Ornis Fennica 87:99–105. 2010

Winter nocturnal roost selection by a solitary passerine bird, the Great Grey Shrike *Lanius excubitor*

Marcin Antczak

M. Antczak, Department of Behavioural Ecology, Adam Mickiewicz University, Umultowska 89, PL-61 614 Poznań, Poland. E-mail antek@amu.edu.pl

Received 17 August 2009, accepted 8 April 2010

The night roost selection of the Great Grey Shrike *Lanius excubitor,* was investigated in a farmland landscape in western Poland between the winters 2002/3 and 2004/5. In total, 24 territories were surveyed and 39 night roost sites detected, with willow *Salix* spp. bushes being the most frequently used roost. The number of roosts varied between one and four per territory. The number of roosting perches within a given bush was significantly correlated with the overall bush volume. Shrikes selected bushes that had a large volume, had a high density of stems, and were isolated from other bushes or trees. Micro-habitat patterns of night-roost selection suggested that the roosts fulfilled two main functions: thermoregulation and predator avoidance. However, a trade-off may have existed between minimizing thermoregulatory costs and avoiding potential predators, because shrikes selected bushes for roosting. In contrast to Great Grey Shrikes e.g. in Finland, birds in the studied population avoided impaling and caching prey in roosting sites, which might be a strategy to avoid detection by predators or might reflect differences in climate. The availability of roosting sites might be an important factor in habitat selection for wintering Great Grey Shrikes.

1. Introduction

The behaviour of animals reflects a chain of important decisions such as where to settle, who to mate with or where to forage, each with different fitness outcomes. The choice of roosting sites during winter might be especially important, as birds face long hours of darkness, low air temperature and consequently enforced fasting. Mortality may increase substantially on nights with inclement weather conditions, and night roosting, especially in the winter, might therefore be a critical part of bird behaviour (Odum & Pitelka 1939, Pinowski *et al.* 2008). However, despite its possible great importance, night-roosting behaviour of wild birds is a poorly explored aspect of avian behaviour and ecology (c.f. Cody 1985). Theoretical predictions indicate that roosting sites should fulfil at least two important functions: protection against predators and/or mobbers (Sunde *et al.* 2003, Hendrichsen *et al.* 2006) and minimisation of thermoregulatory costs, including heat loss. These assumptions have been supported by field studies (e.g., Atkinson 1993, Körtner & Geiser 1999). On the other hand, some studies failed to find striking thermoregulatory benefits when examining roosting sites in relation to microhabitat features (Webb & Rogers 1988). However, the majority of studies were performed on communal roosting species (e.g., Engel *et al.* 1992, Caccemise *et al.* 1997, Yap *et al.* 2002), birds roosting in cavities (Pitts 1976) or on snow roosting of grouse and ptarmigan

(Korhonen 1980, Marjakangs 1990). Only a handful of studies have examined night-roost selection in solitary roosting birds, especially passerines (Chander *el al.* 1995). One of the main reasons for such a striking imbalance is caused by the secretive behaviour and consequent difficulties in locating roosting sites of birds at night (Cody 1985, Körtner & Geiser 1999).

In this paper, data on winter-season night-roost selection of a medium-sized passerine (body mass 67–70 g), the Great Grey Shrike *Lanius excubitor,* are presented. This species occupies semi-open habitats, mainly farmland landscapes (Lefranc & Worflock 1997, Harris & Franklin 2000), exhibits strong territoriality, and holds exclusive winter territories (Lefranc & Worflock 1997). Wintering Great Grey Shrikes in Poland are constrained by continental climatic conditions (Kuczyński *et al.* 2009), and the availability and quality of night roosts might be important cues in habitat selection for this species. Night roosts of the Great Grey Shrike are relatively easy to locate for experienced observers, mainly due to accumulated droppings and characteristic pellets (see photos in Olsson 1984). Winter night roosts of the Great Grey Shrike have been described in North America (Atkinson 1993) and in Scandinavia (Olsson 1984, Karlsson 1997, 2007) but none of these papers deal with night-roost selection, the main research objective of the current study. Particular emphasis is put on the microhabitat differences between roosting and control sites. In addition, general information about roost utilization by Great Grey Shrikes is presented.

