ISSN: 2230-9926

International Journal of Development Research

Vol.6, Issue 09, September - 2014

IMPACT FACTOR / INDEXING JOURNAL

ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of
DEVELOPMENT RESEARCH

International Journal of Development Research
Vol. 4, Issue, 9, pp. 1887-1893, September, 2014

Full Length Research Article

ABUNDANCE AND HABITAT PREFERENCE OF THE NEAR-THREATENED ENDEMIC ABYSSINIAN LONG-CLAW (*Macronyx flavicollis* IN THE NORTHERN MONTANE GRASSLANDS OF THE BALE MOUNTAINS, ETHIOPIA

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ARTICLE INFO

Article History:
Received 24th June, 2014
Received in revised form
19th July, 2014
Accepted 25th August, 2014
Published online 30th September, 2014

Key words:
Abundance,
Abyssinian long-claw,
Bale Mountains,
Habitat preference,
Montane grasslands,
Threat.

ABSTRACT

Abyssinian long-claw (*Macronyx flavicollis* Rüppell, 1840) is a near-threatened bird species endemic to the highlands of Ethiopia. Little is known of the species demography, biology and ecology. This study was conducted in the northern montane grasslands of the Bale Mountains, southeast in Ethiopia, to determine abundance, habitat preferences and potential threats to Abyssinian long-claws. Survey was carried out along 53 transects established in three (open grassland, marsh grassland and shrubland) vegetation types in protected (low-moderate grazed) and unprotected (heavily grazed) areas in June 2014. The birds were observed only in open grasslands of both areas, with significantly greater density in the protected open grasslands. The estimated overall mean density was 0.57 ± 0.08 birds per ha, yielding an estimated an overall total population size of 815.67 ± 114.48 individuals in the northern montane grasslands of the Bale Mountains. Vegetation measurements varied among vegetation types and between land-use types (i.e. grazing levels). This may indicate the possible effects of livestock grazing regime on abundance and habitat preferences of the species. However, more research is required to estimate the population size of the species in the Bale Mountains region as a whole and to determine effects of grazing on the species.

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INTRODUCTION

Abyssinian long-claw (*Macronyx flavicollis authority of name*; Rüppell, 1840) family Motacillidae) is an endemic bird species to the highlands of Ethiopia (Ash and Gullick, 1989; Keith, Urban and Fry, 1992; BirdLife International, 2014). It has brownish-black upper parts with buff fringes, buff under parts with black streaks at sides of breast, yellowish throat with broad black necklace, and white tail corners in flight(Fig. 1) (Redman, Stevenson and Fanshawe, 2009). The species inhabit treeless open grasslands and tussock-grassland on moorlands from 1600-4100 m a.s.l. (Ash and Gullick, 1989; Keith *et al*., 1992; BirdLife International, 2014). Their food consists of ground insects and other invertebrates (Keith *et al*., 1992; BirdLife International, 2014). Although the population size of the species has not been quantified, Keith *et al*. (1992) described as locally scarce to abundant and EWNHS (1996) as locally uncommon. Abyssinian long-claw is a globally threatened species, currently classified as near-threatened under IUCN criteria (BirdLife International, 2014). As related to the continuing expansion of human population in Ethiopia,, conversion of grassland ecosystems to cultivated and livestock grazing (pasture) lands are considered to be the main threats to the species. These have lead the species to decline in population size (BirdLife International, 2014). BirdLife International (2014) also suggested that its small, declining population and alterations of its habitat might qualify the species for a higher threat category. Therefore, there is an urgent need of data on the ecology and conservation biology of the species to understand its conservation status and develop appropriate conservation measures. Despite critical need of information on the abundance, habitat preferences and threats to Abyssinian long-claw, little is known of the species (BirdLife International, 2014). As a result, its population size, habitat preferences, main threats and its behavioral response to different types and levels of disturbances across its ranges

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have not been quantitatively determined (BirdLife International, 2014;). Main habitat ranges of the species is known to have been densely inhabited by humans and livestock (inhabited by 88% of humans and 65% of its livestock population; EWNHS, 1996; Mckee, 2005). This has led to degradation of its ranges through agriculture overgrazing and soil erosion, which are the most serious threat to the sustainability of these areas (EWNHS, 1996; Stephens *et al.,* 2001; Mckee, 2005). In view of the speed with which these highland grassland habitats are being destroyed (EWNHS, 1996; Mckee, 2005; BirdLife International, 2014), it is likely that protected areas may represent relatively safer sites where Abyssinian long-claw would immune from anthropogenic pressures in the future. Therefore, the availability of information on population size, habitat preferences and possible threats to the species in areas such as Bale Mountains National Park (BMNP) that has potentially suitable habitat for the species is crucial. This will be useful to monitor its population changes overtime and to determine what conservation and management might be appropriate.

