Reassessment of the distribution and threat status of the Western Ghats endemic bird, Nilgiri Pipit *Anthus nilghiriensis*

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Montane grasslands in India face threats from habitat modification and climate change, but have received little conservation attention. In the Western Ghats, 55–80% of this habitat has been converted to commercial and non-commercial plantations. We examine the distribution of a range-restricted, grassland-endemic bird, the Nilgiri Pipit *Anthus nilghiriensis* through both fieldwork and literature survey. We combine our mist-net-based capture data with museum records that appear to indicate a smaller distributional range for the species than indicated by secondary sighting records. We argue that the species is limited to grasslands above 1900 m. Using GIS methodology, we estimate the area of this habitat to be only 441 sq. km. Spread over just two mountain-tops, our analyses indicate a drastic reduction from the presently projected distribution, making this species one of the most restricted-range birds in India. We discuss potential causes for this discrepancy, including misidentification, which may mislead potential conservation action for such threatened birds. We propose palaeoclimatic changes to be the cause for the present distribution limit to the two large mountains (Nilgiris hills and Anamalai-Palani hills), while anthropogenic habitat modifications may limit the distribution at a finer scale within these mountains. Given the combined effect of historical large-scale landscape modification in this region and the possibility of climate change affecting this species, the Nilgiri Pipit and its habitat appear to be under considerable threat and the bird requires urgent conservation measures, starting with an elevation of IUCN threat level to 'Endangered'.

Keywords: *Anthus nilghiriensis*, endemic bird, montane grasslands, Shola forest, threat status.

GRASSLAND habitats are often a neglected landscape in the Indian conservation scenario[1], with these habitats often being classified as 'waste lands' and used as pasture land[1,2]. Species living exclusively in grasslands are thereby subjected to high pressures of habitat modifications. The global biodiversity hotspot, the Western Ghats hosts high-elevation grasslands in the sky islands or montane habitats, which have received insufficient conservation attention[1]. Although a considerable part of these grasslands is within India's protected area network, large parts remain outside this network. These habitats have faced multiple threats; historical forestry activities have converted large parts of this habitat to pine and wattle plantations[3,4]. There has also been extensive conversion to commercial plantations like tea, coffee and cardamom[5] and more recently, several species of invasive herbs and grasses have been noticed in these habitats[6]. Despite significant land-use change, these habitats have received little conservation action.

Montane habitats are also subject to greater threats from anthropogenic climate change[7,8]. Montane specialists are often inflexibly adapted to the micro-climatic conditions in such habitats, and any changes in these habitats impact these species adversely[9]. The Shola (montane) grasslands in the Western Ghats have been identified as a habitat that will be affected by anthropogenic climate change[10]. Range and distributional shifts are often the first observed effects of climate change[11], making reliable distribution information on montane specialists critical.

The Nilgiri Pipit *Anthus nilghiriensis* is a medium-sized Pipit with prominent broad, dark brown streaks on the head, back, breast, upper belly and flanks[12,13]; it is found in the high elevation grasslands of the Western Ghats. Many pipits look confusingly similar and careful inspection of key characters is required for accurate identification[14]. The Nilgiri Pipit is recognized to be different from other pipits partly based on dark streaks on the upper belly and flanks, a character that can be easily missed leading to potential misidentifications. It is a fairly common resident bird within the restricted higher elevation grasslands of Kerala and western Tamil Nadu, breeding above 1500 m in the Nilgiris, Palani Hills and the High Ranges[12]. Its distribution overlaps with that of the Paddy-field Pipit, *Anthus malayensis*[12,13] and may be easily confused with this species. Over the past decade, an increase in the reports of the species from different parts of the Western Ghats has led to a substantial extension of its known range (~150 km northwards) covering an area of

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about 11,700 sq. km, as estimated from shape file downloaded from the BirdLife International database[15].

Here we present data from our own expeditions and re-examine historical and recent records of the species. We present a new distribution map for the species and discuss conservation implications.