2. Material and methods

2.1. Study area

The study was conducted near the town of Odolanów (51°34’ N, 17°40’ E) in western Poland during the winters of 2002/03, 2003/04 and 2004/05. The study area (220 km^2) is an agricultural landscape with arable fields, meadows, pastures and small woodlots of different ages, which are occasionally connected by rows of trees. This area supports one of the densest populations of the Great Grey Shrike in both western Poland and in Europe (Tryjanowski *et al.* 1999, Antczak *et al.* 2004). This population is partly resident; i.e., some males stay in the region, all year around (Kuczyński *et al.* 2009, M. Antczak, unpubl. data). In winter, additional birds arrive in the area, probably from north-eastern parts of their breeding range, e.g., from Ukraine and Russia (Stawarczyk & Tomiałojć 2004, Kuczyński *et al.* 2009). During the fieldwork the following potential predators of Great Grey Shrike were recorded: Sparrowhawk *Accipiter nisus*, Long-eared Owl *Asio otus*, Merlin *Falco columbarius*, Red Fox *Vulpes vulpes,* Weasel *Mustela nivalis* and Polecat *Mustela putoris*. During the study period winters were mild with short periods of snow cover (up to two weeks of continuous snow cover, and no prolonged period below 0°C); moreover, the study plot is located in one of the mildest regions of Poland (Lorek 1995, Kuczyński *et al*. 2009).

2.2. Field records

The study area was surveyed for wintering Great Grey Shrikes from late November (after 25th) to mid-February (15th) because this period matches the species wintering period in Poland (Kuczyński et al. 2009, M. Antczak, unpubl. data). Winter territories and movements of birds were mapped and territory boundaries were estimated using extreme locations of birds. During each study period, intensive searches for night roosts were performed, carefully inspecting bushes and trees for accumulations of faecal material and pellets. Occasionally night roosts were found by following birds at dusk. After locating the roost, the following data were recorded: bush species, height, width and depth, distance to the nearest bush taller than 0.5 m, number of bushes and trees within a 20-m radius, and numbers of roosting sites within a given bush, estimated from accumulated droppings and pellets. The bush volume was estimated as being 0.5 × height × width × depth. A density index, comparing light intensity within and outside the bush, was calculated as (number of luxes outside the bush – number of luxes within bush)/100. Measurements of light intensity were done using a TES 1332 DIGITAL LUX METER (TES Electrical Electronic Corp. Taiwan) with range set at 2000 lux. All light-meter readings were taken at a height of 130 cm by facing north. To minimise the influence

Table 1. Micro-habitat characteristics of winter-season nocturnal roosts of the Great Grey Shrike and of control bushes in western Poland (mean ± SD), and results of two-sample randomization tests. Distance = distance from a roost to the nearest bush or tree (m), NB = number of bushes/trees within 20 m, Density = density index (see Material and methods). Height, width, depth were measured in metres, volume in m^3. All tests were significant at $p < 0.0001$.

Type	Height	Width	Depth	Volume	Distance	NB	Density	N
Roost	3.85±1.08	9.03±3.15	18.24±8.21	645.1±493.8	45.08±64.42	1.20±3.27	0.56±0.1	39
Control	2.95±0.87	4.59±1.56	7.76±5.48	134.00±167.2	8.56±11.64	2.97±1.91	0.34±0.2	39
Test statistics	–0.91	–4.43	–10.48	–510.76	–36.52	1.76	–0.21	

of changing weather conditions, the measurements were taken sequentially (within one minute) during stable cloud conditions. The same measurements were taken on control (non-roost) bushes which were selected adjacent to a north-south transect running through the territory. Although data from 212 control bushes from 24 territories were obtained, only 39 were selected at random to match the number of roost sites. Because 11 (28%) night roosts were used in more than one year during the study, data of particular roosts were included only once into the analysis to avoid pseudo-replication.

