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Resident and migrant birds use livestock dung pats for foraging

Las aves residentes y migratorias usan boñigas de ganado para alimentarse

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ABSTRACT. Low intensity grazing is an increasingly used tool in conservation. It creates beneficial conditions for biodiversity by shaping structural diverse habitats. An important resource provided by grazing are dung pats because many species are associated with those, especially arthropods. Because most birds depend on arthropods as a food source, dung pats may improve food availability. To investigate the role of dung pats as food-providing resources for birds, we conceived a camera trap study in the Black Forest National Park (Germany). Up to eight camera traps were simultaneously placed at dung pats of Heck cattle (*Bos taurus*) and Konik horses (*Equus caballus*) on low intensity grazing pastures. They recorded 229 foraging events of 26 different bird species between June 2021 and January 2022. Common Blackbirds (*Turdus merula*) were the most common foraging birds, typically breaking up dung pats in search of food and foraging up to 21 minutes at a single dung pat. Most other birds mainly picked up food items from the surface of dung pats. Birds used dung pats for foraging during the whole study period, even if they were covered with snow. Our study shows that dung pats can provide food for many bird species and highlights the importance of permanent low intensity grazing in conservation.

RESUMEN. El pastoreo de baja intensidad es una herramienta cada vez más utilizada en la conservación. Crea condiciones beneficiosas para la biodiversidad al dar forma a diversos hábitats estructurales. Un recurso importante proporcionado por el pastoreo son las boñigas, porque muchas especies están asociadas con ellas, especialmente los artrópodos. Debido a que la mayoría de las aves dependen de los artrópodos como fuente de alimento, los montículos de estiércol pueden mejorar la disponibilidad de alimentos. Para investigar el papel de las boñigas como fuente de alimento para las aves, desarrollamos un estudio con cámaras trampa en el Parque Nacional de la Selva Negra (Alemania). Hasta ocho cámaras trampa se colocaron simultáneamente en boñigas de ganado Heck (*Bos taurus*) y caballos Konik (*Equus caballus*) en pastizales de pastoreo de baja intensidad. Registraron 229 eventos de búsqueda de alimento de 26 especies de aves entre junio de 2021 y enero de 2022. La mirla común (*Turdus merula*) fue el ave más común que buscó alimento, por lo general, rompen las boñigas en busca de comida y se alimentan hasta 21 minutos en una sola boñiga. La mayoría de las otras aves recogían alimentos principalmente de la superficie de las boñigas. Las aves usaron boñigas para alimentarse durante todo el período de estudio, incluso si estaban cubiertas de nieve. Nuestro estudio muestra que las boñigas de estiércol pueden proporcionar alimento para muchas especies de aves y destaca la importancia del pastoreo permanente de baja intensidad en la conservación.

Key Words: *bird declines; bird foraging; camera traps; land-use change; livestock grazing; rewilding*

INTRODUCTION

The whole terrestrial biodiversity of Central Europe evolved under the influence of megaherbivores (Johnson 2009). Before humans occurred in Central Europe, large herds of herbivores like aurochs (*Bos primigenius*), wild horse (*Equus* spec.), red deer (*Cervus elaphus*), wisent (*Bos bonasus*), and others functioned as keystone species by shaping the landscape (Owen-Smith 1987, Bunzel-Drüke et al. 1999). After the Quaternary extinction event partially caused by human arrival in Europe, the large herds of most herbivores disappeared from Central Europe (Martin and Klein 1984, Pykälä 2000, Bunzel-Drüke et al. 2001, Koch and Barnosky 2006). Since domestication of wild animals about 8000 years ago, the role of wild herbivores in Central Europe has been partially replaced by domestic livestock (Andersson and Appelqvist 1990, Küster 1995, Bocherens 2018). Due to the industrialization of agriculture, traditional livestock grazing mostly disappeared from Central European landscapes (Pykälä 2000, Kapfer 2019). This large-scale loss of herbivores is seen as an underrated cause for the recently observed biodiversity decline by several authors (Pykälä 2000, Ripple et al. 2015). Therefore, simulating a former landscape with megaherbivores by implementing low intensity grazing by domestic livestock is a tool increasingly used in conservation (De Vires 1995, Bunzel-Drüke et al. 2019).