Methods

Study area

Most parts of our study area are the grassy hills and mountains of the Western Ghats, south of Brahmagiri mountains of Karnataka to the southernmost parts of the Ghats in Agasthyamalai hills, Tamil Nadu and Kerala. The locations surveyed include the sky islands or montane habitats of Brahmagiris, Banasura mountains, Kurichyarmala, Chembra peak, Camels hump mountains, Nilgiris, Sispara, Kodaikanal, Munnar, High-Wavies, Ponmudi, Kalakkad and Peppara. The altitude of the sampled areas ranges from 1300 to 2560 m. These areas are known to have high rainfall (~2500 mm annually; range 1200–4000 mm) and low temperatures varying from 22°C to 0°C (mean maximum temperature 18.2°C and mean minimum temperature 9.2°C) and occasional frost in the winter.

Field methods

Probable areas where Nilgiri Pipit could occur were identified using secondary and historical data. We conducted visual searches and mist-net-based capture surveys in different parts of the sky islands of Western Ghats (Figure 1 and Table 1). Our efforts to locate the Nilgiri Pipit at a location started with a visual search for any pipit in the grasslands for several hours (Table 1), usually with a four-member team, all of whom could identify a pipit (though not everyone could differentiate the Nilgiri Pipit). Upon detection of any pipit and watching its movements, we erected several 12 m × 2 m mist-nets (Table 1), often in a single or many 'V-patterned' sets (strategy to capture grassland birds following Martin[16]). Nets were usually opened at dawn and deployed until dusk (under cloudy conditions) and checked every 20 min to capture any pipit at that site. Many such minor sites (2 to 10) were sampled at each larger location. All captured individuals were ringed with Bombay Natural History Society bird bands. Morphometric measurements were taken following standard protocols[17]; the birds were photographed in hand to enable identification and a drop of blood sample was collected from the brachial vein following Sutherland *et al.*[18] for genetic analysis (not presented here). In locations where we were unable to capture the Nilgiri Pipit, we also conducted unstructured searches in larger areas.

Secondary data

We used the results from a previous search[19] of three search engines (1945–2012) – Science Citation Index's *Web of Science* (Thomson Reuters, New York, USA), *Biological Abstracts* (Thomson Reuters, New York, USA) and *Google Scholar* to collect literature on the Nilgiri Pipit. To this, we added information collated from reports, books, thesis and other grey literature. We also searched records of bird watching e-groups – Bangalore Birds, Kerala Birder and Tamil Nadu Birder for sighting records of the species. Photographic records were examined from moderated websites, www.indianaturewatch.in and www.orientalbirdimages.org (Appendix 1). In cases where exact GPS locations were not indicated, the location was assigned on *Google Earth* in the apparently most appropriate nearby habitat (grassland). These were subsequently extracted to a GIS platform (QGIS Lisboa version 1.8). Museum data were collected from American Museum of Natural History New York (AMNH), Smithsonian Institution, Field Museum of Natural History Chicago (FMNH), British Museum of Natural History