Figure 1. Picture of Abyssinian Long-claw (Photo By Yosef Mamo)

This paper presents results of Abyssinian long-claw surveys conducted in the northern montane grasslands of the Bale Mountains, Ethiopia, during June 2014. The Bale Mountains region is part of the Conservation International's Eastern Afromontane hotspot biodiversity area (Williams *et al*. 2004) and contains the largest Afroalpine habitat in Africa (Hillman, 1986). The Bale Mountains have been known for their high level of species richness and endemism across all taxa (Asefa, 2011; Williams *et al*., 2004).

Despite its immense importance as a center of endemism and evolutionary processes, this region is currently under conservation threat (Hillman, 1986; Stephens *et al*., 2001; OARDB, 2007; Teshome, Randal and Kinahan, 2011). Agricultural expansion, livestock grazing, unregulated burning, logging for timber production and settlement expansion are increasing in the area at an unprecedented rate (OARDB, 2007), which could pose severe threats to the survival of wildlife and the ecosystem of the region. The main aims of this study were therefore to estimate population size, determine habitat preferences, and identify potential threats to Abyssinian long-claw in the montane grasslands in the northern part of Bale Mountains of Ethiopia

MATERIALS AND METHODS

Study area

The Bale Mountains region is located in the south-east highlands of Ethiopia at 400 km from, Addis Ababa, the capital city of Ethiopia. At the heart of these chain of mountains is the Bale Mountains National Park (BMNP), which covers an area of c. 2200 km^2 (OBARD, 2007). The region contains five broad vegetation zones (Fig. 2): the northern montane grasslands, the northern woodlands, ericaceous forest, the Afro-alpine moorland and grassland, and the southern Harenna forest (Hillman, 1986). Seventy-eight mammal and 278 bird species have been recorded from the Bale Mountains area; of which 17 mammal and 6 bird species are endemic (Asefa, 2007, 2011). The Bale Mountains area is characterized by eight months (March-October) of rainy season and four months of dry season (Hillman, 1986). In the Bale Mountains, Abyssinian long-claw has been reported from the northern montane grasslands and the Afroalpine moorland habitats (Hillman, 1986; Asefa, 2007). The present study was carried out in the montane grasslands of the area (Fig. 2). This grassland has an area of c. 25 km^2 of which ~ 13.92 km^2 is included in the BMNP and the remaining area is being used as a communal livestock grazing land by the surrounding community (Hillman, 1986; Mamo et al, 2012). This grassland area occurs as a central broad flat valley in between two mountainous ranges from the north and south at an altitudinal range of 3000 and 3150 m a.s.l. The vegetation of the area can be broadly classified in to three types (for detail see Table 1) as: open grassland (dry land areas covered by short grasses), marsh grassland (characterized by tall swamp grasses and sedges), and shrubland (covered by bushes of *Artemesia afra* and *Helichrysum splendidum*) (Hillman, 1986; Afework, Bekele and Balakrishnan, 2009; OARDB, 2007; Mamo *et al*. 2012). This montane grassland generally is considered as a critical habitat for the endangered endemic mountain nyala (*Tragelaphus buxtoni*), as well for several ungulate species in the BMNP (Hillman, 1986; Stephens *et al*. 2001; Mamo *et al*. 2012). Consequently, most conservation efforts in the national park are focused on this grassland (OBARD, 2007).

