

Observations of birds foraging on Desert Locusts *Schistocerca gregaria* in the Afroalpine ecosystem of Bale Mountains National Park, southeast Ethiopia

The Desert Locust *Schistocerca gregaria* has been considered a major pest and cause of famines across the arid regions of southwest Asia, the Middle East and northern Africa. Swarms originating from the Red Sea coastal plains of Eritrea and Sudan, and also from northern Somalia, have historically threatened lowland agricultural regions of Ethiopia, with the highland regions of the country being affected to a lesser extent (Fashing *et al.* 2010, FAO 2010). Unlike this previously observed trend, however, recent reports show the persistence of sexually immature adult individuals and swarms of Desert Locusts in the southeastern Ethiopian highlands (FAO 2020, 2021), encompassing the Bale, Arsi and Harar Mountains.

During fieldwork in the Bale Mountains in 2020/2021, we made opportunistic observations of birds feeding on Desert Locusts. Here, we detail the occurrence of Desert Locusts in the Afroalpine ecosystem of the Bale Mountains during this period, and provide list of bird species observed feeding on locusts, along with brief notes on their foraging strategies and flocking behaviours. Taxonomy, dietary requirements and occurrence follow BirdLife International (2021).

Study area and methods

We made our observations in Bale Mountains National Park (hereafter BMNP), which is the most important representation of the Ethiopian Highlands biome within Conservation International's Eastern Afromontane Hotspot biodiversity area (Williams *et al.* 2004). The park is currently temporarily listed as a UNESCO World Heritage Site. It is situated 400 km southeast of Addis Ababa in southeastern Ethiopia and covers a 2200 km² area. Elevation within the park ranges from 1500 to 4377 m and the park encompasses the largest area of Afroalpine habitat above 3000 m in Africa (BMNP 2017).

Our observation data comes from eight localities, covering four of the five broad vegetation types in the park: Sodota (5°13'09" N, 41°27'41" E), Sanatti (5°23'45" N, 41°19'23" E), Gayssay (5°15'52" N, 41°34' 49" E), Dinsho Hill (5°18'22" N, 41°33'52" E), Gurratti (4°59'08" N, 41°21'09" E), Rafu (6°51'17" N, 39°44'09" E), Genalle (6°57'17" N, 39°38'58" E) and Morebawa (6°54'13" N, 39°35'42" E). Five of these localities are situated in Afroalpine ecosystems at altitudes of 3600 to 4200 m, while the three remaining localities were in the northern montane grasslands (Gayssay Valley; 3000 m), dry Afromontane forest (Dinsho Hill; 3150 m), and the ericaceous scrubland (Gurrati; 3700 m). All observations at localities in the Afroalpine habitat were made between January and March 2021, except at Sodota and Sanatti, which were surveyed in January and February 2020, respectively. Observations were made for a total of 12 days: for three days at Gurrati, two days each at Sodota and Dinsho Hill, and a day each at the other sites.

Field observations and discussion

We first observed the appearance of Desert Locusts at BMNP at Sodota Wolf Camp on 23 January 2020 when a large swarm consisting of millions of individuals moving eastwards invaded the area, reaching the Sannati Plateau by 8 February 2020. For the

remainder of the study period, we frequently encountered swarms, small groups and solitary locusts throughout BMNP. To our knowledge, the maximum elevation recorded for the Desert Locust in Ethiopia is 3500 m at Guassa Plateau in the central highlands of Ethiopia in June 2009 (Fashing *et al.* 2010). Thus, our observation at over 4200 m at several of our study localities (e.g., Sanatti and Rafu) comprises a new altitudinal record for the Desert Locust. The locusts were verified as Desert Locusts based on their size, colour, and presence of a tubercle between the head and thorax (Symmons & Cressman 2001).