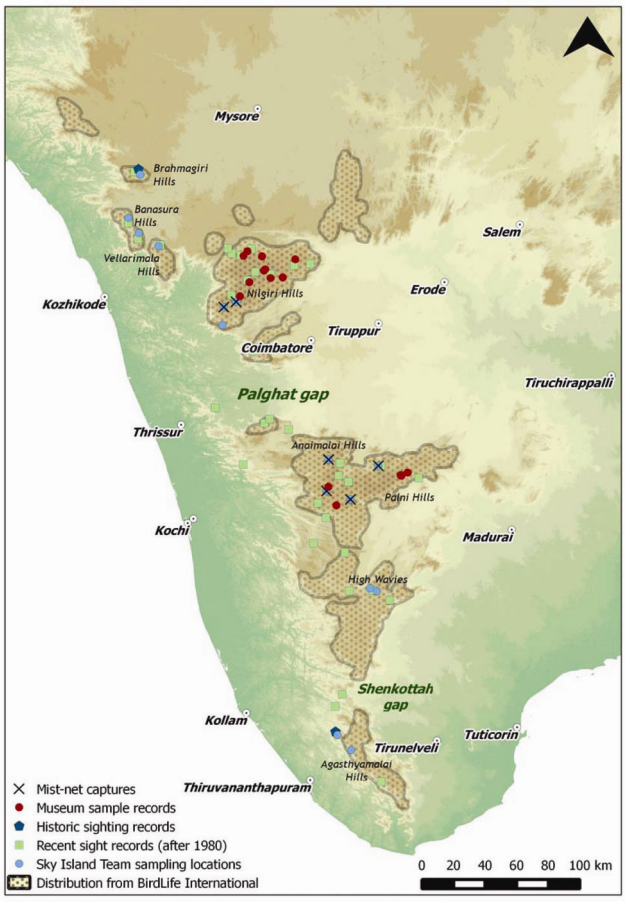

Figure 1. Current Nilgiri Pipit distribution map from the BirdLife International with museum records, historical sighting records (only those outside Nilgiri, Anamalai and Palani hills), recent sighting records and sampling locations from the present study.

Table 1. Mist netting locations and efforts on sky islands, Western Ghats

Elevation gradient (m)	Location	Altitude (m)	Season of mist-netting	No. of Nilgiri pipits		Mist-netting efforts (net-hours)	Visual search hours	Latitude	Longitude
				Capture	Sight				
< 1900	Brahmagiri	1400–1500	December–January–April	0	0	675	64	11.935768	75.98107
	Banasura	1800–1900	December, March	0	0	96	30	11.691429	75.913911
	Kurichyarmala	1400–1500	January–May	0	0	585	54	11.605499	75.972783
	Chembra (Camels hump)	1800–1900	December	0	0	360	21	11.533242	76.086748
	Peppara	1400	February–April	0	0	576	35	8.67533	77.192226
	Meghamalai	1620	March	0	0	48	6	9.595207	77.301531
	Sairandri	1500	April	0	0	2	15	11.088091	76.45355
>1900	Grasshills*	1945		1	3	30	10	10.323857	77.062831
	Sispara	2000–2300	March and April	2	8	72	25	11.189701	76.461381
	Munnar	1900–2000	January	2	12	84	18	10.145777	77.050838
	Meeshapulimala	2400–2500	February	8	18	324	21	10.098037	77.187963
	Kodaikanal	2140	April–May	2	5	72	15	10.289836	77.348084
	Upper Bhavani	2171	April–May	2	2	5	1	11.232459	76.479904

*From sampling in 2006–2008.

London (BMNH), Museum of Comparative Zoology Harvard (MCZ), Yale Peabody Museum (YPM), University of Washington Burke Museum (UWBM), Museum of Zoology, University of Michigan (UMMZ) and Bombay Natural History Society (BNHS), and their collection locations were plotted on *Google Earth* only when they were unambiguous (Appendix 2).

The 1900 m elevation contour was extracted based on Shuttle Radar Topography Mission (SRTM) data and grasslands higher than this elevation were demarcated from a French Institute of India floristics map (http://indiabiodiversity.org). In addition, all grasslands that we were aware of and not included in the above map were digitized on-screen based on the *Google Earth* layers (March 2014). The combination of all the grassland information available was used to demarcate grasslands above 1900 m as the Nilgiri Pipit distribution map (available through the Western Ghats portal at http://indiabiodiversity.org/group/western_ghats_sky_islands). We acknowledge that the current information on high-elevation grasslands is incomplete, with grasslands modified to timber plantations and agriculture. Further research is underway to develop a more precise land-use/land-cover map. The present distribution area (11,700 sq. km) was calculated as a sum of all polygons depicting the distribution of the species in the BirdLife International distribution map downloaded as a shape file and rendered on a GIS platform.