Data collection

The whole grassland area was divided into five blocks based on their dominant vegetation type and protection status (i.e. inside(Protected) or outside the park(Unprotected); Fig 1. and Table 1). Total of 53 transects of varying sizes (100 m – 1000 m; mean ± S.D. = 566 ± 346 m) were randomly established covering the blocks (Table 1). Distance between adjacent transects was limited to minimum of 300 m apart to avoid double counting of same individuals (Buckland *et al*. 2001). Abyssinian long-claws were counted within 50 m width on either sides of each transect using variable distance sampling technique that takes in to account potential differences in detectabilities in different vegetation types (Buckland *et al*. 2001). All counts were made, early in the morning (between 07:00-10:00 a.m.) when the birds are thought to be more active, while slowly walking at speed of ~ 2 km hr^{-1}. Whenever the birds were encountered their number and sighting distance within 50 m (i.e., perpendicular distance from the transect line to the place where it was first sighted) were recorded. Habitat variables (height and percentage cover of shrub, herb and grass, and percent of bare ground) were also

Table 1. Record Abyssinian long-claw in block/Vegetation types and sample sizes

Block/Vegetation type	Total area(m^2)	No. transect($m^{2)}$	Transect length(m^2)	area sampled(m^2)	No. records	No. individuals recorded	Density (mean ± S.D.)
Open grassland PS	831	13	3100	31	17	30	0.92 ± 0.42
Open grassland UPS	600	10	9000	90	5	7	0.08 ± 0.08
Marsh grassland PS	115	8	1200	12	0	0	0
Marsh grassland UPS	300	7	6000	60	0	0	0
Shrubland PS	446	15	10700	107	0	0	0
Total PS	1392	36	15000	150	17	30	0.92 ± 0.42
Total UPS	900	17	15000	150	5	7	0.08 ± 0.08

PS = protected site; UPS = unprotected site

Table 2. Grazing level, its indicators and type of grazers involved in the different vegetation types of the protected and unprotected grassland areas in the northern Bale Mountains

Site/s	Type of habitat	Grazers	Level	Indicators
Protected area	Shrubland, and marsh grassland	Wildlife	Low	Grass and palatable herbs heights tall, no livestock and their dung recorded, wildlife frequently recorded.
Protected area	Open grassland	Wildlife and livestock	Moderate	Grass and palatable herbs heights relatively intermediate, livestock encountered infrequently with low numbers (3-5 heads), livestock dung recorded infrequently, wildlife frequently recorded.
Unprotected area	marsh grassland, and open grassland	Livestock	Heavy	Grass and palatable herbs heights relatively short, hundreds of livestock frequently encountered, wildlife rarely recorded.

