

Dietary composition of Common Wood pigeon (*Columba palumbus*) in Bulgaria

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Abstract

Common Wood pigeon (*Columba palumbus* L., 1758) is a widespread species in Europe including Bulgaria, with increasing population trend. Understanding its diet is essential for assessing its ecological role and predicting responses to habitat changes. This study examines the feeding spectrum in autumn and winter of the species in Bulgaria based on crop content analysis of 54 specimens collected from 11 hunting areas between 2022 and 2024. A total of 21 dietary components were identified, including 17 plant and 4 animal taxa. The primary food resources were sunflower seeds, maize, and acorns, with seasonal variations in diet composition. The study confirms the opportunistic feeding behaviour of the Wood pigeon, influenced by food availability. While cereals and acorns remain staple components, molluscs and insects played a minor role. These findings contribute to a better understanding of the species' feeding habits in Bulgaria and provide a basis for future ecological and conservation research.

Key words: acorns, crop damage, human-wildlife conflict, seeds.

Introduction

Common Wood pigeon (*Columba palumbus* L., 1758) is naturally distributed throughout Europe, parts of Western Asia and Northern Europe, including Bulgaria (BirdLife International 2018). It falls into the category of Least Concern with a growing population according to IUCN criteria (BirdLife International 2018). The European population is estimated to be between 20.5 and 29 million pairs and accounts for 80 % of the global population of the species (BirdLife International 2018). The expansion of agriculture in the 19th century contributed to the species' increasing number (Marchant et al. 1990). This also led to an increase in suburban and urban areas (Slater 1995, Sakhvon and Kövèr 2020). Today, the Wood pigeon is a common species in many European cities with high density of? (Bea et al. 2011, Zbyryt 2014). Urban populations are increasing across Europe, with observed differences in nest-site selection (Gil et al. 2024). The species is among the most frequently recorded birds in urban areas of Mediterranean cities during the summer (Luna and Blanch 2024). During this process of synanthropization, habitat use changes compared to that in rural areas (Frey et al. 2015). The growth of urban Wood pigeon population has been associated with the absence of nest predators, adaptation to human-related food resources, and access to open agricultural land within the species' economic range (Frey et al. 2015, Tomiałojć 2021). In the period 2005–2010, the species had an increasing population in Bulgaria (Spasov et al. 2017). According to a twenty-year study of widespread bird's species, it is also classified as a species with an increasing population trend (Hristov et al. 2023). Wood pigeon is considered a widespread species,

found in forest, shrub and anthropogenic habitats (Baptista et al. 1997). Since the mid-1970s, the increase of its population has been associated with the introduction of oilseed rape (*Brassica napus* L.) as a widespread field crop. At the end of the last century, the species has already been defined as an agricultural pest in some parts of its range (Inglis et al. 1994, 1997).

Determining the diet of a species is important for many population aspects and its management. Food resources directly affect the distribution and breeding potential (Mengesha and Bekele 2008, Ruffino et al. 2014, Sam et al. 2017). Reduced food availability during winter can directly affect the survival of adult birds and subsequently affect breeding potential (Danner 2012, Plummer et al. 2013). Reduced food availability during the breeding season can directly affect breeding success (Brinkhof and Cavé 1997). The leading food components in the Common Wood pigeon diet are seeds, fruits and leaves (Ó hUallachain and Dunne 2013, Gutiérrez-Galán et al. 2017). The season, the study area and the type of crops grown in the agricultural lands have a great influence on its food spectrum (Ó hUallachain and Dunne 2013). During the spring – summer season, the main share of the species' food is occupied by wheat seeds, supplemented with sunflower seeds in the autumn. In winter, the main share is occupied by acorns (Purroy et al. 1984, Jimenez et al. 1994, Kaouchi et al. 2021). In Bulgaria, the food spectrum has been poorly studied, and from 28 stomachs studied, mainly Hawthorn (*Crataegus monogyna* Jacq.), Dog rose (*Rosa canina* L.), Sloe (*Prunus spinosa* L.), and oak and beech acorns, weeds (Simeonov et al. 1990) were found. In the last two decades, the food has not studied in Bulgaria.