2.3. Statistical analysis

To investigate differences between microhabitat characteristics of roosts and control sites a constrained ordination method using CANOCO 4.5 (Lepš & Šmilauer 2003) was used. Because the length of the longest gradient in Detrended Canonical Correspondence Analysis (DCCA) was only 1.845, Redundancy Analysis (RDA; e.g., Lepš & Šmilauer 2003) was used. The overall significance of the multivariate analysis was tested using a Monte Carlo permutation test (MCPT) of 499 permutations (Lepš & Šmilauer 2003). Subsequently, the significance of particular microhabitat characteristics for the roost and control sites were tested using a forward selection procedure, with both manual and automatic testing, to identify the variables that best explained the variance in the data. The characteristics of control and roost sites were also compared using a two-sample randomization test with Holm's correction by using Rundom Pro3.14 software (Manly 1995, Jadwiszczak 2009).

3. Results

3.1. General roosting behaviour

The mean number of roosts per territory was 1.62 ±0.87 SD. Only single Great Grey Shrike individuals were recorded at the night-roost sites; thus solitary roosting behaviour appeared a rule in the studied population. In a few cases shrikes arrived at roosts up to one hour before dusk. Shrikes also spent some time during the day at the night roosts, especially after a series of active forages, when birds rested in the dense interiors of roost bushes. Among the 39 roosts located during the study, 11 (28%) were used in more than one year.

3.2. Tree-species composition of night roosts

Of the 39 night roosts, 35 (90%) were in willow (*Salix species*) bushes, two were in Blackthorn (*Prunus spinosa*), one was in Scots Pine (*Pinus sylvestris*) and one was in Hawthorn (*Crataegus*). The number of roosting perches significantly correlated with the total volume of the roosting bush (Spearman rank correlation; $r = 0.44$, $p = 0.03$, $n = 24$). Thirty-nine night roost and 39 control sites were compared, and there was no significant difference in species composition of roost and control bushes (chi-square test with Yates correction; $\chi^2 = 0.06$, df = 1, $p = 0.8$). As with the roosting bushes, the most common species among the control bushes was willow. Micro-habitat characteristics of roost and control bushes are given in Table 1.

Table 2. Monte Carlo tests for the significance of micro-habitat characteristics in explaining variation among roost and control bushes. Permutations were run using automatic forward selection and manual individual testing of particular variables (see text). Variables that appeared significant using both procedures are marked with bold. Test statistics show% variation explained, and *F* and *p* values for the comparison between roost and control bushes.

	Manual selection			Automatic selection		
Variable	% variation	*F*	*p*	% variation	*F*	*p*
Volume	**33.0**	**37.4**	**0.001**	**33.0**	**37.4**	**0.001**
Density index	**28.1**	**29.7**	**0.001**	**12.0**	**15.9**	**0.002**
Distance	13.8	12.1	0.001	1.0	1.59	0.205
NB	**10.1**	**8.5**	**0.003**	**4.0**	**6.5**	**0.010**

3.3. Night-roost selection

The RDA indicated significant differences between the micro-habitat characteristics of roost and control bushes. The micro-habitat characteristics (volume, density index, distance to the nearest bush, and the number of bushes within 20 m) altogether explained 50.3% of the variance in the data. The manual and automatic forward selection procedures revealed that bush volume, density index and the number of bushes within 20 m significantly explained the variance (Monte Carlo permutation test; Table 2). The distance to the nearest bush/tree was significant in individual testing ($F = 12.1$, $p = 0.001$) but did not significantly improve the overall model in the forward selection procedure (Table 2). Roosting bushes were significantly larger in height, width and depth, and consequently had a larger overall volume than had control bushes (two-sample randomisation test; Table 1). The bushes selected by shrikes also had a significantly higher density index, were significantly further away from the nearest bush/tree, and the number of bushes/trees within 20 m was lower in comparison to control bushes (two-sample randomisation test; all $p < 0.001$; Table 1, Fig. 1).

