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Substrate influences foraging selection by Eurasian Green Woodpeckers *Picus viridis* in autumn and winter: observations in Hungary over a 20-year period

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Abstract The foraging behaviour and habitat use of the Eurasian Green Woodpecker *Picus viridis* at various sites in Hungary over a 20-year period was documented. Detailed observations were recorded on foraging behaviour at hard substrates; in quarries, cliffs and human made structures of brick and stone construction. Using Chi-square tests on the frequency of observations of birds at hard substrates foraging sites, we compared usage during periods of snow cover and those without. Birds were found to be more frequently observed at hard substrates during periods of snow cover because these remained largely free of snow. We supposed that this response was due to invertebrate prey becoming increasingly scarce generally across typical foraging sites, i.e. grasslands and meadows during harsh winter conditions. Accessibility to the alternative sites became important as a source of food because availability of prey was more reliable. Vertical surfaces of hard substrates such as those associated with quarries, cliffs and buildings may be important to sustain Eurasian Green Woodpeckers in periods of snow cover where these provide a valuable foraging resource.

Keywords: *Picus viridis*, woodpecker, foraging, terrestrial-feeding, snow-cover, substrate, ants

Összefoglalás A zöld küllő *(Picus viridis)* táplálékkeresési szokásait és élőhelyhasználatát vizsgáltuk Magyarország különböző területein 20 éven keresztül, 2002–2021 között. Részletes megfigyeléseket végeztünk a madarak kemény felületeken, kőbányákban, sziklákon, illetve ember által épített tégla- és kőépítményeken történő táplálékkeresése során. Ezeken a táplálkozóhelyeken a madarak megfigyelésének gyakoriságát Khi-négyzet tesztek segítségével hasonlítottuk össze hótakaráskor és a hótakarás nélküli időszakokban. Hóborításkor a madarakat gyakrabban figyeltük meg ezeken a kemény felszíneken, mivel ezek nagyrészt hómentesek maradtak. Feltételezésünk szerint ez annak tudható be, hogy zord időjárási körülmények között a gerinctelen zsákmányállatok egyre ritkábban fordulnak elő az egyébként jellemző táplálkozási helyeken, mint a füves területek vagy rétek. Az alternatív helyszíneken biztosabbá vált a zsákmány elérhetősége, ezért fontos táplálékbázist jelentettek a madarak számára. Mindezekből arra következtetünk, hogy hóborítottság esetén a kemény aljzatok – például kőbányák, sziklák és épületek – függőleges felületei fontosak lehetnek a zöld küllők túléléséhez, mert értékes táplálékforrást szolgáltatnak.

Kulcsszavak: zöld küllő, harkályok, táplálkozás, hóborítottság, aljzat/felület, hangyák

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Introduction

The global range of Eurasian Green Woodpecker *Picus viridis* falls almost entirely within the Western Palearctic region. The species occurs from Britain in the west to Russia and Turkmenistan in the east, and from Norway and Sweden in the north to Italy and the Balkans in the south, and in the southeast to Iran and Iraq. It is absent from Finland and islands such as Corsica, Sardinia, Malta, Crete, Cyprus and Ireland. The Eurasian Green Woodpecker is polytypic, with three subspecies recognised: *viridis* in Britain, Scandinavia, continental Europe (including Hungary) and western Russia, *karelini* in Italy, the southern Balkans, the Caucasus and east to Turkmenistan, and *innominatus* in the Zagros Mountains of Iran and Iraq (Gorman 2014, Winkler & Christie 2014). It is replaced in Spain and Portugal by Iberian Green Woodpecker *Picus sharpei,* a species which was previously regarded as a subspecies of *P. viridis* (Perktas *et al.* 2011, Pons *et al.* 2011).

Around 95% of its total population is considered to occur in Europe (BirdLife International 2021), where the species is rather uniformly distributed, occurring in both lowlands and uplands, to around 2,300 m (Wilk 2020). Birds are typically sedentary, although post-breeding dispersal by juveniles is common (Glutz von Blotzheim & Bauer 1980, Gorman 2004, Török 2009).