The aim of this study is to present

novel insights into the autumn-winter diet of the Common Wood pigeon (*Columba palumbus* L.) in Bulgaria, in order to enhance our understanding of its ecological requirements and adaptive strategies in response to habitat alternations.

Materials and Methods

Between September 2022 and December 2024, we analysed the crops of 54 Wood pigeons collected from eleven hunting areas (Fig. 1). The collected samples for analysis were obtained from hunting grounds located within the species' natural range in Bulgaria, outside of human settlements. The habitats in the sampling areas primarily consist of lowland deciduous forests, adjacent to various types

of agricultural land, which provide a diverse range of food resources. The relief is predominantly flat, primarily occupied by arable land. The main cultivated crops include maize, wheat, sunflower, and barley. Forest habitats are represented by small lowland broadleaf woodlands and scattered patches of conifer plantations, mainly Scots pine (*Pinus sylvestris* L.) and black locust (*Robinia pseudoacacia* L.). The lowland broadleaf forests are predominantly composed of Turkey oak (*Quercus cerris* L.) and Oriental hornbeam (*Carpinus orientalis* Mill.), occasionally interspersed with Manna ash (*Fraxinus ornus* L.). Another type of broadleaf forest typical of the region consists of mixed stands of Turkey oak and *Quercus virgiliana* Ten. Additionally, mixed forests composed of Silver linden (*Tilia tomentosa*

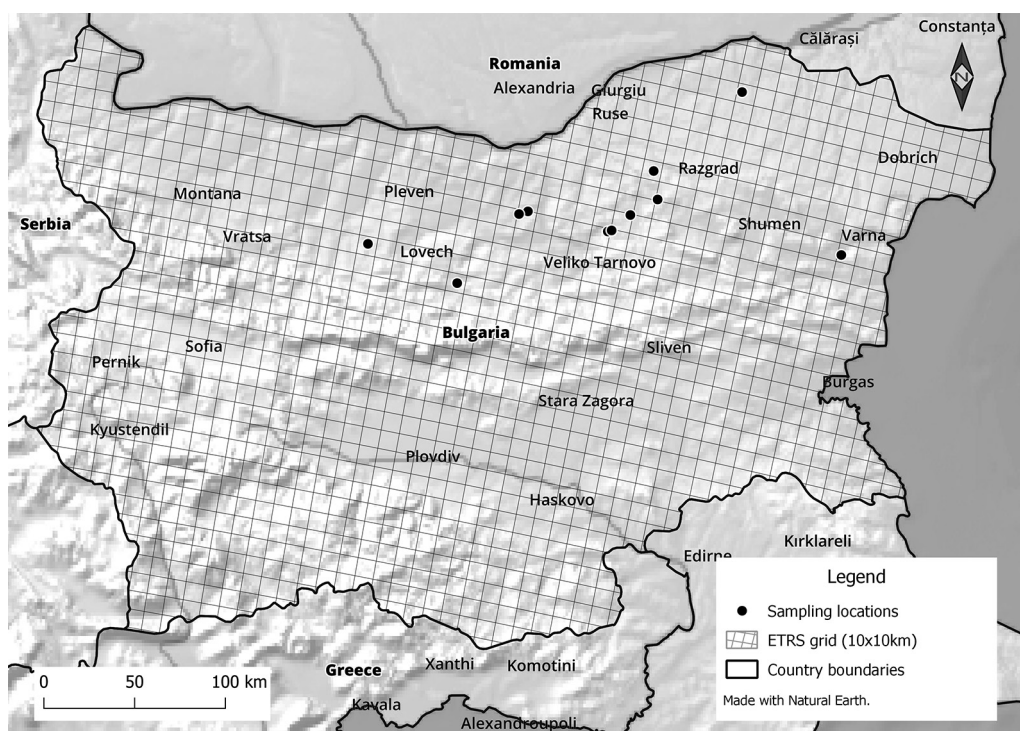


Fig. 1. Wood pigeon sampling areas during the period 2022–2024.