4. Discussion

Roost selection by animals has been assumed to be similar to choosing a nest site in terms of basic requirements, organization process and fitness consequences (Cody 1984). Successful survival over winter months, especially in temperate zones, might depend on various factors, including the selection of an appropriate roosting site. Decisions where to spend the night might affect winter survival in two ways. First, sleeping animals are at high risk of predation (Lima *et al.* 2005). Second, the selection of roosting sites might influence the condition of animals prior to the subsequent breeding season and thus affect their reproductive success. The Great Grey Shrike is among the earliest-breeding passerines in Central Europe (Antczak *et al.* 2004) so there is little time in spring to improve the overall condition before the reproductive season (Lorek 1995).

In the present study, the Great Grey Shrikes most frequently used willows for nocturnal roosting which is in line with results from Scandinavia (Olsson 1984, Karlsson 1997). In South-Western Finland, Karlsson (2007) distinguished two main roosting species: thick Junipers (*Juniperus communis*) and willows. Likewise, willows were also important roosts for wintering Great Grey Shrikes in North America (Atkinson 1993). In Sweden, Olsson (1984) found that Great Grey Shrikes switched roosting sites from deciduous shrubs and trees to conifers when the former began to drop their leaves. This suggests that the selection of bush or tree species might differ between geographic locations, depending on local conditions and species composition. However, the current results clearly indicate particular criteria which the night roosts should meet. In the studied population, shrikes positively selected bushes with a large overall volume and a dense structure. A possible explanation for the choice of such sites is energy saving, especially through the reduction of wind velocity (c.f. Walsberg & King 1985, Webb & Rogers 1988). Wind speed is assumed to be the main factor which increases heat loss and thermoregulatory costs. Birds roosting in sheltered locations reduce the convective heat loss in compari-

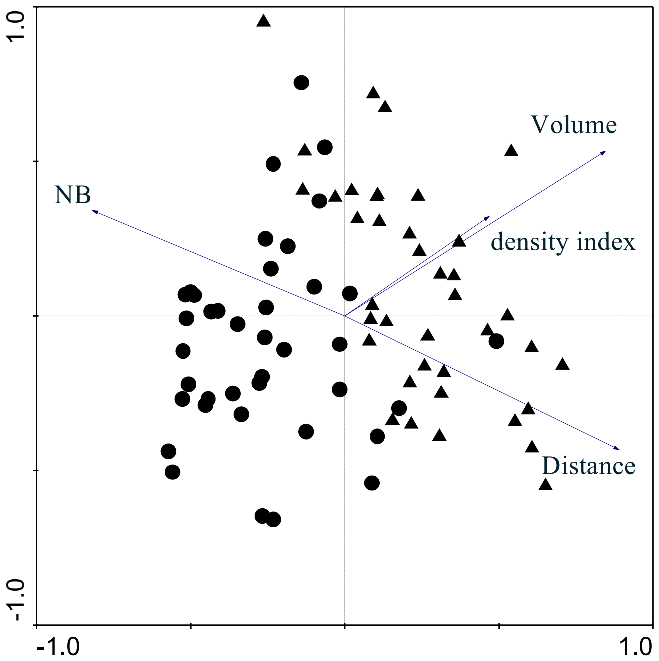

Fig. 1. Scatter plot of roost (triangles) and control bushes (circles) along gradients of environmental variables. "Distance" refers to the distance to the nearest bush or tree, "density index" refers to the local density of bushes, "NB" refers to the number of bushes and trees within 20 m from a roost or a control bush, and "volume" refers to the volume of bushes (see text).

son to unsheltered sites (Walsberg & King 1980, but see Webb & Rogers 1988, Barrentine 1992). Karlsson (2007) also noted the positive effect of wind shelter of roost sites used by shrikes.

In North America, Great Grey Shrikes roost also in bushes with a high stem density (Atkinson 1993). Indeed, large bushes offer more perches for roosting and consequently more opportunities to change perches in subsequent nights in response to particular climate conditions, such as wind direction. This pattern was confirmed in this study where the number of roosting perches in a given roost site, was positively correlated with bush volume. However, large bushes with a high density of stems might be selected for anti-predator purposes as well. Firstly, the high density of stems might provide good cover against potential predators, especially owls. Secondly, large bushes offer elevated perches that provide safety from nocturnal ground-dwelling predators, such as red foxes. Whilst the height of roosting perches within shrubs were not measured in this study, all of them were above 1.5 m (the mean height of roosting bushes was 3.85 ± 1.08 SD m), which is similar to the 1.5 m reported in North America (Atkinson 1993) and 1.8 m in Sweden (Olsson 1984). Thus, it seems that bushes with a large volume and a high stem density will fulfil two main functions of night roosts: thermoregulation and predator avoidance.

