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Food preferences by birds using bird-feeders in winter: a large-scale experiment

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Abstract

Background: Intentional winter bird feeding in gardens is one of the most common interactions between birds and humans. Because feeding may have both desired effects (provisioning of nutritious food for under-nourished birds) and undesired effects (favouritism of competitively superior species, transmission of disease), management of supplementary sites should be optimized from an ecological and conservation perspective. Therefore, the main aim of this study was to experimentally test winter food preferences of birds, with underlying potential influence of habitat (rural vs. urban) on realised food preferences pattern.

Methods: We conducted an experimental analysis of food preferences of wintering birds by provided bird-feeders in urban and rural environments across Poland. Data were collected twice during winter 2013–2014 across Poland, in total with 80 experimental trials.

Results: Sunflower seeds were the most preferred food supplement both in urban and rural habitats, significantly more exploited than any other food simultaneously available in feeders (animal fat, millet seed and dry fruits of rowanberry). However, no significant differences were recorded between urban and rural habitats in use of food.

Conclusions: The degree of use of a particular type of food at bird-feeders depended on the overall use of food in a bird-feeder—consumption of each of the four types of food was significantly positively correlated with that of the others, and it was positively correlated with the number of birds observed at the feeders.

Keywords: Bird, Food preferences, Human–animal interactions, Supplementary food, Winter

Background

Bird-feeders are ubiquitous across the globe, but are mainly used in the temporal zone, with vast quantities of food and other resources being provided for birds (Robb et al. 2008; Orros and Fellowes 2015), also providing an important tool for improving knowledge on birds for people, thereby connecting humans to nature (Cox and Gaston 2015). Generally, people support birds with food in winter not only for conservation purposes, but also for aesthetic reasons, and most providers of food would like to know what is the most preferred food (Lott 1988; Cox and Gaston 2015) to attract more birds (Cowie and Hinsley 1988; Galbraith et al. 2014, 2015; Cox and Gaston 2015). Feeding birds is probably among the most popular animal-human interactions (Jones and Reynolds 2008), and producing and selling bird food is still an increasing market (Buczacki 2007; Jones and Reynolds 2008). On the one hand, estimating the cost of provided food is crucial for calculating recreational and psychological ecosystem services provided by birds (Cowie and Hinsley 1988; Ratcliffe et al. 2013). Provided food to birds differs not only in price, caloric value and attractiveness to birds, what is best recognised by human supported birds, but also remaining (unconsumed) food may endanger bird health (Wilcoxen et al. 2015). This is due to feeders accumulating faeces and pathogenic microorganisms that pose a threat to birds.

However, birds use bird-feeders during critical periods like winter, because birds are like other animals strongly

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resource-limited, and provisioning of feeders plays a significant role as a determinant of important life-history traits such as survivorship, phenology and fecundity (Robb et al. 2008). Recent studies carried out in Poland have shown that population density of urban birds has more than doubled compared to that of rural birds (Tryjanowski et al. 2015a), and one reason is supplementary birds feeding by people. Bird-feeders are particularly commonly exploited in urban habitats and in areas where feeders are already available. However provisioning of bird-feeders even in rural habitats has become more popular in recent decades (Ockendon et al. 2009; Tryjanowski et al. 2015b). Moreover, it has been suggested that rural and urban populations of particular bird species differ in consumed food resources (Gavett and Wakeley 1986; Krystofková et al. 2011; Von Post et al. 2013). This raises the question whether increasingly more different kinds of food are consumed by birds in urban compared with rural habitats? An answer to this question has practical consequences, because food provisioning increases the fat load of birds with increased cost of flight and risk of predation among birds in winter (Goławski et al. 2015).

The aim of this study was to test food preferences of birds experimentally during winter, with underlining potential influence of habitat (rural vs. urban) of realised food preferences. Because a particular study site could influence the findings, we conducted an experimental study at a large geographical scale, collecting data using the same protocol across study sites. Finally, we discuss the importance of particular kinds of popular food types used in the temperate zone to attract birds in winter.

Methods

Field study

Data were collected twice during winter, in the period 22 December 2013–18 February 2014 in 14 cities (Fig. 1) across Poland and urban sites were matched (up to a distance of 20 km) with a nearby rural area (Tryjanowski et al. 2015c). The site for a replicate of an experiment was chosen randomly, but always in a paired design with bird-feeders in rural and nearby urban habitats, in each habitat 40 trials. To minimize switch of birds between particular bird-feeders, experimental trials were performed at a distance of at least 1500 m between study sites.