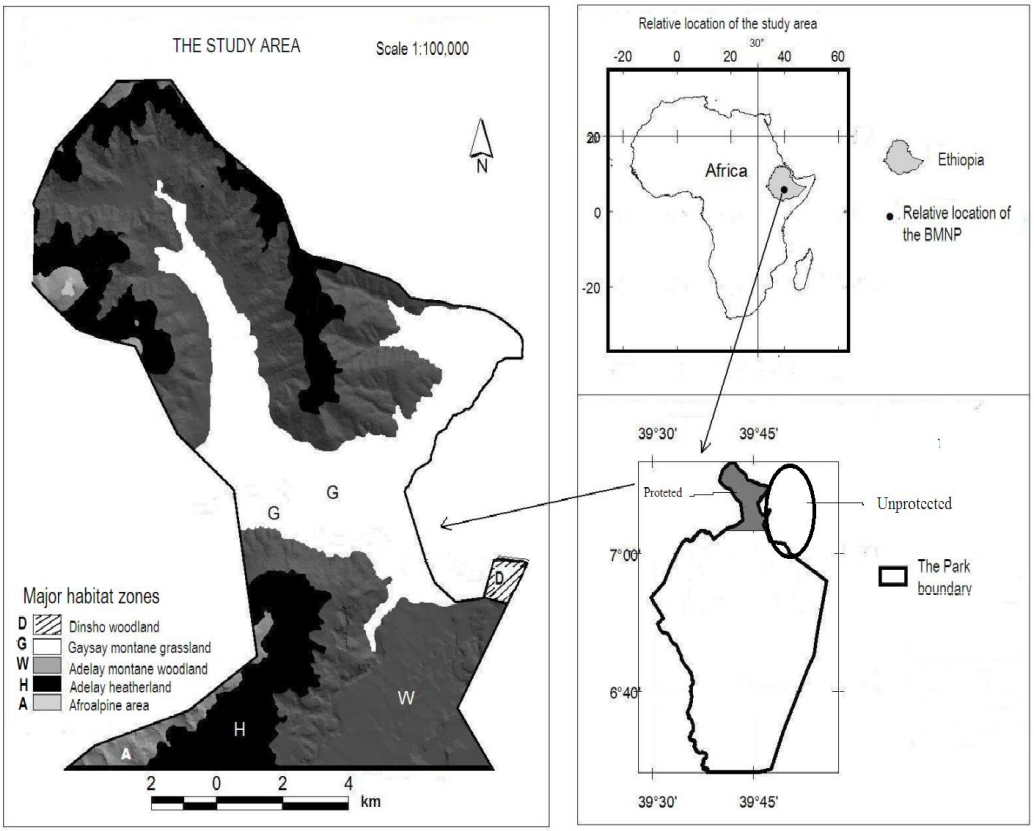

Figure 2. Map of the study area

recorded within 10 m × 10 m quadrates established along each transects at 100 m distance intervals. In order to understand potential threats to the species, evidences of livestock and wildlife herbivory signs were assessed along each transect. Grazing level was recorded on three ordinal scales as: low, moderate and heavy following grazing indicators outlined by Newton (2007) based on number of livestock and wildlife herbivores found within 50m width of each transect, and, indirectly, based on counting of number of their dung piles and/or observing the level of herbivory damages to vegetation at each quadrate established above for vegetation sampling. Some behavioral activities displayed by long-claws were noted in relation to the possible ecological factors limiting its distribution and abundance in the area.

Data analysis

Density (number of individuals per ha) of Abyssinian long-claw was calculated by dividing the mean number of birds recorded per transect by the transect area. Densities were not adjusted for detectability (Buckland et al. 2001) because the number of birds recorded for each vegetation type or block (0 -

17 records) was found to be lower than the minimum number required (at least 20 records) to use Distance sampling (Buckland et al. 2001). Areas of each transect were determined as a product of its length and width, by assuming that a width of 50 m on either side of each transect was covered by the survey. Overall mean (± 95% CI) density was estimated following the method suggested by Greenwood (1996) as a summation of the weighted mean of density of birds in each vegetation type. Total population of the species in the area was estimated simply by multiplying the overall mean density by the total area of suitable habitat (i.e. grassland vegetation type). Abyssinian long-claws were only encountered in the open grassland vegetation type. Further, preliminary data analysis showed that grazing level was found to be different both within and between vegetation types depending on whether a site is situated inside or outside the protected park (for detail on the grazing indicators recorded and level category for each block, see Table 2). Thus it is likely that the distribution and abundances of the Abyssinian long-claw might be affected by vegetation type, grazing, and their interaction. To test this hypothesis, we first examined possible difference in mean density of long-claws between the open grassland blocks with different grazing levels (i.e. moderate and heavy) using one-way ANOVA in SPSS version 20.0 statistical package. Following this, we examined the differences in habitat structural composition of vegetation types using a multivariate analysis of similarity (ANOSIM) in PRIMER software version 6.1.13 (Clarke and Gorley, 2006).

A Euclidean Distance, an appropriate resemblance measurement for environmental variables (Clarke and Gorley, 2006), was used to calculate similarities in structural composition between the sites. Prior to analysis, data were square-root transformed to attain normality, followed by normalization (to standardize them to same measurement scale) (Quinn and Keough, 2002; Clarke and Gorley, 2006). Global R values were used to determine the degree of similarity among treatments. This is a non-parametric permutation procedure applied to rank similarity matrices underlying sample ordinations; the closer the R value is to 1, the more dissimilar species assemblages are (Clarke and Gorley, 2006). This was conducted thrice by defining vegetation type, grazing level, and interaction thereof as different factors. Finally, one-way ANOVA was also conducted in SPSS to test the mean differences of each habitat variable between each pair of factor levels of the two factors and their interaction discussed above. Tukey's *post hoc* tests were conducted for multiple mean comparisons (Quinn and Keough 2002). This analysis was conducted after applying log and arcsine transformations to vegetation height and cover, respectively, as recommended by Quinn and Keough (2002).