One of the most striking patterns revealed by this study is the spatial isolation of roosts from nearest other bushes and trees. This result shows that shrikes avoided clumps of bushes, confirmed by the negative correlation with the number of bushes and trees within 20 metres. These findings are in contrast to the thermoregulatory hypothesis, because wind speed and thus wind penetration should be greater in such exposed sites. So, if roosting in such sites might be unfavourable from a thermoregulatory point of view, why do shrikes choose such locations? Here, the predation avoidance hypothesis may hold. In farmland landscapes nocturnal mustelid predators mainly forage in highly heterogeneous patches, including linear habitats and large aggregations of bushes (Macdonald *et al.* 2004). Perhaps isolated bushes are less frequently visited by carnivores than are large patches of bushes. However, in the case of shrikes wintering in North America, the distance to neighbouring bushes was shorter than it was in Poland, but there, too, no night roosts were located in large aggregations of bushes. A contrasting pattern was found in South-Western Finland where the majority of roosts were located near forest edges or in small forest patches, as well as in willow bushes surrounded by reed beds (Karlsson 2007), which indicates that local conditions such as potential predators, climate, and the availability of potential roosts may vary between geographic locations.

Wintering shrikes in the present study appeared to spend short periods perching and resting during the day, in the interior of dense bushes which were used as night roosts. If raptors (mainly Sparrowhawk and Merlin) approached, these shrikes rapidly flew into dense bushes to hide. Similar behaviour in terms of daytime use of roosts and raptor response has been recorded in North America (Atkinson 1993). It seems that large and dense shrubs equate to safety, and using such sites in the course of diurnal activity might reduce the overall exposure to predators.

Great Grey Shrikes regularly impale vertebrate and invertebrate prey and cache food throughout the year (Antczak *et al.* 2005). However, the studied individuals did not cache food in roosts, although large and dense bushes in the study area are otherwise regularly used for storing food by shrikes in winter (Antczak *et al.* 2005). Shrikes in Finland, however, often impale prey in roosting sites, especially willow bushes. A possible explanation for such behaviour, proposed by Karlsson (2007), might be nocturnal feeding activity, especially important in the northern part of the species range where temperatures are more extreme and days shorter. It is possible that in the mild winter climate of western Poland, shrikes are not as stressed by weather conditions as they are in Finland, and hence locate their larders outside the night roosts. However, such behaviour might also be part of an anti-predator strategy for safe roosting. Firstly, impaled prey items, including rodents which form the bulk of the diet in wintering Great Grey Shrikes (Antczak *et al.* 2005), might produce olfactory cues that could attract potential predators, especially carnivores. Secondly, some carnivores return regularly to sites where they have successfully predated earlier, and might be potential klepto-parasites.

For wintering Great Grey Shrikes in Poland, the occurrence and density of shrikes appear governed by two main factors: meadow habitats are preferred and severe continental climate is avoided (Kuczyński *et al.* 2009). The density of shrikes on meadows was approximately twice that in arable land, and this pattern can be explained by the high availability of voles, the main winter prey of shrikes (Kuczyński *et al.* 2009). However, the specific habitat requirements for the selection of nocturnal roosting sites, revealed by the current study, support the importance of night roosting sites within wintering territories of the Great Grey Shrike. Areas located in river valleys with a high proportion of meadows and pastures with sparse but large bushes, especially Willows, might be important for wintering shrikes. Thus, the presence of potential roosts might be a key factor in habitat selection during winter for this species. Further studies should be undertaken to experimentally clarify the relative advantages of roosting sites in relation to thermoregulatory considerations, as well as how the activity of potential predators affects the distribution and utilization of roosting sites.