Each bird-feeder contained at the bottom four trays (changed randomly for each trial) with four different kinds of food (containing carbohydrates and lipids) popular during winter bird feeding in Poland (Tryjanowski et al. 2015a): tallow—animal (domestic pig *Sus scrofa* f. *domestica*) fat, sunflower seeds (*Helianthus annuus*, variety black-oil in the shells), millet seeds (a native species *Panicum miliaceum*) and dry fruits of rowanberry (*Sorbus aucuparia*).

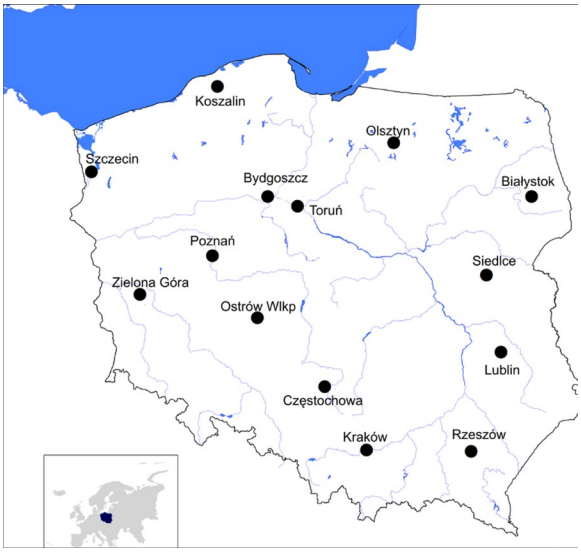

Fig. 1 Location of the study areas

Because we attempted to make each food type equally visible, each food substrate (provided in a separate drawer with 1.5 cm walls), covered 25% of the bottom area of the bird-table at the beginning of the experiment. Identical bird-feeders were used in all trials across the entire country. Each feeder that has the shape of a small house with a roof (see photo in Tryjanowski et al. 2015c) was used in all experiments. The size of bird-feeders was as following: height 27 cm, width 35 cm, and length 25 cm. This type of bird-feeder is the most popular in Poland, both in urban and rural areas, and typically attracts small and medium-size birds (up to Blackbird *Turdus merula*) wintering in garden (Tryjanowski et al. 2015a). The bird-feeder was placed on top of a 1.20 m tine wooden pole, to avoid mammals, such as Domestic Cats (*Felis catus*) that sometimes visit feeders especially during night. However, observations and use of photo-traps in this experiment did not reveal any mammalian predators at the bird-feeder. The pole with the feeder was dug into the ground (grass/soil) and provided in the evening (after the end of daily activity of the birds, after 6:00 p.m. local time). We also recorded the number of already existing bird-feeders within a 100 m radius, and ambient temperature (in °C) was recorded at the start of each experimental trial. The number of already existing bird-feeders in the vicinity of experimental points ranged from 0 to 17 (mean ± SD = 1.3 ± 2.7).

After a 48-h trial of each bird-feeder in a particular place, the remainder of the food was dried, and weighed in the laboratory and the consumed food was expressed as percentage of consumed food of a particular type. Food displaced from each feeder and on the ground was

minimal, containing mainly husks, was not used in the subsequent analyses.

Statistical analyses

For each of the 80 experimental trails, we calculated the percentage of food eaten from each category: animal fat, sunflower, rowanberry and millet. In the analyses, the obtained values for each trail were treated as "dependent measurements". Because of very diverse distributions of the dependent variables that also significantly differed from normal distributions (Fig. 2), the possible differences among groups and significance of correlations were tested using nonparametric statistics. Bonferroni correction was applied to adjust alpha values for the increased probability of obtaining statistical significance from multiple testing.

Results

In total 14 and 11 bird species were recorded at the bird-feeders in urban and rural habitats, respectively. The most numerous species recorded in both kinds of habitat was the Great Tit (*Parus major*) that constituted respectively 71.5% and 74.9% of the bird communities, respectively (Table 1).

The distributions of percent of food eaten from each of the four categories are presented in Fig. 2. The choice of food in both types of habitat differed significantly (Friedman ANOVA, urban: $\chi^2 = 70.49$, df = 3, $n = 40$, $p < 0.001$; rural: $\chi^2 = 58.52$, df = 3, $n = 40$; $p < 0.001$; Fig. 3). Sunflower seeds were the most preferred kind of food both in urban and rural habitats, significantly more exploited than any other food simultaneously available in the feeders (multiple comparisons within urban and rural habitat using Wilcoxon matched-pairs test, in both cases $p < 0.001$, Fig. 3). No differences in consumption of each kind of food available in the bird-feeders between the compared habitats were recorded (multiple comparisons using Mann–Whitney *U* test, in all cases $p > 0.2$; Fig. 3).