The species ranges across three eco-climatic regions: temperate, Mediterranean and boreal. Wooded pastures, parks, groves, woodlands with clear-cut areas, open plantations with glades or grassy patches, orchards, gardens, sports-fields, paddocks, farmland and floodplain woods with grassy dykes are all inhabited. Open broadleaved and broadleaf-conifer woodlands are favoured over coniferous stands. Drier ground with a sunny aspect is preferred for foraging over shady and damp areas because it generally harbours abundant ants (Alder & Marsden 2010).

In many countries, Eurasian Green Woodpecker has become increasingly synanthropic, even expanding into urban areas. The overall trends are positive with the European population found to have moderately increased in recent decades (Wilk 2020). In the IUCN Red List of Threatened Species, it is classified as Least Concern (BirdLife International 2021). In Hungary, where all of the observations documented here took place, the species occurs nationwide and is locally fairly common, with 15,000–17,000 breeding pairs currently estimated (Gorman *et al.* 2021).

As is characteristic for species in the *Picus* genus, the staple diet of Eurasian Green Woodpecker is soil-, ground- and mound-living ants (Glutz von Blotzheim & Bauer 1980, Cramp 1985). Ants from the genera *Lasius*, *Formica* and *Myrmica* are mainly consumed and are taken in all stages (egg, larva, pupa, adult) and collected directly from the ground surface or dug from their colonies (Blume 1996, Raqué & Ruge 1999). Most food is sought on the ground with short-grazed and mown grasslands preferred (Alder & Marsden 2010). Indeed, though other sympatric woodpeckers will, to varying degrees, forage terrestrially, Eurasian Green Woodpecker has become a specialist of grassland habitats. The species, however, also forages in trees and bushes and searches for invertebrates in cowpats, fungi, spider-webs and leaf-litter. Soil-dwelling invertebrates such as earthworms are taken as well as the larvae of beetles and caterpillars, spiders and wasp and bee grubs (Glutz

von Blotzheim & Bauer 1980). Nevertheless, like many woodpeckers, this species is opportunistic and resourceful when circumstances dictate and vegetable matter, such as windfall fruit, nuts and berries, are also occasionally consumed (Glutz von Blotzheim & Bauer 1980, Gorman 2004).

In the autumn and winter, Eurasian Green Woodpecker is reported to be sensitive to prolonged periods of snow cover affecting accessibility to food (De Bruyn *et al*. 1972, Glutz von Blotzheim & Bauer 1980). The importance of access to a reliable source of food is critical for a species which is vulnerable to harsh winter weather (Rolstad *et al*. 2000). With 20 years of observational records of Eurasian Green Woodpeckers utilising hard surfaces in natural and human sites (quarries, cliffs and buildings), the aim of this study was to elucidate any patterns in foraging behaviour during the autumn-winter period. We wanted to identify whether Eurasian Green Woodpeckers showed any strong selection for foraging substrate by accounting for differences in snow cover.

Methods

Study area: The observations documented here by one of the authors (GG) took place across Hungary over a twenty-year period (2002–2021). A total of 58 observations were made of individuals visiting quarry walls, cliffs and buildings: 30 in stone quarries (both abandoned and active), 17 on buildings (walls and rooftops of houses, apartment blocks, hotels, abandoned military base) and 11 on limestone and other cliffs. All involved single adult birds: 31 males and 27 females. Some of the locations were situated within or by woodlands, but others were in quite open areas in villages and suburban areas.

Study period: All observations were made in Hungary, in autumn and winter, from September to March, as follows: September (1), October (1), November (10), December (12), January (15), February (13), March (6). On 39 of the 58 occasions snow of various depths covered the ground in the surrounding area. Although locations were visited by the author at all times of day, the vast majority of observations of foraging woodpeckers were in the afternoon hours (54 from 58).

Analysis: Using the frequency of observations Chi-square tests were used to 1) explore whether there were differences between male and female Eurasian Green Woodpeckers, using cross tabulation to perform a test for association. Following which 2) a Goodness of fit test for homogeneity was undertaken to compare the frequency of observations of birds at hard surfaces when snow was present and absent compared to an expected theoretical frequency. Because the cross tabulation is for two categories in each of these tests, there is a risk of rejecting the null hypothesis when it is in fact true, therefore Yates's correction was applied to adjust for this (Fowler & Cohen 1996).