Acknowledgements. I would like to thank to Jana Antczak for field assistance and help during data recording. Piotr Tryjanowski, Martin Hromada, and especially Tim Sparks kindly commented on, and improved, an early version of the manuscript. Zdenek Fric and Michał Skierczyński kindly discussed the use of statistical methods. Stefan Karlsson and an anonymous reviewer provided helpful comments which substantially improved the paper.

Isolepinkäisen yöpymispaikan valinta talvikautena

Työssä tutkittiin isolepinkäisen *Lanius excubitor* yöpymispaikan valintaa maatalousmaisemassa läntisessä Puolassa talvien 2002/3 ja 2004/5 välillä. Aineisto käsitti 24 reviiriä ja 39 yöpymispaikkaa, joista pajut (*Salix*) olivat useimmin käytettyjä. Yöpymispaikkoja löytyi reviiriä kohden yhdestä neljään. Yöpymisoksien määrä pensasta kohti riippui pensaan kokonaistilavuudesta. Lepinkäiset valitsivat pensaita, jotka olivat suuria, joissa oli runsaasti oksia ja jotka olivat erillään muista pensaista tai puista. Lähiympäristömuuttujien tarkastelu viittasi siihen, että yöpymispaikat täyttivät kaksi tarkoitusta: lämmönsäätely ja saalistuksen välttäminen. Tekijöiden välillä voi kuitenkin olla hyöty–haitta -suhde, koska lepinkäiset yöpyivät nimenomaan pensaissa. Toisin kuin esim. suomalaisilla isolepinkäisillä, tutkitun populaation yksilöt välttivät saaliin keihästämistä ja varastointia yöpymispaikoillaan, mikä voi selittyä saalistuksen välttelyllä: pedot eivät voi käyttää lepinkäisen saaliita visuaalisena vihjeenä. Toisaalta maantieteel-

linen ero voi johtua ilmastotekijöistä. Yöpymispaikkojen saatavuus voi olla merkittävä elinympäristön valintakriteeri isolepinkäisille talviaikaan.

References

Antczak, M., Hromada, M., Grzybek, J. & Tryjanowski, P. 2004: Breeding biology of the Great Grey Shrike in W Poland. — Acta Ornithologica 39: 9–14.

Antczak, M., Hromada, M. & Tryjanowski, P. 2005: Spatio-temporal changes in great grey shrike *Lanius excubitor* impaling behaviour: from food caching to communication signs. — Ardea 93: 101–107.

Atkinson, E.C. 1993: Winter territories and night roosts of northern shrikes in Idaho. — Condor 95: 515–527.

Barrentine, C.D. 1992: Comparison of recapture frequencies for White-crowned Sparrows night released in preferred and marginal cover at winter roost. — North American Bird Bander 17: 140–142.

Caccamise, D.F., Reed, L.M., Romanowski, J. & Stoufer, P.C. 1997: Roosting behaviour and group territoriality in American Crows. — Auk 114: 628–637.

Chander, C.R., Katterson, E.D. & Nolan, V. Jr. 1995: Spatial aspects of roost selection in breeding male Dark Eyed Juncos. — Condor 97: 279–282.

Cody, M.L. 1985: Habitat selection in birds. — Academic Press, London.

Engel, K.A., Young, L.S., Steenhof, K., Roppe, J.A. & Kochert M.N. 1992: Communal roosting of Common Ravens in Southwestern Idaho. — Wilson Bulletin 104: 105–121.

Harris, T. & Franklin, K. 2000: Shrikes and bush shrikes. — Christopher Helm, A & B Black, London.

Hendrichsen, D.K., Christiansen, P. Nielsen, E.K., Dabelsteen, T. & Sunde, P. 2006: Exposure affects the risk of an owl being mobbed – experimental evidence. — Journal of Avian Biology 37: 13—18.

Jadwiszczak, P. 2009: Rundom Pro 3.14. Software for classical and computer-intensive statistics available free from the New Rundom Site. — URL: www.pjadw.tripod.com.