Low intensity grazing creates beneficial conditions for biodiversity by shaping structurally diverse habitat as a result of browsing, trampling, and dung (Bunzel-Drüke et al. 2019). Dung pats are a scarce resource in Central European landscapes but of high importance for biodiversity because many invertebrate species are associated with dung pats (Bunzel-Drüke et al. 2019), including earthworms (Bacher et al. 2018), springtails (Thome and Desière 1975), mites (Hanski 1991), and about 500 insect species in Europe, mainly from the orders Coleoptera, Diptera, and Hymenoptera (Buse 2019). Because arthropods are the major food resource for many bird species, birds may also benefit from increased food availability due to dung pats (Newton 2018, Bunzel-Drüke 2019).

Several studies analyzing droppings of numerous bird species confirmed dung-pat associated prey items like dung beetles (Young 2015). Other studies directly described foraging at dung pats for single bird species (e.g., Davies 1977, Horgan and Berrow

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2004). To the best of our knowledge there are so far no systematic studies in Europe that investigate the foraging behavior of birds at dung pats in general.

The objectives of our study were to investigate which bird species actively use dung pats for foraging and to document how these species forage on these pats. To accomplish these objectives, we used camera traps to observe birds foraging at dung pats of Heck cattle (*Bos taurus*) and Konik horses (*Equus caballus*) in a low intensity grazed mountain heathland in the Black Forest National Park (Germany) over a period of eight months.

METHODS

The study took place in the Northern Black Forest within the management zone of the Black Forest National Park in SW Germany (48° 31′ 21.4068″ N, 8° 14′ 54.0216″ E) continuously between June 2021 and January 2022. The studied habitat contains open and semi-open grasslands and mountain heathlands that originated by deforestation through clear felling, burning, litter use, and grazing until the end of the 19th century (Förschler et al. 2016). Low intensity grazing was reintroduced in 1995 to maintain the ecological value of open and semi-open habitats. Our study was conducted in low-intensity grazed pastures with Heck cattle or Konik horses in altitudes between 650 and 1050 m a.s.l. The Heck cattle is a breed of domestic cattle with similarity to the extinct aurochs and the Konik horse is a back-bred equine surrogating the extinct Tarpan (*Equus ferus*). Both are hardy species often used to functionally replace large herbivores in rewilding projects across Europe (e.g., Vera 2009, Nickel et al. 2016). Initially (Jun - Nov 2021), the actively grazed areas we studied were found at higher altitudes in our study site (900-1050 m). During the later winter months of our study (Nov 2021 - Jan 2022), we shifted the areas studied to lower elevation pastures (650 m a.s.l.) because livestock was rotated down from these higher elevations.

We used up to eight Reconyx HyperFire 2 camera traps at a time to record bird foraging behavior at dung pats. Cameras were set on 10 sec video function without a quiet period between triggering events to document the behavior of birds at dung pats continuously and were active for 24 hrs per day.

Because detection probability of birds increases with bird size (Randler and Kalb 2018), small birds could be underrepresented in this study. Cameras were placed 1-1.5 m from the center of clearly visible fresh horse or cattle dung pats in semi-open areas in the pastures and at least 10 m away from other cameras. Horse and cattle in the study area inhabited different pastures during the study period, and the number of cameras at horse and cattle dung pats differed. Hence, we are not able no compare both types of dung pats.

On average, cameras were allowed to record for about 10 days before being moved to a new pat. Cameras were often twisted by grazers and were therefore not continuously oriented on the dung pat. Recorded videos were screened for foraging birds. Only events in which birds actively foraged at the dung pats were counted. Sitting or walking birds were not included. Birds foraging for several minutes at the same dung pat were considered as a single event. If there was a break between two visits of the same species of more than five minutes, the visits were counted separately. For each foraging event, we noted time and date, duration, species, and foraging strategy. We distinguished three foraging strategies: (1) pick = foraging by picking up food items from the dung-pat surface; (2) pluck = foraging by breaking up a dung pat with the bill; and (3) poke = foraging by poking in a dung pat with the bill.