Table 1. Observations of *Picus viridis* foraging on quarry walls, cliffs and buildings over a 20-year period (2002–2021) in Hungary (A – male, B – female)

1. táblázat A zöld küllők kőfejtő-falakon, sziklákon és épületeken való táplálkozásának megfigyelései egy 20 éves periódus alatt (2002–2021) Magyarországon (A – hím, B – tojó)

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Location	Foraging habitat	Month/Year	Time (approx.)	Sex	Ground snow-cover
Bükk Hills	quarry	Jan 2002	12.30	Male	Yes
Tatabánya	quarry	Dec 2002	17.00	Male	Yes
Zemplén Hills	quarry	Nov 2003	14.00	Male	No
Gerecse Hills	cliff	Dec 2003	13.00	Male	Yes
Vértes Hills	cliff	Mar 2004	15.00	Male	No
Mátra Hills	quarry	Jan 2005	12.30	Male	Yes
Gerecse Hills	cliff	Dec 2005	14.00	Male	Yes
Visegrád Hills	building	Oct 2006	10.30	Male	No
Bükk Hills	quarry	Nov 2006	13.00	Male	No
Vértes Hills	quarry	Feb 2008	11.00	Male	Yes
Bükk Hills	quarry	Nov 2008	14.30	Male	No
Budaörs	cliff	Dec 2008	15.00	Male	Yes
Pilis Hills	quarry	Jan 2009	14.00	Male	Yes
Tata	building	Jan 2010	11.00	Male	Yes
Tata	building	Feb 2011	14.00	Male	Yes
Bükk Hills	quarry	Mar 2011	15.00	Male	No
Pilis Hills	quarry	Nov 2011	15.00	Male	No
Visegrád Hills	quarry	Jan 2012	14.30	Male	Yes
Zemplén Hills	quarry	Nov 2012	16.00	Male	No
Aggtelek	cliff	Jan 2013	15.00	Male	Yes
Budapest	building	Dec 2013	12.30	Male	Yes
Tokaj	quarry	Mar 2014	16.00	Male	No
Visegrád Hills	building	Nov 2015	16.30	Male	No
Tatabánya	quarry	Jan 2016	14.00	Male	Yes
Aggtelek	quarry	Dec 2016	15.00	Male	Yes
Zemplén Hills	building	Feb 2017	12.30	Male	Yes
Pilis Hills	quarry	Dec 2017	15.00	Male	Yes
Tatabánya	quarry	Feb 2018	12.30	Male	Yes
Buda Hills	quarry	Feb 2018	15.00	Male	Yes
Bükk Hills	quarry	Jan 2019	11.30	Male	Yes
Vértes Hills	cliff	Mar 2021	16.00	Male	No

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Location	Foraging habitat	Month/Year	Time (approx.)	Sex	Ground snow-cover
Aggtelek	building	Feb 2002	15.00	Female	Yes
Pilis Hills	building	Feb 2003	13.30	Female	No
Budapest	building	Jan 2004	14.30	Female	Yes
Börzsöny Hills	quarry	Dec 2004	13.00	Female	Yes
Tokaj	quarry	Jan 2006	16.00	Female	Yes
Fertőd	building	Feb 2007	12.30	Female	Yes
Visegrád Hills	building	Nov 2007	15.00	Female	No
Tatabánya	quarry	Mar 2009	13.00	Female	No
Pilis Hills	cliff	Nov 2009	13.30	Female	No
Gödöllő	building	Feb 2010	12.30	Female	Yes
Börzsöny Hills	quarry	Sept 2010	15.00	Female	No
Budapest	building	Dec 2011	13.00	Female	Yes
Gerecse Hills	cliff	Feb 2012	17.00	Female	Yes
Mátra Hills	quarry	Feb 2013	13.00	Female	Yes
Gerecse Hills	cliff	Jan 2014	14.00	Female	Yes
Bükk Hills	building	Nov 2014	15.30	Female	No
Börzsöny Hills	quarry	Feb 2015	16.00	Female	Yes
Balf	quarry	Dec 2015	14.00	Female	Yes
Tata	building	Jan 2016	12.30	Female	Yes
Börzsöny Hills	quarry	Jan 2017	13.00	Female	Yes
Zemplén Hills	quarry	Mar 2017	13.00	Female	No
Visegrád Hills	cliff	Jan 2018	14.30	Female	Yes
Tapolca	building	Dec 2018	13.00	Female	Yes
Pilis Hills	cliff	Jan 2019	14.00	Female	Yes
Pilis Hills	quarry	Dec 2019	13.00	Female	Yes
Visegrád Hills	quarry	Jan 2021	14.00	Female	Yes
Pilis Hills	building	Feb 2021	13.30	Female	No

