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SHORT NOTES

Aggressive interactions among birds in winter-fruiting plants

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Bird social organization in the nonreproductive season varies from solitary individuals that aggressively defend food resources to single or mixed species flocks whose members do not interact aggressively, while many species show a wide behavioural spectrum depending on the energetic costs and profits that each strategy involves at any given point in time (1-4). Very few field studies have examined the behaviour of birds feeding on fleshy fruits (5-7), particularly aggressive encounters, which are considered to be rare and therefore are poorly documented (8). Although aggressive interactions have been recorded in spring, probably due in part to paternity guarding (9), they are more frequent during winter in temperate and cold latitudes where fruit availability is low and fruit defence advantageous in spatially concentrated and lasting fruit patches (8; 10-16).

I report a study of aggressive interactions among frugivorous birds feeding on spindle *Euonymus europaeus* (Celastraceae) and guelder rose *Viburnum opulus* (Caprifoliaceae) from late autumn through to winter in northwestern Spain. I discuss the possible causes with relation to food availability and energy demand.

The study area covers 1.5km^2 and is located in the Torío river valley (30TTN93 U.T.M. coordinates, 900-1000m a.s.l., León province, NW Spain). It is part of the Supramediterranean bioclimatic stage in the Mediterranean biogeographic region, but very near the Eurosiberian region. The landscape is a mosaic of riparian woodland, hedges, irrigated pastureland, scrub, and Pyrenean oak *Quercus pyrenaica* woods. Cold winters with low overall food availability, fleshy fruit included, characterize the area. Eighteen plant species bear fleshy fruit but only eight do during winter period (spindle, guelder rose, hawthorn *Crataegus monogyna*, dog rose *Rosa canina*, blackthorn *Prunus spinosa*, dogwood *Cornus sanguinea*, ivy *Hedera helix*, and privet *Ligustrum vulgare*), and only four (guelder rose, dog rose, ivy, and privet) are available in late winter (pers. obs.). Seasonal abundance of insects and other invertebrates peaks in summer, progressively decreasing by up to 90% in normal winters (17).

Spindles and guelder roses are shrubs or small trees. The spindle fruit is a pink capsule when ripe and opens up revealing three or four small seeds covered in a fleshy, orange aril; each arillate seed is the unit taken by a feeding bird. The guelder rose fruit is a small red drupe when ripe. Between November 1996 and January 1997 I spent 55.5 hours, distributed over 19 days, directly observing birds feeding on the fruits of four spindle plants. Similarly, between late December 2004 and February 2005 I spent 36 hours, distributed over 12 days, observing birds feeding in six guelder rose plants. Plants were not situated close together thus were not observed simultaneously. Both winters were very cold with mean minimum temperatures below zero and the ground regularly covered in snow, particularly in the period December 2004-February 2005. Each visit by an individual bird was scored as one feeding visit if the bird was seen to eat at least one seed or fruit; however, I could not differentiate individuals as birds were not marked. I noted the number of birds involving in aggressive interactions while they fed in the same plant. In spindle I particularly recorded whether the attacked bird was displaced from the plant or not, and in guelder rose I particularly recorded additional birds that visited the plants and were attacked but did not succeed in feeding. Guelder roses were observed during a short, strictly winter period, so temporal variation in attack rate was not analysed for this plant species.

I recorded 330 feeding visits to spindle. Ten bird species visited spindle, principally blackcaps *Sylvia atricapilla* (40.6% of visits) and robins *Erithacus rubecula* (33.9%). I recorded 450 feeding visits to guelder rose. Five bird species visited guelder rose, principally song thrushes *Turdus philomelos* (48.4%) and robins (42.7%). During the period December 2004-February 2005 the blackcap was virtually absent from the study area, as usually happens in the harshest winters (pers. obs.). The other bird species feeding on spindle and/or guelder rose fruit were the black redstart *Phoenicurus ochruros*, blackbird *Turdus merula*, redwing *T. iliacus*, mistle thrush *T. viscivorus*, long-tailed tit *Aegithalos caudatus*, great tit *Parus major*, blue tit *P. caeruleus*, and bullfinch *Pyrrhula pyrrhula*.

Aggressive interactions always involved just two individuals. In spindle I recorded 19 aggressive interactions, 15 of which (c.80%) resulted in the attacked bird being displaced from the plant. Aggressive interactions in spindle involved just two species, robins and blackcaps. Fourteen of the aggressive interactions were intraspecific (eight robin-robin interactions and six blackcap-blackcap interactions) and five were interspecific, robin attacking blackcap, interactions. Aggressive interactions accounted for 18.7% of feeding visits by robins (21/112) and 12.7% of feeding visits by blackcaps (17/134) to spindle (no significant interspecific differences: $\chi^2_1=1.28$, $p>0.05$). The attack rate increased during the study period (0.02

attacks/10min up to 14 December, 0.11 attacks/10min from 15 December; z=-3.42, p<0.001, test for Poisson rates). Aggressive interactions accounted for 17.7% of feeding visits by robins (34/192) and 0.9% of feeding visits by song thrushes (2/218) to guelder rose (significant interspecific differences: χ^2_1=33.87, p<0.001). All the aggressive interactions were intraspecific. Moreover, 6.3% of robins (13/205) visited guelder rose but did not succeed in feeding because of attacks by other robins.

Several plant species lacked fruit during autumn-winter, the availability of fleshy fruit decreased from 31.3 fruits/m^2 in November 1996 to 1.1 fruits/m^2 in January 1997 (18), and some of the longer lasting fruits were not suitable for robins and blackcaps due to their large size (e.g. hips, sloes). Therefore fruit was in limited supply to frugivorous birds during winter. The availability of insects and other invertebrates also decreased noticeably (pers. obs.); however, bird energy demand increased owing to the drop in temperature (3). Low availability of arthropods and cold temperature increases winter fruit removal rate of bird-dispersed plants in temperate zones (19). Winter food shortages were therefore likely to lead to an increase in aggressive encounters as birds concentrated in the few sources of fruit. An increase in population does not explain the increase in aggressive interactions as bird density (robins plus blackcaps) decreased from 29 birds/10ha in November 1996 to 7 birds/10ha in January 1997 (18).

In conclusion, robins, as usual, attacked conspecifics as well as blackcaps within their territories (20; 21) and fed on fruit alone (22; 23). In contrast, blackcaps frequently feed on fruit in small intraspecific aggregates without attacking conspecific individuals or other bird species (8; 22-24); however, in this study they rarely joined other conspecific individuals and attacked them from late December (pers. obs.). In severe winters at temperate latitudes, up to 19% of feedings events involved aggressive encounters among birds feeding on fleshy fruit. Relatively high levels of winter feeding aggressions are likely to influence 1) the identity and number of birds visiting and consuming the fruit of each plant species; 2) the density and spatial distribution of the bird species; and 3) seed dispersal processes (3; 25). Further research is required to determine the generality of the findings and their ecological repercussions.

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