RESULTS

We observed 12 cattle and 83 horse dung pats at high altitudes (Jun - Nov 2021) and 27 horse dung pats at low altitudes (Nov 2021 - Jan 2022). Dung pats were used for foraging in all seasons, even during the winter when dung pats were covered with a slight layer of snow. Our camera traps recorded 704 videos with about 2 hours of video of foraging birds. These resulted in 229 independent foraging events of 26 different bird species that actively used dung pats for foraging (Table 1). Seven of these species only occur during migration in the study area, the others were resident birds (Förschler et al. 2021).

Foraging Common Blackbirds (*Turdus merula*) made up the majority of recorded events with 49%, followed by Black Redstarts (*Phoenicurus ochruros*) with 13%, Common Chaffinches (*Fringilla coelebs*) with 7%, European Robins (*Erithacus rubecula*) with 5%, and Song Thrushes (*Turdus philomelos*) with 5%. Many species have only been recorded once (Table 1). Most foraging events (75%) lasted less than 1 minute but plucking events lasted sometimes up to 21 minutes. Common Blackbirds accounted for 88% of all foraging events that lasted longer than one minute.

Plucking was the dominant foraging strategy (57% of all events), but only because this was the primary strategy of Common Blackbirds (Table 1). Among other species, picking was the most common foraging strategy (82%; Table 1). Poking birds were recorded only twice (Table 1). Dung pats that were opened by Common Blackbirds were shortly afterward used by other species like Common Redstarts, Common Chaffinches, and European Robins, which picked up food items from the surface of the opened dung pat. Birds exploiting a dung pat for several minutes also defended their dung pat against potential competitors.

Most foraging events were recorded in the morning between one hour before sunrise and four hours after sunrise (Fig. 1). This pattern was especially pronounced for Common Blackbirds and the plucking foraging behavior, whereas other species and the picking foraging behavior were more consistently distributed during the day (Fig. 1).

Although we could not quantify the exact foods taken, it appears that earthworms and arthropods were common, but seeds also were taken by Common Chaffinches, Bramblings (*Fringilla montifringilla*), and Yellowhammers (*Emberiza citrinella*) and one time the fruit body of a dung fungus was systematically fed on by a Common Blackbird. In some cases, birds stored food items exploited from dung pats in their bill, probably for their nestlings or fledglings. Even first-year birds recently independent of their parents were seen foraging at dung pats. Besides foraging, dung pats were also used for collecting nesting material (hair) and as a lookout during cleaning and resting or for hiding food (Eurasian Jay, *Garrulus glandarius*).

Besides foraging, dung pats were also used for collecting nesting material (hair), as a lookout during cleaning and resting, or for hiding food (Eurasian Jay, *Garrulus glandarius*). A compilation

Table 1. List of bird species observed via video camera traps and number of times they actively foraged at livestock dung pats within the Northern Black Forest (Germany) between Jun 2021 – Jan 2022. We distinguished the three foraging strategies as pick, pluck, and poke.