Results

Recent sighting records

The compilation of recent survey and sighting records of the Nilgiri Pipit from various sources include several locations from the high elevations of Nilgiri, Anamalai and the Palani hills[20,21]. There were also sightings reported from other areas to the north and south of these two mountains respectively (Aralam Sanctuary, Kottiyur Reserve Forest, Wayanad, Periyar Tiger Reserve, Ponmudi, Neyyar, Shendurney, Kulathupuzha). All primary sightings of Vinod[21] were from above 2000 m (except Siruvani, approximately above 1800 m), while secondary data from other birdwatchers between 1000 and 2000 m were also reported in Vinod's compilation[21].

Historical records

All accessed museum records and historical records of this Pipit were from either Nilgiris or Anamalais and also above 2000 m elevation (Figure 1). There are, however, historical records without museum specimens from two locations lower than 1300 m elevation, one from an unspecified location in Coorg by Betts[22], and another from Ponmudi Hills[12]. However, other surveys and expeditions by various groups, including the survey by Ali and Whistler[23], Sasikumar *et al.*[24] and Robin *et al.*[25,26] failed to record this species from these two locations.

Our capture records

We recorded the Nilgiri Pipit only from the higher-elevation grasslands above 1900 m and limited only to the Nilgiris and Anamalai-Palani hills (Table 1). Although the Anamalai and Palani hills are generally considered as different mountain ranges, in this article we denote this as a single unit (hyphenated) to highlight that the species distribution here is of a contiguous unit isolated from the Nilgiris. We could not locate Nilgiri Pipit in Brahmagiri,

Kottiyur, Banasura, Kurichyar mala, Chembra and Sairandri, 6 out of 11 locations where it was reported in the BirdLife International distribution map[15], despite considerable mist-net and visual search efforts.

The highest number of capture of the Pipit were at Meeshapulimala (Table 1), a grassland plateau in Munnar, with captures increasing with elevation between 2400 and 2600 m, a pattern also recorded by Vinod[21]. In some parts of this range like Kodaikanal, we found very little intact grasslands but found extensive *Acacia* and pine plantations and had great difficulty finding pipits and their habitats in this region.

We did not find or capture any Nilgiri Pipit north of the Nilgiris or south of Anamalai-Palani Hills despite our best efforts (Table 1). To the north of the Nilgiris, we sampled areas included in the current BirdLife International distribution map and in Sashikumar *et al.*[20], but recorded only Paddyfield Pipit or Long-billed Pipit from these sites.

Similarly, our expeditions to the south of Anamalai-Palani Hills, despite sampling in the grasslands of Agasthyamalai Hills (Peppara Wildlife Sanctuary and Kalakkad–Mundanthurai Tiger Reserve) and Meghamalai recorded only Paddyfield, Long-billed or Richard's pipits.

Discussion

Our mist-net-based capture records match museum records and majority of sighting records for the Nilgiri Pipit. All these records suggest that the Nilgiri Pipit is largely restricted to grasslands above 1900 m in the sky islands of the Western Ghats. In the absence of museum specimens or capture records of the Nilgiri Pipit north of the Nilgiri Hills or south of Anamalai-Palani Hills, we propose that the Nilgiri plateau and the Anamalai Hills (including the Palani Hills) be considered as distributional limits for this species.

Interestingly, the recent Nilgiri Pipit records in Sashikumar *et al.*[20] are all from the lower elevations (900–1400 m) of the regions north of Nilgiris, where we only recorded other species of pipits. With no museum record of the Nilgiri Pipit from this area, we are unsure about these sighting records.

The current distributional range of the Nilgiri Pipit on the BirdLife International map is about 11,699.55 sq. km. However, our study proposes that the distribution is restricted to two large mountains, i.e. grasslands above 1900 m in the Nilgiris and the Annamalai complex (inclusive of Palani Hills), with a total area of 441.24 sq. km.