RESULTS

Population size

Abyssinian long-claw was recorded on 22 occasions along 15 (28% of total) transects (Table 1). All these records were from open grassland habitat, where they occurred along 85% and 40% of transects surveyed in the protected, the BMNP; and unprotected grassland sites, respectively (Table 1). They frequently occur in pairs [15 (68% total records) of the records], with mean (± S.D.) flock size of 1.6 ± 0.5 birds. A

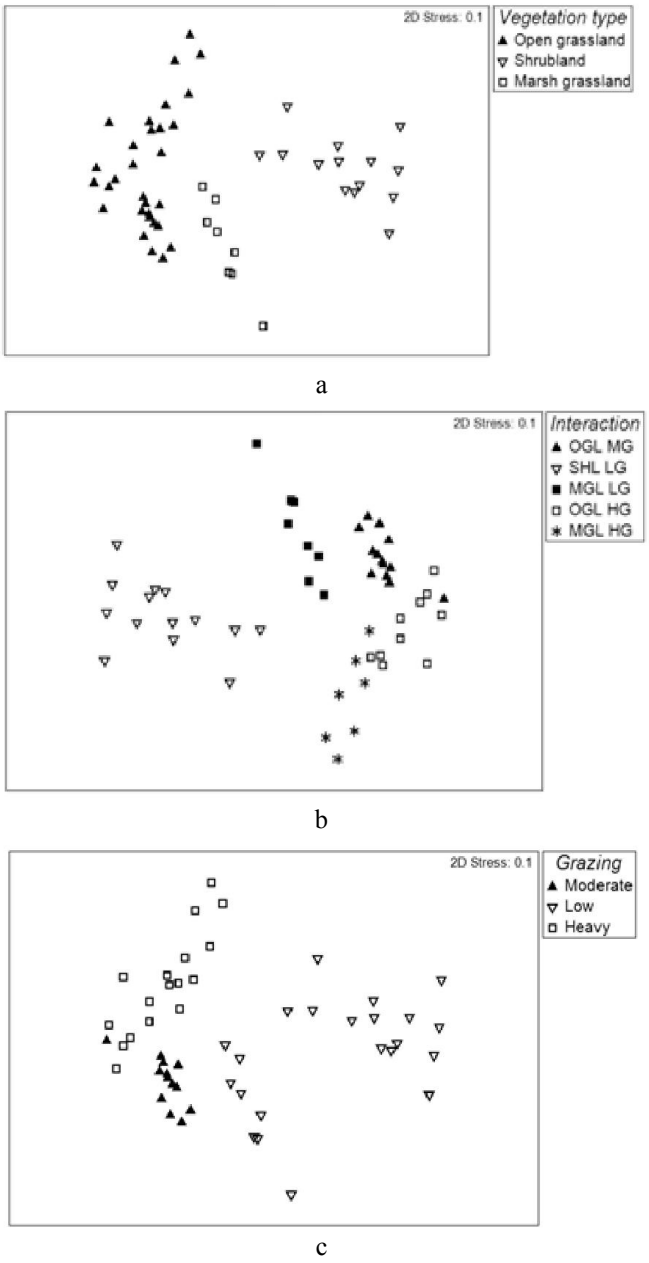

Figure 3. Non-metric multidimensional ordination of sample transects for (a) vegetation types, (b) grazing levels, and (c) their interaction (abbreviations: OGL MG – open grassland moderate grazing; SHL LG – shrubland low grazing; MGL LG - marsh grassland low grazing; OGL HG – open grassland heavy grazing; MGL HG – marsh grassland heavy grazing)

total of 37 birds (30 birds in the protected and seven in the unprotected open grasslands) were recorded. Mean (± 95% CI) density in the protected site was estimated to be 0.92 (± 0.42) birds/ha (range 0 – 2, n = 13), while 0.08 ± 0.08 (range = 0 – 0.3, n = 10) in the unprotected one. Thus, the estimated overall means density to be 0.57 ± 0.08 birds per ha. This yields an estimated overall total population of Abyssinian long-claw in the northern montane grasslands of the Bale Mountains 815.67 ± 114.48 individuals.