During their appearances, locusts were mostly airborne but also sometimes landed on the ground in large numbers where birds were observed chasing, capturing, and eating them. Overall, we observed 37 species of birds feeding on desert locusts in BMNP during the years 2020 and 2021 (Appendix A). This comprised: (i) 27 (73 %) resident, including five endemic or near endemic, species, (ii) ten migratory species, and (iii) five globally threatened species, including the vulnerable Tawny Eagle *Aquila rapax* and Eastern Imperial Eagle *Aquila heliaca*, and the near-threatened Rouget's Rail *Rougetius rougetii*, Pallid Harrier *Circus macrourus* and Abyssinian Longclaw *Macronyx flavicollis* (BirdLife International 2021; Appendix A). Although previous reports (e.g., Bocheński & Jerzak 2006, Sanchez-Zapata *et al.* 2007, Fashing *et al.* 2010) show that a wide variety of bird species may prey upon Desert Locusts, our observations comprise the first records of foraging on locusts for 12 species: Wattled Ibis *Bostrychia carunculata*, Rouget's Rail, Alpine Chat *Cercomela sordida*, Rüppell's Robin-chat *Cosyphya semirufa*, Mountain Thrush *Turdus plebejus*, Ethiopian Thrush *Psophocichla simensis*, Abyssinian Ground Thrush *Zoothera piaggiae*, Red-breasted Wheatear *Oenanthe bottae*, Thekla's Lark *Galerida malabarica*, Abyssinian Longclaw, Abyssinian Slaty Flycatcher *Melaenornis chocolatina* and Red-billed Chough *Pyrrhocorax pyrrhocorax*. We noted two major types of foraging strategies used by the birds: aerial and ground. Most raptors, crows and ravens were feeding on airborne locusts by circling them from above, while other species foraged on the ground, capturing locusts either by leaping into the air and grabbing low flying locusts, or by pouncing on those that had already landed (Appendix A). Twenty-two (60 % of the total species) species observed foraging on locusts were obligate insectivores, with ten and five species being carnivores and omnivores, respectively (Appendix A; for species-specific dietary requirements, see BirdLife International 2021). At BMNP, bird species recognized as carnivorous are known to forage on the abundant rodents there (Clouet *et al.* 2000). Our observations suggest that large quantities of easily accessible protein available in locust swarms (Sanchez-Zapata *et al.* 2007) are enough to stimulate some species to temporarily shift to intensive opportunistic feeding on insects. Elsewhere, predatory bird species are known to be significant as a mortality factor affecting the population size and breeding success of Desert Locusts (Mullié *et al.* 2021).

We also noted that for some species, they occurred in larger flocks while feeding on locusts than is their typical flock size at BMNP. For example, we observed Yellow-billed Kite (typically 2 individuals vs observed >40 individuals in our study), Thick-billed Raven (3 vs >20), Tawny Eagle (2 vs >10), Red-billed Chough (7 vs 18), Fan-tailed Raven (3 vs 8), and White Stork (10 vs >1000) in unusually large flock sizes. Our regular observation of flocks constituting thousands of White Storks at each of Gayssay grassland, Dinsho Hill woodland forest and Gurrati localities is particularly noteworthy (Fig. 1). White storks are migratory birds that use the Bale Mountains as a stop-over on their way southward in Africa (BirdLife International 2021).

They are known to feed on Desert Locusts on their wintering grounds, such as in the Sahel zone, and sometimes follow such swarms during their migration (Bocheński & Jerzak 2006). However, we have never encountered such large-sized flocks at BMNP during 20 years of observations in the park.



Figure 1. Part of a large flock of White Storks following locusts at Gurrati, Bale Mountains National Park, on 21 February 2021 (photo: S. Wondimu).

Locusts play an important role within the food web structure in natural ecosystems through food competition with herbivores, and by providing a food source for predators (Sanchez-Zapata *et al.* 2007, Fashing *et al.* 2010). Many bird taxa, including numerous raptors, storks and passerines, have long been known to prey on locusts, and sometimes migratory birds may follow desert locust swarms specifically (Sanchez-Zapata *et al.* 2007, Mullié *et al.* 2021). Our findings also highlight the vital ecosystem services provided by birds in pest control and the need to consider this role in developing biological locust pest control strategies. In conclusion, our observations have provided new information on birds that feed on Desert Locusts at the highest elevations they are known to occur. While these findings are consistent with the predicted invasion of highlands by locusts associated with global warming, continued monitoring is necessary to determine whether this trend will continue at BMNP.