Species	Number of events	Events by foraging strategy			Resident (R) or migrant (M) bird
		Pick	Pluck	Poke	
Common Blackbird *Turdus merula*	122	9	113	-	R
Black Redstart *Phoenicurus ochruros*	29	29	-	-	R
Chaffinch *Fringilla coelebs*	17	17	-	-	R
European Robin *Erithacus rubecula*	12	10	2	-	R
Song Thrush *Turdus philomelos*	11	9	2	-	R
Mistle Thrush *Turdus viscivorus*	8	5	3	-	R
Common Redstart *Phoenicurus phoenicurus*	4	4	-	-	R
Meadow Pipit *Anthus pratensis*	4	4	-	-	R
Coal Tit *Periparus ater*	2	2	-	-	R
Great Tit *Parus major*	2	-	2	-	R
Redwing *Turdus iliacus*	2	1	1	-	M
Ring Ouzel *Turdus torquatus*	2	-	2	-	R
Brambling *Fringilla montifringilla*	1	1	-	-	M
Dunnock *Prunella modularis*	1	1	-	-	R
Eurasian Jay *Garrulus glandarius*	1	-	1	-	R
Eurasian Woodcock *Scolopax rusticola*	1	-	-	1	R
European Grey Wagtail *Motacilla cinerea*	1	1	-	-	M
Fieldfare *Turdus pilaris*	1	-	1	-	M
Great Spotted Woodpecker *Dendrocopos major*	1	-	1	-	R
Magpie *Pica pica*	1	-	1	-	M
Pied Flycatcher *Ficedula hypoleuca*	1	1	-	-	M
Starling *Sturnus vulgaris*	1	-	-	1	M
Tawny Owl *Strix aluco*	1	1	-	-	R
Tree Pipit *Anthus trivialis*	1	-	1	-	R
Wryneck *Jynx torquilla*	1	1	-	-	R
Yellowhammer *Emberiza citrinella*	1	1	-	-	R
Total	229	97	130	2	19 x R; 7 x M

of camera trap sequences of birds foraging at dung pats can be found in Video 1, https://www.youtube.com/watch?v=ImuIV4oRd2o.

DISCUSSION

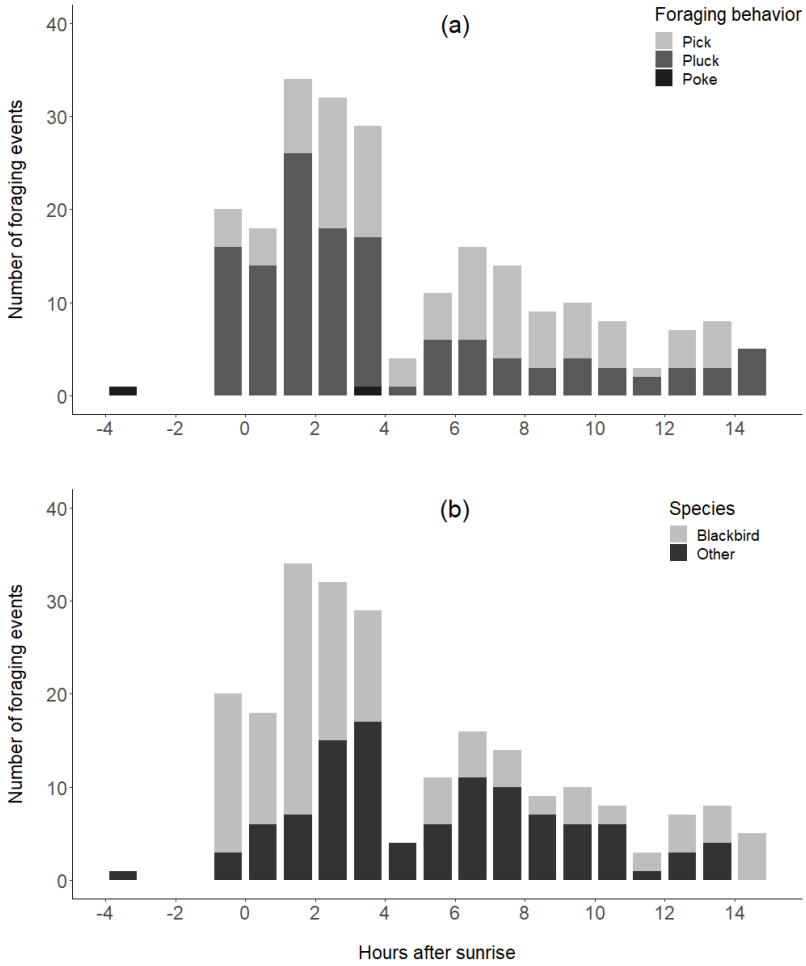
Our study shows that dung pats can provide food for the different bird species from most of the bird families that occur in the study area. Six of the recorded species are listed in the local red list of breeding birds (Bauer et al. 2016). Two of them are rated as Critically Endangered: Meadow Pipit (*Anthus pratensis*) and Ring Ouzel (*Turdus torquatus*). Another three are listed as Endangered: Pied Flycatcher (*Ficedula hypoleuca*), Tree Pipit (*Anthus trivialis*), and Eurasian Wryneck (*Jynx torquilla*). One species is rated as Near Threatened: Common Redstart (*Phoenicurus phoenicurus*). Not only birds, but other animals foraged at dung pats. Butterflies, moths, grasshoppers, wild boars (*Sus scrofa*), European polecats (*Mustela putorius*), Eurasian red squirrels (*Sciurus vulgaris*), garden dormice (*Eliomys quercinus*), shrew mice (Soricidae), and mice (Muridae) foraged or ingested minerals at the dung pats.