Moench) and European hornbeam (*Carpinus betulus* L.) are represented, as well as silver linden mixed with Turkey oak, occasionally accompanied by Hungarian oak (*Quercus dalechampii* Ten.) and Field maple (*Acer campestre* L.). A small part of the studied quadrants is occupied by pastures, which are characterised as xerothermic grassland formations, dominated by plant communities *Dichanthietum ischaemi* Knapp ex Oberd. 1954, *Poaetum bulbosae* and *Poaetum concinnae* Soó 1964, *Chrysopogoneta grylli* Horvat 1951, and ephemeral communities (*Ephemeret*) (Bondev 1991).

All specimens were obtained during regular hunting trips in September 2022, September-December 2023, and January 2024. The contents of each crop were extracted, sorted by species, and air-dried for two weeks. Each fraction was then weighed using an electronic scale with an accuracy of 0.001 g (KERN PLJ-N (KERN & Sohn GmbH)). The dietary components were categorised into plant, animal, and inorganic matter. Plant material was identified using a LEICA EZ4 W trinocular stereoscope and a reference collection. Additionally, the identification keys of Franke et al. (1979), Chepik (1981), and Artjuschenko and Teodorov (1986) were used. For acorns, the identifier, according to the

key by Schwartz (1937), was also used.

The snail species were identified by D. Georgiev using the author's reference shell collection. The significance of each dietary component was calculated using the formula (1) (Mihaylov 1995).

$$\text{Significance} = \frac{\% \text{ occurrence} \cdot \% \text{ weight}}{\sum (\% \text{ occurrence} \cdot \% \text{ weight})}, \% \quad (1)$$

where: % occurrence – the percentage of crops containing the given dietary component; % weight – the mean weight of the given component relative to the average total crop content.

The percentage contribution of food items was calculated so that the data can be compared with these of previous studies (Murton et al. 1964, Ó hUallachain and Dunne 2013, Gutiérrez-Galán et al. 2017, Luna et al. 2024).

Results

A total of 21 dietary components were identified, including 17 of plant and 4 of animal origin. Sunflower seeds had the highest occurrence rate (47.7 %), while maize seeds had the highest significance percentage (31.3 %), followed by acorns from various oak species (29.1 %) (tables 1 and 2).

Table 1. Taxonomic composition of dietary components identified in the crop contents of Wood pigeons.

No	Food spectrum	Family	Order
Tree species			
1	Silver birch (<i>Betula pendula</i> Roth.)	Betulaceae	Fagales
2	Hungarian oak (<i>Quercus frainetto</i> Ten.)	Fagaceae	Fagales
3	Downy oak (<i>Quercus pubescens</i> Willd.)	Fabaceae	Fabales
4	Black locust (<i>Robinia pseudoacacia</i> L.)	Fabaceae	Fabales
5	Undetermined species Fabaceae	Fabaceae	Fabales
6	Willows (<i>Salix</i> sp.)	Salicaceae	Malpighiales

No	Food spectrum	Family	Order
Shrub species			
1	Roses (<i>Rosa</i> sp.)	Rosaceae	Rosales
2	Common ivy (<i>Hedera helix</i> L.)	Araliaceae	Apiales
3	Undetermined fruit	N/A	N/A
Grass species			
1	Centaury (<i>Centaurea</i> sp.)	Asteraceae	Asterales
2	Barnyard grass (<i>Echinochloa crus-galli</i> (L.) P.Beauv.)	Poaceae	Poales
3	Common knotgrass (<i>Polygonum aviculare</i> L.)	Polygonaceae	Caryophyllales
4	Hairy vetch (<i>Vicia villosa</i> Roth)	Fabaceae	Fabales
5	Alfalfa (<i>Medicago sativa</i> L.)	Fabaceae	Fabales
6	<i>Polygonum</i> sp.	Polygonaceae	Caryophyllales
7	Undetermined cereal grasses	Poaceae	Poales
8	Undetermined grass	N/A	N/A
Agricultural crops			
1	Sunflower (<i>Helianthus annuus</i> L.)	Asteraceae	Asterales
2	Common Wheat (<i>Triticum aestivum</i> L.)	Poaceae	Poales
3	Maize (<i>Zea mays</i> L.)	Poaceae	Poales
4	Common oat (<i>Avena sativa</i> L.)	Poaceae	Poales
5	Common barley (<i>Hordeum vulgare</i> L.)	Poaceae	Poales
Snails			
1	<i>Morlina glabra</i> Rossmassler, 1835	Oxychilidae	Stylimmatiohora
2	<i>Pomatias rivularis</i> Eichwald, 1829	Pomatiidae	Littorinimorpha
3	Species Hygromiidae 1	Hygromiidae	N/A
4	Species Hygromiidae 2	Hygromiidae	N/A
5	Undetermined species Mollusca	N/A	N/A
Insects			
1	Unidentified insects	N/A	N/A
Inorganic component			
1	Gastroliths		
2	Soil		
3	Cable insulation		