Results

Differences between male and female observations were examined by comparing their respective frequencies at hard surfaces in the winter months *(Figure 1)*. There was a positive association regardless of snow-cover and therefore no significant difference between the frequencies of observations for male and female Eurasian Green Woodpeckers ($X^2 = 0.04$,

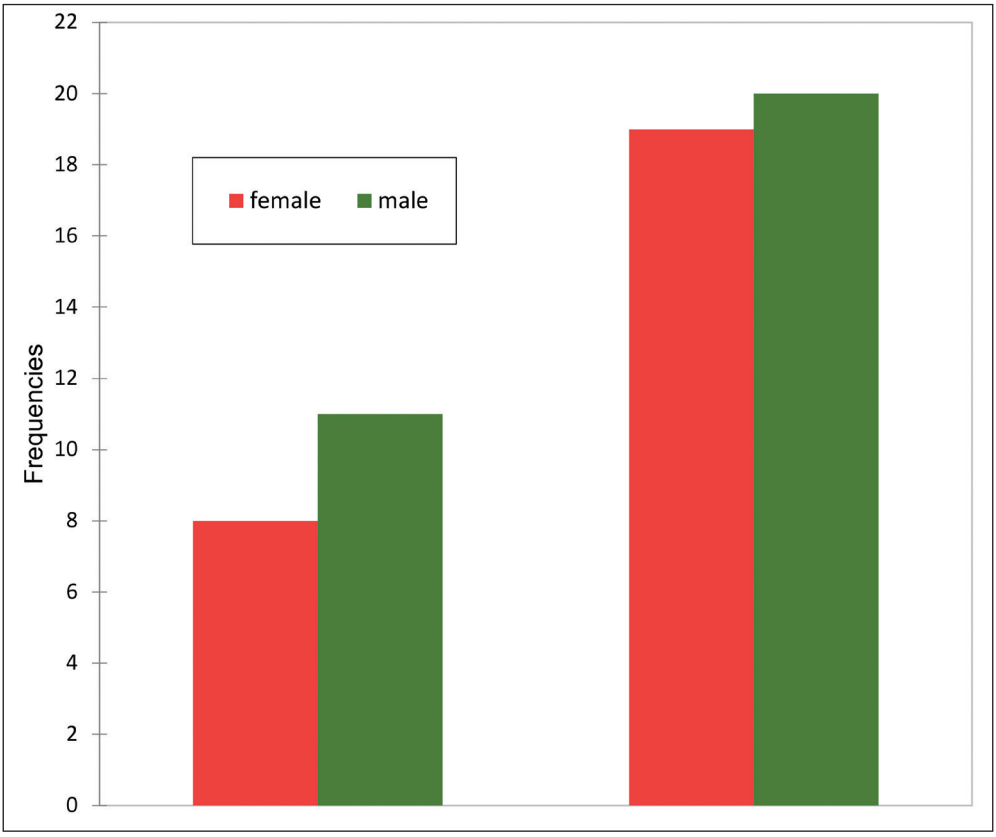

Figure 1. Frequencies of observations of male and female Eurasian Green Woodpeckers at hard surface substrates during periods without (left) and with (right) snow-cover

1. ábra A hím és tojó zöld küllő egyedek megfigyelési gyakorisága kemény felületeken hótakaró nélküli (bal) és hótakarás alatti (jobb) időszakokban

df = 1 P = 0.85, n = 58). Therefore, the data for male and female woodpeckers was pooled. We found a significantly higher frequency of observations at hard surfaces when snow was present ($X^2 = 6.22$, df = 1, $P < 0.01$, n = 58). Using a Goodness of Fit test (Fowler & Cohen 1996) it was concluded that there were significantly more birds foraging at hard surfaces during snow-cover.