The degree of use of a particular type of food at bird-feeders depended on the overall use of food in the bird-feeder—each of the four types of food was significantly and positively correlated with that of the others (r_s in Spearman rank-order correlations ranged between 0.60–0.71, and all

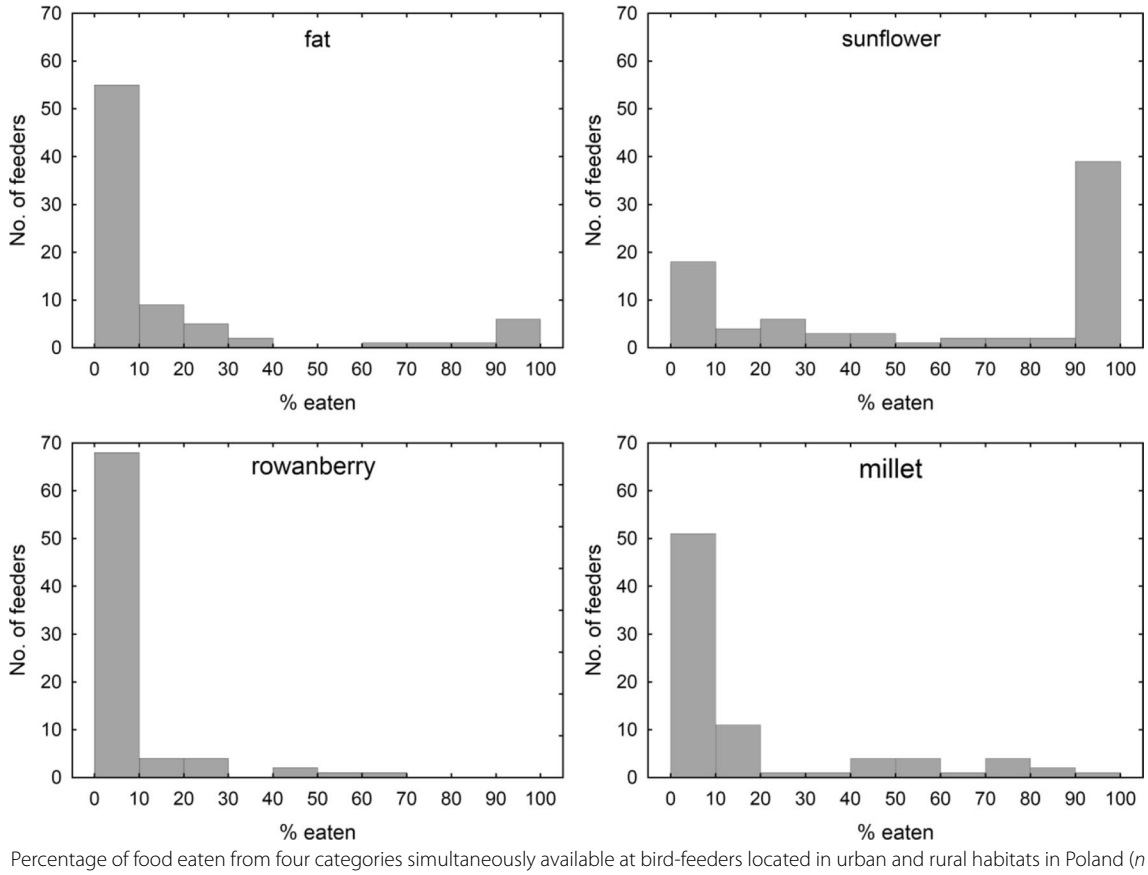

Fig. 2 Percentage of food eaten from four categories simultaneously available at bird-feeders located in urban and rural habitats in Poland ($n = 80$). Note that all sites were pooled

Table 1 Species recorded at bird-feeders in urban and rural habitats (all 80 sites were pooled)

No.	Species	Urban area		Rural area	
		No. of observations	%	No. of observations	%
1	*Parus major*	358	71.5	305	74.9
2	*Chloris chloris*	76	15.2	0	0.0
3	*Cyanistes caeruleus*	29	5.8	38	9.3
4	*Coccothraustes coccothraustes*	16	3.2	2	0.5
5	*Pica pica*	5	1.0	2	0.5
6	*Corvus monedula*	4	0.8	0	0.0
7	*Passer montanus*	3	0.6	18	4.4
8	*Garrulus glandarius*	2	0.4	7	1.7
9	*Sitta europea*	2	0.4	11	2.7
10	*Streptopelia decaocto*	2	0.4	1	0.2
11	*Turdus merula*	1	0.2	1	0.2
12	*Passer domesticus*	1	0.2	5	1.2
13	*Carduelis spinus*	1	0.2	17	4.2
14	*Poecille palustris*	1	0.2	0	0.0
	Totals	501	100.0	407	100.0