One of the reasons for the discrepancy between visual sighting records and capture records could be due to problems with sampling. A species may not always be detected even when present due to varying detection probabilities, particularly in parts of a species' range where densities could be low[27]. While museum collections and mist-net-based captures are few and limited in spatial coverage, visual sighting-based surveys may cover larger areas, but less intensively. Alternatively, the discrepancy between records could be due to misidentification. In general, pipits are known to be difficult to identify, and the Nilgiri Pipit co-occurs with the much darker race of Paddyfield Pipit (*A. malayensis*). It is difficult to distinguish between these species in the field[14] and even in hand, unless both are available for comparison simultaneously. During our explorations of museum specimens, we found two museum specimens (BNHS museum) of Paddyfield Pipit collected in 1977 from the Nilgiris that were labelled incorrectly as Nilgiri Pipit (also commented on by Pamela Rasmussen; Figure 2). Those not familiar with these restricted species could be easily confused. We suggest that the discrepancy in recent sighting records and some museum specimens may be due to varied skill levels and familiarity with this species. It is possible to address some of these issues by supplementing sightings with adequate photo documentation that includes key identifying features of the species (see Vinod[21] for a list of features). Such photographs could be posted on web archives like India Nature Watch and Oriental Bird Images (see Appendix 1 for details) that can be verified/commented on by a larger community.

Although we do not have additional information to rule out either of these probable causes, the simplest explanation is that of misidentification and we hope that additional, more focused studies in the future will spread further light on this issue. Our results also highlight the usefulness of museum specimens and capture-based studies in the light of recent debate, e.g. Madhusudan *et al.*[28] regarding the difficulties in getting permissions from the Indian Government for such capture-based research. The projected distribution map of the Nilgiri Pipit is available publicly at the open data sharing portal: http://indiabiodiversity.org/group/western_ghats_sky_islands, so that additional records can be added to the species page to build on the current body of work.

Distribution in Kodaikanal/Palani Hills

Large parts of the species' range (between 53% and 85%) of high-elevation grasslands have been lost to commercial and non-commercial plantations over the last 150 years (R. Prabhakar in litt. and also cited in Vinod[21]). Such drastic reduction in habitat could have also resulted in some small populations of pipits (e.g. grasslands, if any, near Kodaikanal town) going extinct, although we do not suggest this to be the reason for the lack of records in the low-lying grasslands. There is also a discrepancy in the lack of recent records of the Nilgiri Pipit from Kodaikanal, compared to the many museum collections from this region. We suggest that this is due to considerable habitat alteration here. All museum collections from

Figure 2. Museum specimens of Nilgiri and Paddyfield pipits from Bombay Natural History Society. ***a***, Four Nilgiri pipits above (horizontal) and two Paddyfield pipits (vertical) that were misidentified as Nilgiri pipits with a note on the misidentification perhaps by Pamela C. Rasmussen. Note the more heavily streaked breast and flanks of the Nilgiri Pipit, and minor individual variations. Nilgiri Pipit is darker brown than Paddyfield Pipit, although not very evident in this photograph. ***b***, The heavily streaked flanks of Nilgiri Pipit (centre and bottom) compared to lightly streaked flanks of Paddyfield Pipit above.

Kodaikanal were from before 1938, when extensive grasslands are thought to have existed. Although we have not found documented evidence of conversion of grasslands from Kodaikanal, there is an indication from the Nilgiris that 85% of grasslands has been modified to plantations since the landscape map by Outcherlony in 1849. In Kodaikanal, Matthew[29], during his extensive surveys in the 1980s, also noted the drastic reduction in grasslands. Additionally, Stewart and Balcar[30–32] (R. Stewart and T. Balcar, pers. commun.), who have led Shola forest and grassland restoration for over two decades in the Palani Hills landscape, have also indicated the massive historical decline in grasslands from Kodaikanal and adjacent areas. Very recent, but preliminary visual study of remote sensing images by Ian Lockwood (http://goo.gl/Y1Zdre) and independent information (http://goo.gl/uWSFTu) also point to the same large-scale decline in the grasslands of Kodaikanal. Although there is substantial information that grasslands (and pipit habitat) in Kodaikanal have been drastically reduced, this needs to be quantified and studied separately.