Karlsson, S.1997: Winter-time behaviour of the great grey shrike in SW-Finland in 1992–1997. — Linnut 6: 4–10. (In Finnish with English summary.)

Karlsson, S. 2007: Food consumption and roosting behaviour of great grey shrike *Lanius excubitor* wintering in south-western Finland. — Ornis Fennica 84: 57–65.

Korhonen, K. 1980: Microclimate in the snow burrows of willow grouse (*Lagopus lagopus*). — Annales Zoologici Fennici 17: 5–9.

Körtner, M. & Geiser, F. 1999: Roosting behaviour of the tawny frogmouth. — Journal of Zoology (London) 248: 501–507.

Kuczyński, L., Rzępała, M., Goławski, A. & Tryjanowski, P. 2009: The wintering distribution of Great Grey Shrike in Poland: predictions from large-scale historical survey. — Acta Ornithologica 44: 159–166.

Lefranc, N. & Norfolk, T. 1997: Shrikes. A guide to the shrikes of the World. — Pica Press, Sussex.

Lepš, J. & Šmilauer, P. 2003: Multivariate Analyzes of Ecological Data using CANOCO. — Cambridge University Press.

Lima, S.L., Rattenborg, N.C., Lesku, J.H. & Amlaner, C.J. 2005: Sleeping under the risk of predation. — Animal Behaviour 70: 723–736.

Lorek, G. 1995: Breeding status of the great grey shrike in Poland. — Proc. West. Found. Verteb. Zool. 6: 98–104.

Macdonald, D.W., Tew, T.E. & Todd, I.A. 2004: The ecology of weasels (Mustela nivalis) on mixed farmland in southern England. — Biologia Bratislava 59: 235–241.

Manly, B.F. 1995: Randomization tests to compare means wit unequal variation. — Sankhya: The Indian Journal of Statistics 57: 200–222.

Marjakangas, A. 1990: A suggested antipredator function for snow-roosting in the black grouse *Tetrao tetrix*. — Ornis Scandinavica 21: 77–78.

Odum E.P. & Pitelka, F.A.1939: Storm mortality in winter starling roost. — Auk 56:451–455.

Olsson, V. 1984: Varfågelns *Lanius excubitor* vintervanor. Del I. Biotop. [The winter habits of the Great Grey Shrike *Lanius excubitor*. 1. Habitat.] — Vår Fågelvärld 43: 113–124. (In Swedish with English summary.)

Pinowski, J.,Pinowska, B., Chernetsov, N., Romanowski, J. & Sierakowski, K. 2008: Nest construction during autumn display and winter roosting in the Tree Sparrows *Passer montanus.* — Acta Ornithologica 43: 185–195.

Pitts, T.D. 1976: Fall and winter roosting habits of carolina chickadees. — Wilson Bulletin 88: 603–610.

Sunde, P., Břlstad, M.S. & Desfor, K.B. 2003: Diurnal exposure as a risk sensitive behaviour in tawny owl *Strix aluco*? — Journal of Avian Biology 34: 409–418.

Stawarczyk, T. & Tomiałojć, L. 2004: Birds of Poland. The avifauna of Poland. Distribution, numbers and trends. — PTPP. Wrocław.

Thompson, F.R. & Fritzell, E. K. 1988: Ruffed grouse winter roost site preference and influence on energy demands. — Journal of Wildlife Management. 52: 456–460.

Tryjanowski, P., Hromada, M, & Antczak, M. 1999: Breeding habitat selection in the Great Grey Shrike *Lanius excubitor* – the importance of meadows and spring crops. — Acta Ornithologica 34: 59–63.

Walsberg, G.E. & King, J.R. 1980: The thermoregulatory significance of the winter roosts selected by robins in eastern Washington. — Wilson Bulletin 92: 33–39.

Webb D.R. & Rogers, C.M. 1988: Nocturnal energy expenditure of dark-eyed juncos roosting in Indiana during winter. — Condor 90: 107–112.

Yap, C.A.M., Sodhi, N.S. & Brook, B.W. 2002: Roost characteristics of invasive mynas in Singapure. — Journal of Wildlife Management 66: 1118–1127.