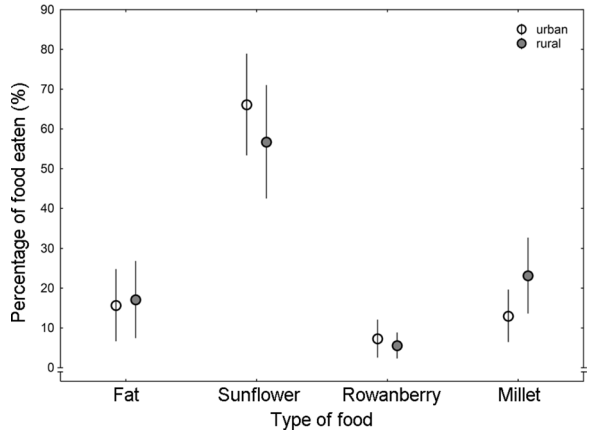

Fig. 3 Differences in preferences for selected types of food by birds using feeders in urban ($n=40$) and rural ($n=40$) habitats in Poland; mean values are presented with 95% confidence limits

coefficients were significant even after Bonferroni corrections at $p<0.001$, in each case $n=80$). The average use of each type of food in the particular bird-feeder during an experiment was 25.5% (95% CI 20.8–30.2; $n=80$), and the total amount of food consumed was positively correlated with the number of birds observed at the feeders (Spearman correlation, $r=0.64$, $n=80$, $p<0.001$). However, it was not related to the number of other feeders located in the vicinity of out experiment and with air temperature (Spearman correlation respectively $r=0.19$ and $r=-0.09$, in both cases $p>0.1$).

Discussion

In this study, we provide one of the first pieces of evidence on wintering bird food preferences across wide geographical ranges. We expressed this using the four widely used different kinds of food at bird feeders in urban and rural habitats during winter, at least in Poland (Tryjanowski et al. 2015b). Our methods, although experimental, are limited. We used an equal availability of four types of food that differ in size, weight and form of the items. We can imagine the situation, when the food items are taken one by one (as is the case for separate items like seeds), and the food items differ in size, the same area would be covered by different numbers of these items (e.g. millet seeds vs. sunflower). In the end, depletion of smaller items would be underestimated, while larger ones overestimated, and food preferences estimated on that basis are clearly biased. Birds preferred sunflower seeds over the three other categories of food, even though sunflower is not a native plant species in Europe (Carney et al. 2000). Therefore, this suggests rapid adaptation to food availability over ca. 50 generations to new food sources. Birds had similar preferences and levels of food consumption at bird-feeders in rural and urban habitats. A high preference of one type of food, in case of our study introduced sunflower, is similar to a finding obtained in USA showing that House Sparrows (*Passer domesticus*) preferred millet over seeds of native prairie forbs and grasses (Whelan et al. 2015). Sunflower is also a key component in mixtures of food for birds sold commercially (Buczacki 2007; Orros and Fellowes 2015). Hence, birds exploit this type of food, especially in the vicinity

of human settlements. The food preferences obviously depend on species, and in our case the main dominant species was the Great Tit, and perhaps that is the reason for so clear preferences for sunflower seeds. Many birds prefer to grab a food item and take it away to cover for eating (Tvardíková and Fuchs 2012), so selection might be influenced by food item size. Sunflower seed may be preferred simply because it can be removed from a feeder and taken elsewhere for consumption.

Consumption of different food types was strongly positively correlated, and this pattern of consumption shows that if birds discover a bird feeder, they may exploit all food types available to them at the feeder (Ockendon et al. 2009; Tryjanowski et al. 2015a, b). Moreover, when the preferred food is depleted (as in this study, sunflower seeds) birds foraged on alternative sources. This is understandable because different bird species may provide information about the locations of bird-feeders to other birds in the winter community, and this may stimulate foraging on different food types (Cowie and Hinsley 1988; Dunn and Tessaglia-Hymes 2001; Wojczulanis-Jakubas et al. 2015).

Conclusions

The study has shown that sunflower seeds are preferred over three other types of food provided at bird feeders, and sunflower can be successfully used to feed birds during winter. However, as previously observational studies indicated, sunflower is used only by a limited number of species (known as typical users of bird feeders, especially finches and tits, Tryjanowski et al. 2015b), but to attract other species (like thrushes and corvids, and even sparrows) it is better to use a combination of different kinds of food.

Authors' contributions

All authors made substantial contributions to conception and design, analysis and interpretation of data. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Consent for publication

Not applicable.

Ethics approval and consent to participate

The studies were carried out in accordance with the approved guidelines and Polish National Law.

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