Distribution in Meghamalai/High-Wavies

No grasslands above 1900 m in the Meghamalai or southern regions were detected, but this needs to be explored further with higher resolution maps. In our opinion, in this region, there was very little high-elevation grassland habitat left after conversion to tea estates during the colonial era. Targeted searches should be conducted here, as a recent survey by Babu and Bhupathy[33] has reported the Nilgiri Pipit from about 1550 m, although no photo documentation accompanies this record.

Anthropogenic habitat loss affecting fine-scale Nilgiri Pipit distribution patterns

Nilgiri Pipit appears to be a specialist species[21] in the high-elevation grasslands, which, at a fine scale (within each mountain) is affected by habitat loss and changes in land-use patterns. Conversion of grasslands to monoculture timber plantations such as pine and eucalyptus, commercial plantations like tea and activities including tourism, infrastructure development, reservoirs and agriculture may have all affected the species presence in the landscape. At this fine landscape level, the Nilgiri Pipit is also reported to prefer the marshy valley areas for nesting than the more extensive grassy slopes[21], implying that the actual preferred breeding habitat of the species is much smaller than the overall grasslands depicted in Figure 3. Such fine-scale habitat preference and detailed information on available high-elevation grasslands need to be collected to arrive at a more detailed distribution of the species.

Large-scale distribution pattern of Nilgiri Pipit shaped by palaeo-climate?

The Nilgiri Hills and Anamalai-Palani Hills are the largest high-elevation (above 1900 m) mountains in the Western Ghats, and the ranges to the north and south of these mountains are lower elevation mountains. This natural geography of the Western Ghats gives high-elevation specialists a larger area in the Nilgiri and Anamalai-Palani Hills. The smaller, lower elevation regions, can also be more severely impacted by climate change than the higher mountains, driving local population extinction.