Discussion

On quarry and cliff walls birds usually worked on certain spots, often at cracks and crevices, and did not move around actively as, for example, Grey-headed Woodpeckers have been observed to do when visiting such sites (Gorman 2020). When not disturbed, the birds tended to forage for between 30–50 minutes which is not dissimilar to foraging duration at other times of the year in other typical habitat as witnessed in a radio-tracking study in southern

UK (D. Alder own observation). On buildings, birds explored vertical walls, but also in rain gutters, beneath eaves and on one occasion the thatched roof of a cottage. Hosking (2011) reported a similar observation of bird in Suffolk, England, that regularly visited his newly re-thatched house in the autumn.Ant-based diet is influenced by season (Rolstad *et al.* 2000). Severe winters, with low temperatures and deep snow, affect the terrestrial ants that Eurasian Green Woodpeckers predominantly feed upon. For example, in Britain the hard winter of 1962/63 is thought to have severely impacted this woodpecker, with declines reported from many localities (Dobinson & Richards 1964). After another severe winter in Britain in 1981–82, local declines were again noted, some lasting several years (Glue 1993). Although terrestrial ants form the staple diet of this species, when these are not available other more accessible prey is sought and a shift in foraging areas and diet occurs. Such seasonal shifts are not unusual in the *Picus* genus. It has been observed that Grey-headed Woodpecker *Picus canus* also changes foraging locations, and hence prey sought, when deep snow or frozen ground impedes feeding (Rolstad & Rolstad 1995, Gorman 2020). In Sweden, Edenius *et al.* (1999) found that in periods with heavy snow, the same species moved from open-ground foraging to feeding on carpenter ant *(Camponotus)* colonies in tree trunks and stumps above ground level. In Japan, Matsuoka and Kojima (1979) found that in winters with deep snow the proportion of the Black Ant *Lasius niger*, which is a major food resource in spring and summer, was almost absent in the diet of Grey-headed Woodpeckers.

Rolstad *et al*. (2000) found that Eurasian Green Woodpecker was able to use Formica nests beneath tree cover in winter which was accessible because the trees afforded some protection from heavy snow. Being large nest mounds, these were more accessible than other sources in exposed open habitats e.g. meadows. Similarly, such nests are perennial and can be used for many years by the ants and thus, are a predictable source of food for the birds. It may be that hard surfaces as we have found which remain clear of snow can help to sustain at least some of the winter foraging requirements for Eurasian Green Woodpeckers. Clearly, more work is required to fully understand this behaviour particularly by identifying the invertebrates being taken and also looking at the microclimate conditions in such areas compared to other known foraging sites and controls.

It is likely that Eurasian Green Woodpeckers forage on rock walls and buildings in winter when their favoured ant prey become dormant and difficult to retrieve from hard or snow-covered ground (De Bruyn *et al.* 1972). As probing, gleaning and licking are the primary feeding techniques of Eurasian Green Woodpeckers, deep snow and frozen ground inhibits them from accessing terrestrial ant colonies that have moved far below ground. Consequently, the shift to sites above ground level, such as vertical walls and places where the temperature is above freezing such as buildings, to feed on the invertebrates that are found there occurs. The shift to foraging on rocky walls and buildings appears to be an adaptive response to seasonal variation in prey availability.

Foraging of this kind by this species has been occasionally discussed, mainly in the German literature, for example by Baier (1973), Löhrl (1977), Glutz von Blotzheim and Bauer (1980) and Blume (1996). This behaviour has, however, sometimes been interpreted and presented as rather uncommon. Anecdotal reports often refer to it as being unusual.

Foraging on buildings may be more frequent than reported, as the skittishness of this species probably means that birds immediately flee from such sites when people approach.

Eurasian Green Woodpeckers foraging on different non-terrestrial substrates when weather conditions prompt them to do so, is probably a regular shift, at least for populations in areas where winters are harsh. The fact that most foraging visits documented here occurred in afternoon hours also seems to indicate that warmth by the sun is important as invertebrates are more active and accessible at such times.

We suggest that the shifts in the foraging behaviour of Eurasian Green Woodpeckers described here, take place frequently and are not at all unusual.

These woodpeckers can and will dig through snow using their large, stout bill. Funnel-shaped, tunnel-like holes, 5–10 cm in diameter and of varying depth (up to 60 cm but sometimes more) are often bored into ant mounds and through snow to reach prey (Gorman 2015). But when low temperatures and hard frost result in ants retreating deep below ground or into their mounds, they become inaccessible and other food resources are then sought. At such times the availability of food at alternative sites away from the ground can be vital to this woodpecker when foraging for the terrestrial ants that form its staple diet becomes difficult.

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