Habitat preferences and threats

Mean density of Abyssinian long-claw was significantly higher in the moderately grazed open grassland as compared to the open grassland with heavy grazing level (ANOVA: $F_{1, 22}$ =

8.25, P < 0.005). Results of ANOSIM showed that habitat structural compositions vary across all vegetation types (Global R =0.818, P < 0.05; Fig. 1a), grazing levels (R =0.559, P < 0.05; Fig. 1b), and interaction between them (R =0.867, P <0.05; Fig. 1c). Similar results were obtained using ANOVA (for all variables, vegetation type: $F_{2, 50}$ = 5.55 – 54.06, P < 0.005; grazing level: $F_{2, 50}$ = 12.99 – 34.77, P < 0.005; Interaction: $F_{4, 48}$ = 19.61 – 31.25, P < 0.005; Figs. 3a-c). Tukey's *post hoc* pair-wise comparison of each factor level of each of the main factors (i.e. vegetation type and grazing level) and their interactions on mean abundances of log-claw showed significant differences (Figure 4 a-c).

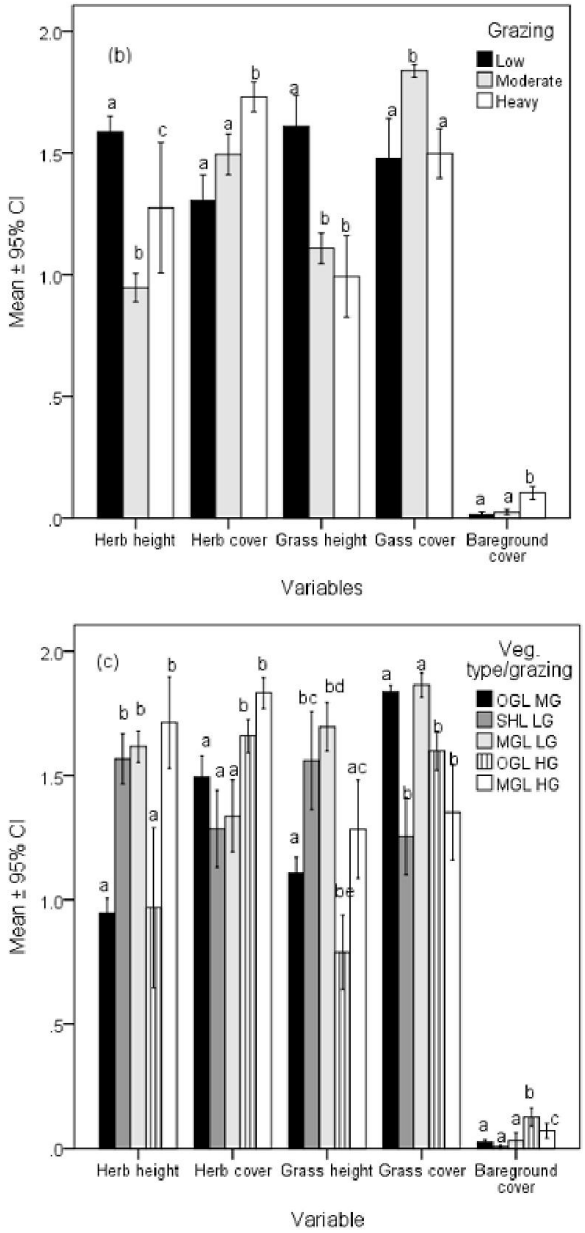

Figure 4. Comparison of mean values (based on log and arcsine transformed for height and cover, respectively) habitat variables among (a) vegetation types, (b) grazing levels and (c) their interaction. Mean values indicated by different letter in each series indicates statistically significant difference at alpha = 0.05 (Abbreviations, vegetation type: OGL = open grassland, SHL = shrubland, and MGL = marsh grassland; veg. (vegetation type) type/grazing: OGL MG = open grassland moderate grazing, SHL LG = shrubland low grazing, MGL LG = marsh grassland low grazing, OGL HG = open grassland heavy grazing, and MGL HG = marsh grassland heavy grazing)

As depicted on Figure 2c, the open grassland vegetation with moderate grazing level (which was situated in the National park and where the majority of Abyssinian long-claws were recorded; see also Table 1) was characterized by taller grass height and greater percentage grass cover compared to that situated outside the park and with heavy grazing level. In contrast, the grassland area considered to be under heavy grazing pressure had greater percentage of cover bare ground.

