair: $F_{10,100} = 0.8$, $P = 0.636$; Fig. 2) Differences in breeding parameters between the two habitats studied were also not significant (breeding success: $\chi^2 = 1.6$, df = 1, $P = 0.204$; mean number of fledglings per successful pair: $t_{23} = 1.4$, $P = 0.187$; and mean number of fledglings per breeding pair: $t_{23} = 0.1$, $P = 0.937$). The mean number of fledglings per breeding pair recorded in suburban plots of Rome was comparable to those observed in similar habitats of Berlin Grunewald ($t_{30} = 0.7$, $P = 0.464$) and Oxford Wytham Wood ($t_{22} = 0.5$, $P = 0.597$), but lower than those observed in mixed woodlands of Cote d'Or ($t_{19} = 5.1$, $P < 0.001$) and farmlands of Hradec Kralowe ($t_{13} = 6.6$, $P < 0.001$), where

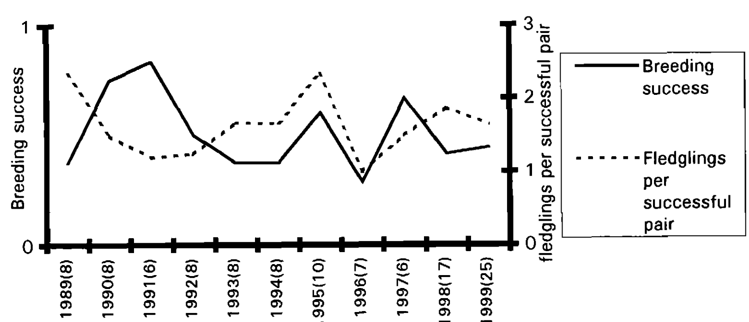

Figure 2. Annual variations in the rate of breeding success and mean number of fledglings per successful pair in suburban Rome. The number of breeding attempts studied are given in parentheses.

all Tawny Owl pairs bred in nest boxes. In northern European areas (see Table 1 for statistics and references), significant differences among years in the rate of breeding success were observed over a long-term period in both Berlin (χ^2 = 1382.9, df = 20, $P < 0.001$) and Oxford (χ^2 = 57.2, df = 12, $P < 0.001$), but no differences were observed in Cote d'Or (χ^2 = 11.7, df = 9, P = 0.233) and Hradec Kralowe (χ^2 = 7.7, df = 3, P = 0.068), probably due to the limited number of study years. As for the productivity of owl pairs, we could test for differences among years only in two areas, Hradec Kralowe and Kielder. In Kielder, the mean number of fledglings per breeding pair showed a significant difference among years (t_{148} = 4.4, $P < 0.001$). In Hradec Kralowe, the difference in productivity among years was not significant (t_{80} = 0.9, P = 0.350), again probably due to the small sample considered (N = 183 breeding attempts observed during four consecutive years).

DISCUSSION

The breeding success of Tawny Owls in Rome showed weak annual fluctuations when compared with those of some northern populations, although the overall production of young did not vary significantly among different populations nesting in natural cavities. In northern Europe, significant fluctuations in breeding parameters are specifically linked to the abundance of woodland rodents, which make up the main part of the Tawny Owl diet. In low rodent-years, breeding success is significantly lower than in high rodent years (Southern 1970, Wendland 1984, Petty 1989), and alternative prey, such as birds and amphibians, increase in the diet (Baudvin 1990, Plesnik and Dusik 1994). By contrast, as rodent fluctuations are weakly observed in Mediterranean areas (Rizzo et al. 1993, Gil-Delgado et al. 1995) and their abundance generally decreases along an urban gradient (Galeotti 1994), Tawny Owl reproduction in Rome should be less affected by this factor. In fact, in Mediterranean urban habitats as well as in most coastal and arid hilly areas, small mammals are a minor component of the diet which is composed mainly of birds and insects, especially beetles, as well as geckos, bats, frogs, and snails (Manganaro et al. 1999, Ranazzi et al. 2000). The availability of these prey throughout the breeding season (Capula et al. 1993, Rizzo et al. 1993, Gil-Delgado et al. 1995, Manganaro et al. 1999) allows Tawny Owls to avoid concentrating their predation on few mammal species, probably providing young with a comparable amount of prey each year. The use of alternative prey such as insects and stable breeding success have been observed in Mediterranean populations of the Eurasian Kestrel (*Falco tinnunculus*), a rodent-eating raptor that, in northern Europe, shows significant variations in its reproductive output due to cyclic fluctuations of its main prey (Rizzo et al. 1993, Gil-Delgado et al 1995, Piattella et al. 1999). On the other hand, other factors affecting Tawny Owl reproductive output in northern Europe are probably reduced in southern Europe. Both harsh weather conditions and high levels of competition with other predators may increase fluctuations in population density as well as in reproductive output (Kostrzewa and Kostrzewa 1990, Selås 1998). In Rome, nighttime temperatures throughout the nesting season are generally higher than 10°C. From March–May 1984–98, the average temperature was 10.7 ± 3.1°C (N = 15 years), while during the post-fledging period, it was often higher than 20°C (average temperature in June 1984–98 = 17.9 ± 1.2°C, N = 15 years). Also rainfall was generally low in both spring and early summer with rainfall in March–June 1984–98 averaging 189.9 ± 60.8 mm (N = 15 years). This provided good weather conditions for rearing young and reducing energy requirements when nestlings were growing (Gil-Delgado et al. 1995). As already observed for some raptors in cities (Sodhi et al. 1992, Tella et al. 1996), competition levels with other predators were substantially reduced in the study area, where only the Eurasian Kestrel, the Little Owl (*Athene noctua*), and the red fox (*Vulpes vulpes*) reached relatively high densities in some Tawny Owl habitats. Therefore, both mild weather conditions and low level of trophic competition with other predators may have further accounted for the long-term stability of the Tawny Owl breeding success in Rome.