Note: Unidentified species Hygromiidae 1 and 2 are species in this family but they were not identified to species taxon. The last 3 rows of the table contain empty columns for family and order because inorganic parts are not classified this way.

Table 2. Frequency, mean weight, and relative nutritional importance of food items identified in the crop contents of Wood pigeons.

No	Food spectrum	Occurrence, %	Mean weight, g	Significance, %
1	Black locust (<i>Robinia pseudoacacia</i> L.) – seeds	6.8	0.048	0.570
2	Hungarian oak (<i>Quercus frainetto</i> Ten.) – acorns	9.1	12.021	18.947

No	Food spectrum	Occurrence, %	Mean weight, g	Significance, %
3	Downy oak (<i>Quercus pubescens</i> Willd.) – acorns	6.8	8.558	10.117
4	Other oaks (<i>Quercus</i> sp.) – acorns	2.3	0.226	0.089
5	Willows (<i>Salix</i> sp.) – seeds	2.3	0.003	0.001
6	Ivy (<i>Hedera helix</i> L.) – fruit	6.8	1.265	1.495
7	Ivy (<i>Hedera helix</i> L.) – leaf	2.3	0.010	0.004
8	<i>Rosa</i> sp. – fruit	2.3	0.610	0.240
9	Centaury (<i>Centaurea</i> sp.) – leaf	2.3	0.000	0.000
10	Barnyard grass (<i>Echinochloa crus-galli</i> (L.) P. Beauv.) – seeds	2.3	0.729	0.287
11	Knotgrass (<i>Polygonum aviculare</i> L.) – seeds	2.3	0.180	0.071
12	Hairy vetch (<i>Vicia villosa</i> Roth) – seeds	2.3	0.208	0.082
13	Cereal grasses – leaf	20.5	0.037	0.131
14	Undetermined grass – leaf	31.8	0.041	0.226
15	Sunflower (<i>Helianthus annuus</i> L.) – seed husks	4.5	0.014	0.011
16	Sunflower (<i>Helianthus annuus</i> L.) – leaf	2.3	0.004	0.002
17	Sunflower (<i>Helianthus annuus</i> L.) – seeds	47.7	3.258	26.960
18	Common wheat (<i>Triticum aestivum</i> L.) – leaf	2.3	0.030	0.012
19	Common oat (<i>Avena sativa</i> L.) – seed husks	2.3	0.000	0.000
20	Common barley (<i>Hordeum vulgare</i> L.) – seed husks	2.3	0.000	0.000
21	<i>Polygonum</i> sp. – seeds	2.3	0.009	0.004
22	Alfalfa (<i>Medicago sativa</i> L.) – leaf	20.5	0.051	0.181
23	Common wheat (<i>Triticum aestivum</i> L.) – seeds	20.5	2.598	9.214
24	Maize (<i>Zea mays</i> L.) – seeds	22.7	7.952	31.335
25	<i>Morlina glabra</i> Rossmassler, 1835	2.3	0.012	0.005
26	<i>Pomatias rivularis</i> Eichwaid, 1829	2.3	0.021	0.008
27	unidentified Fabaceae – leaf	2.3	0.021	0.008
28	Unidentified snail 1	2.3	0.026	0.010
29	Unidentified snail 2	2.3	0.005	0.002
30	Unidentified snail 3	2.3	0.025	0.010
31	Unidentified snail 4	2.3	0.000	0.000
32	Unidentified snail 5	2.3	0.013	0.005
33	Unidentified insects 1	2.3	0.000	0.000
34	Unidentified insects 2	2.3	0.000	0.000
Inorganic components				
35	Gastroliths	15.9	0.114	0.314
36	Soil	9.1	0.107	0.169
37	Cable insulation	2.3	0.000	0.000
Undetermined				
38	Unidentified fruit 1	2.3	0.012	0.005
Mean				2.632