There are probably several reasons for the dominance of Common Blackbirds exploiting dung pats. Common Blackbirds are very common in the study area (Anger et al. 2020) and their earthworm-dominated food selection (Hölzinger 1999) fits well with the food supply offered by dung pats (Buse 2019). Also, their regular foraging behavior of foraging on the ground and digging in the litter layer enables them to exploit dung pats optimally. By digging over dung pats, Common Blackbirds and other thrush species also make the food resource normally hidden in dung pats available for other bird species picking up food items from the surface of dung pats.

The observed circadian differences in picking and plucking events might give a hint as to the different diets of pickers and pluckers. The cause for the observed peak in plucking events in the morning is likely because generally, birds are more active in the morning as has been proven for many birds, among others, blackbird species (Robbins 1981). However, picking events should then also peak in the morning. The similar number of picking events over the day might be explained by the increasing insect activity with increasing temperatures (Mellanby 1939) and therewith higher prey availability during the day for picking bird species. The prey of pluckers, mainly represented by Common Blackbirds, predominantly consists of earthworms present in dung pats during the whole day.

Because we only observed up to eight dung pats of the thousands available at the same time in our study area, we expected thousands of birds foraging at dung pats in the study area.

Fig. 1. Circadian distribution of foraging events split by (a) foraging behavior and (b) Common Blackbirds (*Turdus merula*) and other species.



Moreover, dung pats also produce flying arthropod biomass, which itself serves later as food for birds foraging during flight like flycatchers, swallows, swifts, or nightjars (Young 2015).

The broad diversity of insects supported by dung pats highlights the importance of dung pats as food-providing resources for birds. In addition to the absence of dung pats in Central European landscapes in general, the prophylactic use of antiparasitics in grazing livestock farming might be a problem for birds foraging on dung pats because residues of antiparasitics in dung pats can kill arthropods and their larvae (Wardhaugh and Rodriquez-Menendez 1988, Lumaret et al. 2012, Schoof and Luick 2019). Furthermore, year-round grazing should be provided to supply continuous food availability during the whole year and therewith also during dry periods. For example, the Ring Ouzel, an alpine bird species showing heavy declines during the last decades in the study area (Anger et al. 2020), could strongly benefit by increased food availability due to grazing because their diet mainly consists of earthworms (Glutz von Blotzheim and Bauer 1988, Hölzinger 1999). Under dung pats, four times more earthworms have been ascertained when compared to control sites (Bacher et al. 2018). Fumy and Fartmann (2021) also suggested low intensity grazing as a powerful tool for protecting Ring Ouzels.

Aside from improving food availability, permanent low-intensity grazing also has effects on habitat in general. It creates structurally diverse microhabitats that vary in vegetation height and density, and it shapes a diverse micro-relief through browsing and trampling (Bunzel-Drüke et al. 2019). This can, for example, enhance food reachability for birds (Vandenberghe et al. 2009, Leal et al. 2019) or create beneficial structures for nesting sites of ground nesting birds (Cimiotti et al. 2015, Fijen et al. 2015, Handschuh and Klamm 2022).

Author Contributions:

FA and MIF conceived the study; FA collected the data and analyzed the data. FA and MIF discussed the results and contributed to the writing of this paper.

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Data Availability:

Data are available from the authors upon request.

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