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References

- BIRDLIFE INTERNATIONAL. 2021. IUCN Red List for birds. Downloaded from <http://www.birdlife.org> on 08/07/2021.
- BMNP (BALE MOUNTAINS NATIONAL PARK). 2017. *Bale Mountains National Park General Management Plan (2017–2027)*. Dinsho: BMNP.
- BOCHEŃSKI, M. & JERZAK, L. 2006. Behaviour of the White Stork *Ciconia ciconia*: a review pp. 296–324 in Tryjanowski, P., Sparks, T.H. & Jerzak, L. (eds) *The White Stork in Poland: studies in biology, ecology and conservation*. Poznań: Bogucki Wydawnictwo Naukowe.
- CLOUET, M., BARRAU, C. & GOAR, J.L. 2000. The diurnal raptor Afro-alpine community of the Ethiopian Bale highlands. *Ostrich* 71 (3 & 4): 380–384.

- FAO. 2020. *Desert Locust Bulletin No. 496 (3 February 2020): General Situation during January 2020 and Forecast until Mid-March 2020*. Downloaded from <http://www.fao.org/ag/locusts> on 07/07/2021.
- FAO. 2021. *Ethiopia: Desert Locust Situation Report (4 June 2021, Issue 20)*. Rome: FAO.
- FASHING, P.J., NGUYEN, N. & FASHING, N.J. 2010. Behaviour of Geladas and other endemic wild-life during a Desert Locust outbreak at Guassa, Ethiopia: ecological and conservation implications. *Primates* 51: 193–197.
- MULLIÉ, W.C., CHEKE, R.A., YOUNG, S., IBRAHIM, A.B. & MURK, A.J. 2021. Increased and sex-selective avian predation of Desert Locusts *Schistocerca gregaria* treated with *Metarhizium macridum*. *PLoS ONE* 16(1): e0244733. <https://doi.org/10.1371/journal.pone.0244733>
- SANCHEZ-ZAPATA, J.A., DONAZAR, J.A., DELGADO, A., FORERO, M.G., CEBALLOS, O. & HIRALDO, F. 2007. Desert Locust outbreaks in the Sahel: resource competition, predation and ecological effects of pest control. *Journal of Applied Ecology* 44: 323–329.
- SYMMONS, P.M. & CRESSMAN K. 2001. *Desert locust guidelines. 1. Biology and behaviour*. Rome: Food and Agriculture Organization of the United Nations.
- WILLIAMS, S., VIVERO POL, J.L., SPAWLS, S., SHIMELIS, A. & KELBESSA, E. 2004. Ethiopian Highlands pp. 262–273 in Mittermeier, R.A., Gill, P.R., Hoffmann, M., Pilgrim, J., Brooks, T., Mittermeier, C.G., Lamoreux, J. & Da Fonseca, G.A.B. (eds) *Hotspots revisited*. Washington DC: CEMEX Publisher.

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Appendix A. List of bird species observed feeding on Desert Locust at eight localities in the BMNP in 2020 and 2021, detailing species-specific foraging strategies (on the ground, aerial or both) and primary dietary requirement (Carn. = Carnivore; Ins. = Insectivore, and Omni. = Omnivore). Superscript letters following English names indicate whether a species is endemic or near endemic (a), resident (b) or migrant (c)]. Taxonomy, dietary requirement and occurrence follow BirdLife International (2021).

English name	Scientific name	Locality	Foraging strategies	Diet
Rouget's Rail ^a	<i>Rougetius rougetii</i>	Gennale	Ground	Ins.
White Stork ^c	<i>Ciconia ciconia</i>	Gurrati, Gayssay, Dinsho Hill	Both	Ins.
Wattled Ibis ^a	<i>Bostrychia carunculata</i>	Morebawa	Aerial	Ins.
African Harrier-Hawk ^b	<i>Polyboroides typus</i>	Dinsho Hill	Aerial	Carn.
Lesser Spotted Eagle ^c	<i>Aquila pomarina</i>	Morebawa	Ground	Carn.
Tawny Eagle ^b	<i>Aquila rapax</i>	Gayssay, Dinsho Hill	both	Carn.
Eastern Imperial Eagle ^b	<i>Aquila heliaca</i>	Morebawa	Ground	Carn.
Rufous-breasted Sparrowhawk ^b	<i>Accipiter rufiventris</i>	Dinsho Hill	Aerial	Carn.