Note: The unidentified snails and insects indicated by numbers 1, 2, etc., are of different species, but due to remnants of shell parts, they could not be identified.

The animal component of the Wood pigeon's diet included several snails (Molluscs) species, of which only two were identified: *Morlina glabra* and *Pomatias rivularis*. However, their contribution to the overall diet was minimal.

Discussion

This study identified 16 food species in the diet of the Wood pigeon during the autumn-winter period. An additional 11 food components remained unidentified (Table 1). The results indicate that the primary food sources are seeds from various agricultural crops and acorns from different oak species.

The diet of the Wood pigeon has been relatively well studied across most of its range, with plant species forming the bulk of its food intake. However, significant variations in species composition occur depending on the availability and accessibility of specific food sources (Glutz von Blotzheim et al. 1986). Recent studies have shown that in some parts of Ireland, beech acorns are the dominant food source, whereas in southern Spain, oak acorns are the most commonly consumed (Ó hUallachain and Dunne 2013, Gutiérrez-Galán et al. 2017). Our findings support previous research highlighting the importance of acorns in the Wood pigeon diet (Table 2). In this study, acorns were among the most significant food sources, playing a major role in the winter diet (Purroy et al. 1984, Jimenez et al. 1994).

In Algeria, studies have found that seeds from the genera *Oxalis*, *Hordeum*, and *Triticum*, among others, contribute significantly to the diet (Guezzoul et al. 2004, Merabet et al. 2014). Further research in Eastern Algeria has identified a

variety of food sources, including Juniper berries (*Juniperus communis* L.), Cork oak (*Quercus suber* L.), Holm oak (*Quercus ilex* L.), Algerian oak (*Quercus canariensis* Willd.), Aleppo pine (*Pinus halepensis* Mill.), White willow (*Salix alba* L.), olive (*Olea* sp.), as well as ash seeds, weeds, cereals, oats, clover, wheat, and barley (Kaouachi et al. 2021).

Naturally, the Wood pigeon's diet varies across seasons, reflecting fluctuations in food availability and diversity (Glutz von Blotzheim et al. 1986, Ó hUallachain and Dunne 2013). However, cereals, acorns, and various tree fruits remain staple food sources throughout most of the year (Gutiérrez-Galán et al. 2017, Fazekas 2023). These findings are further confirmed by the present study (Table 2). Previous research in southern Europe has highlighted the importance of cereal seeds such as wheat, barley, and sunflower, particularly in late summer. Bioclimatic differences within the Wood pigeon's range also contribute to dietary variations across habitats. For instance, while sunflower seeds form a significant part of the species' diet in southern Spain (Jimenez et al. 1994), they are consumed less frequently in central Europe (Ó hUallachain and Dunne 2013). In the present study, sunflower seeds were notably prevalent in the diet (Table 2). However, it should be noted that part of the data collection period coincided with the sunflower harvest. This seasonal factor likely influenced the observed high consumption, as Wood pigeons tend to gather in areas with abundant food resources, supporting the idea that they opportunistically exploit widely available food sources.