DISCUSSION

In the absence of any data to compare our findings against, the results of this study may indicate that, although small in extent, the montane grasslands of the northern Bale Mountains holds considerable population of Abyssinian long-claw. Since the survey was undertaken over a short temporal period, the population size/density reported here could be higher or lower if seasonal movements occur between the study area and the Afroalpine habitat of the Bale Mountains. The species' distribution and abundance in the study area seems to have been primarily limited by vegetation type, and then by habitat quality which in turn might be influenced by grazing. Abyssinian long-claw tends to show a preference for open grassland vegetation (where grasses are relatively shorter in height) to either of marsh grassland (covered by tall grass) and shrub lands, which might be attributed to its natural history related to its foraging and breeding behaviour (Keith *et al*. 1992; BirdLife International, 2014). Within the open grassland, however, habitat quality (height and cover of grasses), which was altered by herbivore grazing, is found to be a determinant factor that affected abundance of the species.

Several studies in Africa and across the globe (Knopf, 1994; Fuller and Gough, 1999; Muchai, Lens and Bennun, 2002; Evans *et al*., 2006; Borghesio *et al*., 2013) have reported that livestock grazing in grassland ecosystem to be the major cause for habitat alteration, but with varying effects on birds depending on the level of grazing, type of livestock involved and bird species concerned. It has been suggested that both low and heavy grazing negatively affects habitat quality for grassland specialist bird species such as the Abyssinian long-claw (Muchai *et al*., 2002; Evans *et al*., 2006; Borghesio *et al*., 2013). This is because low grazing usually results in long grass, but intense grazing destroys grasses (Fuller and Gough, 1999; Muchai *et al*., 2002; Evans *et al*., 2006; Borghesio *et al*., 2013). This accords well with our findings that heavy grazing has led to significant reduction in grass height and cover but higher herb and bare ground cover compared to the site considered to be with moderate grazing level. Conversely, these habitat structural differences between the two open grasslands (protected and unprotected), but with different grazing levels, were reflected in the abundance of the Abyssinian long-claw; being higher in the moderately grazed site. Similar to this species, the related Sharp's long-claw in Kenyan highlands was also reported to prefer grasslands with moderate grass height to those with either short or tall heights (Muchai *et al*., 2002; Borghesio *et al*., 2013). Therefore, the implication of our findings was that Abyssinian long-claw might be tolerant to some degree of grazing disturbances, at least, in areas where grass height was taller than that of the species' preferred height. Thus, livestock grazing regime could have significant conservation implications for the management of Abyssinian log-claw in the study area, as well across its ranges elsewhere in the country.

In addition to vegetation structure other ecological processes such as interactions with other species and landscape structure (e.g., habitat matrices surrounding the grassland patch, the presence of perching shrubs and/or tall herbs within or near the grassland, grassland patch size and distance to the nearest patch; (Muchai *et al*., 2002) could also be factors that affect the distribution, local abundance and habitat use of the species. For instance, Abyssinian long-claws were observed (three times while foraging on the ground, and twice while perching on a conspicuous shrub) to be aggressively chased-away by Hill Chat (Asefa, A. *Unpublished data*). This may provide a support for the supposition that inter-specific interactions (e.g. competition for food and habitat resources) with other co-occurring species could also be of the factors that affect distribution and abundance of the species in the area. Furthermore, it was also observed that when disturbed, long-claws usually take a short flight (up to ~ 20 m distance) before landing (Asefa, A. *Unpublished data*). This may reflect that the types of habitat matrixes, such as tall herbs and shrubs that provide additional substrate for perching and singing around open grassland vegetation may be also influence the distribution and abundances of the species. However, the degree to which these assumptions could work needs further research.

Conclusions

This study has provided for the first time estimation of population size and some ecological aspects of Abyssinian long-claw which could help in its future studies and to set appropriate conservation measures for the species. It also demonstrated that livestock grazing regime could have significant implications for the conservation and management of Abyssinian Log-claw in the study area. However, more research is required *firstly*, to estimate the population size of the species in the Bale Mountains region as a whole, including the Afroalpine habitat, as well in Ethiopian highlands at large; and *secondly*, to test tolerance of Abyssinian long-claw to moderate disturbances and the effects of disturbances on the species of inter-specific interactions.

Acknowledgements

We thank Daniel Tilaye for his help during data collection and Girma Bekele of Wondo College of Forestry and Natural Resources (WGCF-NR) at Hawassa University for his driving services. We are also grateful to WGCF-NR for the financial support provided. Finally, we are grateful to the Ethiopian Wildlife Conservation Authority and the Bale Motains National Park for the research permission.

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