RESÚMEN.—La reproducción de *Strix aluco* fue estudiada desde 1984–99 y en 1989–99 en la Roma urbana y suburbana respectivamente. El exito de anidación y el numero medio de pichones por parejas exitosas y por parejas en reproduccion no tuvo variaciones significativas en un período de 15 y 11 años en habitats urbanos y suburbanos respectivamente. Comparado con las poblaciones del norte de Europa, los factores principales que afectan la estabilidad de la población reproductiva de *Strix aluco* en Roma pueden estar relacionados con la dependencia de roedores en bosques, los cuales tienen una disponibilidad limitada en las áreas urbanas mediterráneas. Tambien es importante su alta dependencia de fuentes alternas de alimento, tales como aves y geckos. Las condiciones climáticas durante la primavera y el verano son favorables para la cría de juveniles, permitiendo una considerable reducción de energía requerida en la estación reproductiva. Existe tambien una limitada competencia por comida con otros depredadores.

[Traducción de César Márquez]

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Table 1. Breeding success of some European populations of Tawny Owls.

Study Area (Habitat Type)	Nest Type	Study Period (No. Years)	Breeding Success Mean ± SD (Range)	χ	Fledglings/Successful Pair Mean ± SD (Range)	F	Fledglings/Breeding Pair Mean ± SD (Range)	F	No. of Pairs	Source
Rome (Urban)	C[a]	1986–99 (14)	43.5 ± 10.4 (22.2–63.6)	ns[b]	1.86 ± 0.42 (1.17–2.43)	ns	0.83 ± 0.32 (0.26–1.55)	ns	200	This work
Rome (Suburban)	C	1989–99 (11)	51.0 ± 17.7 (28.6–83.3)	ns	1.63 ± 0.42 (1.00–2.33)	ns	0.82 ± 0.30 (0.29–1.40)	ns	111	This work
Berlin (DW)[a]	C	1959–79 (21)	44.8 ± 16.3 (21.1–76.9)	*	1.99 ± 0.36 (1.25–2.60)	—[c]	0.93 ± 0.44 (0.40–1.77)	—[c]	368	Wendland (1984)
Oxford (DW)	B + C	1947–59 (13)	44.5 ± 20.9 (0–70.0)	*	1.48 ± 0.55 (0–2.0)	—[c]	0.74 ± 0.41 (0–1.3)	—[c]	331	Southern (1970)
Cote d'Or (DW)	B	1980–89 (10)	69.6 ± 10.0 (47.8–80.4)	ns	2.94 ± 0.74 (2.00–4.34)	—[c]	2.06 ± 0.75 (1.00–3.46)	—[c]	347	Baudvin (1990)
Hradec Kralowe (F)	B	1986–89 (4)	79.9 ± 10.1 (64.9–85.7)	ns	2.62 ± 0.40 (2.26–3.19)	—[c]	2.18 ± 0.49 (1.62–2.74)	ns[d]	183	Plesnik and Dusik (1994)
Kielder (CW)	B	1981–87 (7)	—	—	—	—	1.48 ± 1.2[e] (0.20–2.58)	*[d]	210	Petty (1989)

[a] DW = deciduous forest; CW = coniferous forest; F = farmland; B = nest box; C = natural cavity.

[b] Probability levels for each statistical test reported as follows: ns = $P > 0.05$; * = $P < 0.001$.

[c] Yearly means with SDs were not available, so we could not test for differences among years.

[d] Differences between the mean number of fledglings in high compared to declining vole years.

[e] Mean and SD calculated using the mean values of many different years pooled into three young production classes according to the relative abundance of rodents.

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