Despite this, the results reinforce the importance of cereals, which remain a staple component of the Wood pigeon's diet, consistent with findings from other stud-

ies (Jimenez et al. 1994, Gutiérrez-Galán et al. 2017). Alfalfa leaves had an occurrence of 20.5 % in our study but showed low dietary significance (0.18 %) (Table 2). This low significance is likely attributed to the season in which the study was conducted. Similar studies have reported high consumption of species from the genera *Trifolium* and *Medicago*, with their contribution reaching 44.2 % in spring and an average of 12.7 %. Clovers (*Trifolium* sp.) can constitute up to 22 % of the diet in summer, with an occurrence rate of up to 61 % (Ó hUallachain and Dunne 2013, Gutiérrez-Galán et al. 2017). The lower values observed in our study are likely due to seasonal variation and the limited availability of these food sources during the autumn-winter period.

Weed seeds and various fruits were recorded at low occurrence rates and had a low significance percentage in this study. This aligns with previous research indicating that such food sources were as secondary resources when seeds and acorns are available, becoming more important only when primary food sources are scarce (Jimenez et al. 1994, Ó hUallachain and Dunne 2013, Perea and Gutiérrez-Galán 2015).

Animal-based food is poorly represented in the diet of the Wood pigeon across most of its range. According to our results, the invertebrate component of its diet includes two unidentified insect species and five snail species, three of which could not be identified at the species level (Table 1). Their occurrence and dietary significance were both low (Table 2).

Various insects have been recorded in the Wood pigeon's diet, sometimes in substantial quantities (Glutz von Blotzheim et al. 1986). However, the limited presence of insects in this study is likely due to the seasonal timing of sample collection.

Snails (Molluscs) were also found in small amounts, which align with previous studies suggesting their role in calcium balance. The consumption of snails during the summer may be linked to increased protein and calcium requirements during the breeding season (Glutz von Blotzheim et al. 1986, Graveland 1996, Graveland and Drent 1997, Ó hUallachain and Dunne 2013, Gutiérrez-Galán et al. 2017). Additionally, the presence of molluscs in the diet of juvenile birds may indicate a specific dietary preference at an early stage of development (Gutiérrez-Galán et al. 2017). Different snail species have been recorded in various parts of the Wood pigeon's range, including Decollate snail (*Rumina decollata* L.), *Ferussacia folliculum* (Schröter, 1784), *Microxeromagna armillata* (Lowe, 1852), *Cochlicella barbara* (Linnaeus, 1758), and *Candidula gigaxii* (Pfeiffer, 1847) (Gutiérrez-Galán et al. 2017). Our study expands this list by documenting *Morlina glabra* and *Pomatias rivularis* as new additions to the known diet of the Wood pigeon.

The results of this study are consistent with findings from other parts of the species' European range, reinforcing the observation that Wood pigeons tend to gather around abundant and easily accessible food sources. While some dietary variations were noted across different regions and seasons, these were primarily driven by fluctuations in food availability. Overall, our findings support the idea that the Wood pigeon has a broad and flexible dietary niche, similar to patterns observed elsewhere in its range.

Conclusions

The present study confirms that the diet of the Wood pigeon during the autumn

– winter period is primarily composed of plant-derived food items. Three components alone accounted for more than 85 % of the total dietary significance (Table 2), indicating their crucial role in fulfilling the energetic and nutritional needs of the species in this season. The strong preference for agricultural seeds, underscores the species' opportunistic foraging behaviour and its tendency to exploit abundant and accessible food sources (e.g., post-harvest fields). The relatively high occurrence of acorns (19.1 % combined significance from *Quercus* spp.) reaffirms their importance as a staple autumn-winter food resource, especially in forest-edge habitats. From a management perspective, two key recommendations emerge: Preservation of mixed landscapes combining farmland with native oak woodlands can help sustain populations by ensuring both crop and wild food resources throughout the year; Delaying deep tillage or plowing after harvest could prolong access to residual seeds for granivorous birds during late autumn and winter, reducing nutritional stress in critical periods.

Future studies should explore seasonal shifts in dietary composition with higher temporal resolution, especially in relation to agricultural practices and habitat structure, to better understand how land use influences trophic dynamics and bird distribution.

Conflict of Interest

The authors declare that there is no conflict of interest.

All materials were collected in accordance with the legislation of the Republic of Bulgaria.

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