English name	Scientific name	Locality	Foraging strategies	Diet
African Goshawk ^b	<i>Accipiter tachiro</i>	Dinsho Hill	Aerial	Carn.
Western Marsh Harrier ^c	<i>Circus aeruginosus</i>	Morebawa	Aerial	Carn.
Pallid Harrier ^c	<i>Circus macrourus</i>	Sodota, Rafu, Morebawa, Gayssay	Aerial	Ins.
Yellow-billed Kite ^b	<i>Milvus aegyptius</i>	Sodota, Gayssay, Dinsho Hill	Aerial	Carn.
Augur Buzzard ^b	<i>Buteo rufufuscus</i>	Morebawa	Aerial	Carn.
Lesser Kestrel ^c	<i>Falco naumanni</i>	Rafu; Morebawa, Gayssay	Aerial	Ins.
Common Kestrel ^b	<i>Falco tinnunculus</i>	Rafu	Aerial	Ins.
Peregrine Falcon ^b	<i>Falco peregrinus</i>	Sodota, Rafu, Morebawa, Gayssay	Aerial	Carn.
Ethiopian Boubou ^b	<i>Lanius aethiopicus</i>	Dinsho Hill	Aerial	Ins.
Red-billed Chough ^a	<i>Pyrhocorax pyrrhocorax</i>	Gennale, Morebawa	Both	Ins.
Common Fiscal ^b	<i>Lanius collaris</i>	Gayssay, Dinsho Hill	Aerial	Ins.
Cape Crow ^b	<i>Corvus capensis</i>	Gayssay	Aerial	Omni.
Pied Crow ^b	<i>Corvus albus</i>	Gayssay	Aerial	Omni.
Somali Crow ^b	<i>Corvus edithae</i>	Rafu	Aerial	Omni.
Fan-tailed Raven ^b	<i>Corvus rhipidurus</i>	Sodota, Sanatti, Rafu, Morebawa	Aerial	Omni.
Thick-billed Raven ^a	<i>Corvus crassirostris</i>	Sodota, Morebawa, Gayssay, Dinsho Hill	Aerial	Omni.
Thekla's Lark ^b	<i>Galerida malabarica</i>	Sanatti, Rafu	Ground	Ins.
Abyssinian Ground Thrush ^b	<i>Zoothera piagiae</i>	Dinsho Hill	Ground	Ins.
Ethiopian Thrush ^b	<i>Psophocichla simensis</i>	Gayssay, Rafu	Ground	Ins.
Abyssinian Slaty Flycatcher ^a	<i>Melaenornis chocolatina</i>	Dinsho Hill	Aerial	Ins.
African Dusky Flycatcher ^b	<i>Muscica adusta</i>	Dinsho Hill	Aerial	Ins.
Rüppell's Robin-chat ^b	<i>Cossypha semirufa</i>	Dinsho Hill	Ground	Ins.
Common Stonechat ^b	<i>Saxicola torquata</i>	Gayssay	Ground	Ins.
Moorland Chat ^b	<i>Cercomela sordida</i>	Sodota, Gennale, Sanatti, Rafu, Gayssay, Dinsho Hill	Ground	Ins.
Northern Wheatear ^c	<i>Oenanthe oenanthe</i>	Rafu	Ground	Ins.
Mountain Thrush ^b	<i>Turdus plebejus</i>	Dinsho Hill	Ground	Ins.
Red-breasted Wheatear ^c	<i>Oenanthe bottae</i>	Rafu	Ground	Ins.
Abyssinian Longclaw ^a	<i>Macronyx flavicollis</i>	Rafu	Ground	Ins.
Red-throated Pipit ^c	<i>Anthus cervinus</i>	Rafu	Ground	Ins.