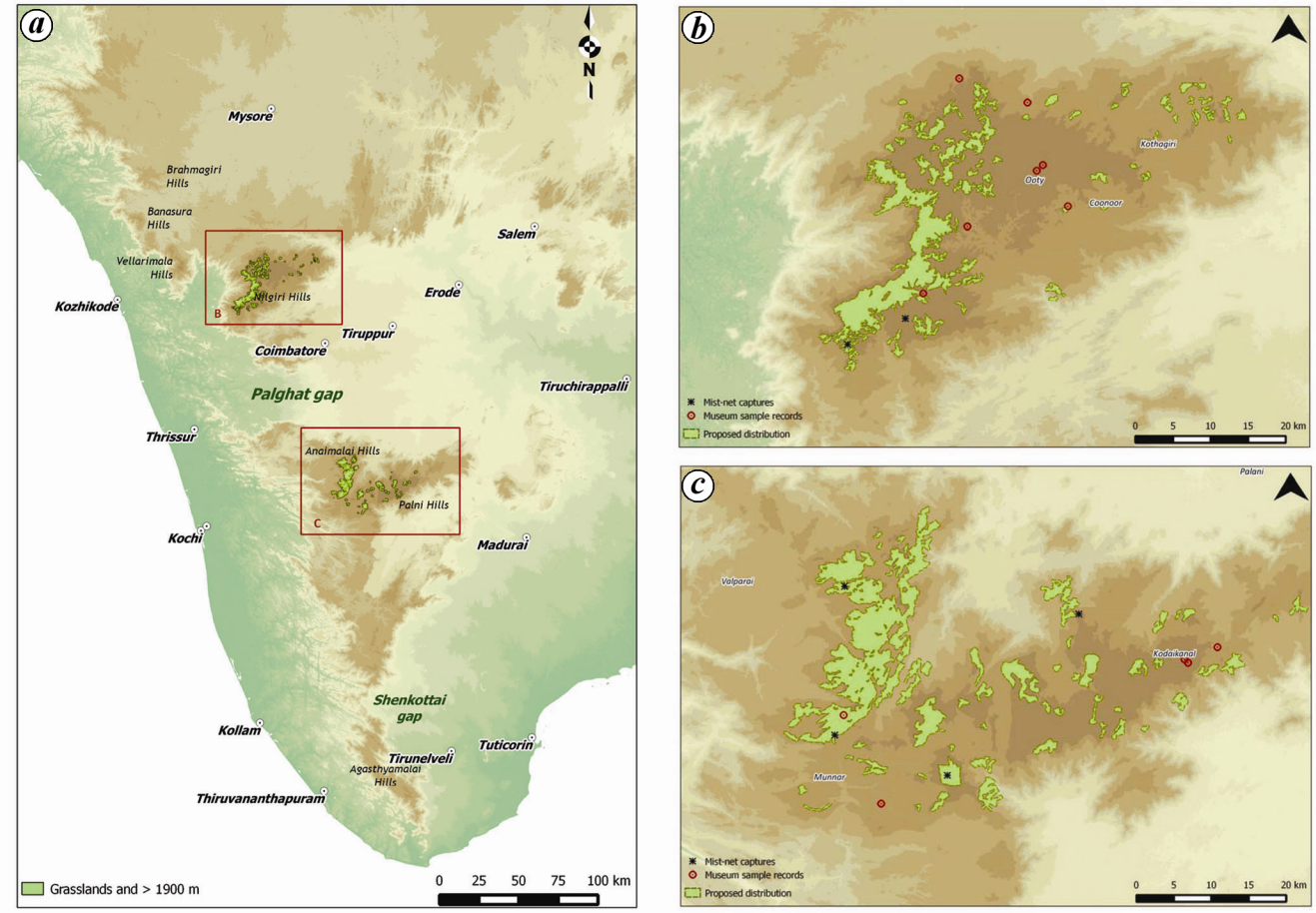

Figure 3. ***a***, Proposed Nilgiri Pipit distribution map indicating high-elevation grasslands (>1900 m), museum samples and capture records. ***b***, ***c***, Higher resolution views of the distribution map.

We suggest that the large-scale distribution and restriction of the species to the two mountaintops (sky islands) could have been driven by palaeo-climatic changes. There are other species with similar restricted distribution, like the high-elevation specialist plant *Rhododendron*, known from the Nilgiris and Anamalai-Palani-Meghamalai Hills[34]. Although no studies have been conducted on the Nilgiri Pipit, genetic studies of a Western Ghats montane specialist, Shortwing/Blue Robin complex (*Myiomela major* and *albiventris*), have shown effects of a demographic decline and expansion (in evolutionary timescale) correlating with palaeo-climatic events[35]. This indicates that such processes could impact species like the Nilgiri Pipit, a species restricted to higher elevations (distribution above 1900 m) than the shortwing (distribution above 1400 m). In the tropics, Pliestocene climatic fluctuations (like ice ages) are known to cause drastic effects on habitats due to aridification and subsequently affect montane populations[36].

Studies have indicated that such effects of palaeo-climate on species can also be used to predict future effects of anthropogenic climate change on species[37,38]. In the Western Ghats, the lower mountains can serve as an indicator for impending changes in the higher mountains, indicating a further loss of Nilgiri Pipit habitat with anthropogenic climate change. Additionally, tropical birds with their small ranges are more prone to effects of landscape change that adds to effects of climate change[39].

Red List status

We propose that the current red list status of the Nilgiri Pipit be elevated from Vulnerable[40] to Endangered (The IUCN Red List of Threatened Species, www.iucnredlist.org) based on calculations of area of available habitat from this study (~441 sq. km). This meets the IUCN Red List criteria for an Endangered species – B2 (area of occupancy estimated to be less than 500 sq. km) with B2a (known to exist at no more than five locations) and B2b ii & iii (area of occupancy and quality of habitat is continuing to decline). Our estimates agree with a suggestion by the BirdLife International[40] that the area of this species occupies may be approximately 400 sq. km, although their range maps indicate a larger distribution (as of 16 February 2014). We realize that much more focused sampling may be required in the mountains north and south

of the Nilgiris and Anamalai-Palani Hills respectively, to bring clarity to the species distribution. Higher resolution habitat maps demarcating Shola grasslands will also bring greater clarity to the distribution of the species. Such a map can update the present distribution map available through the Western Ghats portal at http://indiabiodiversity.org/group/western_ghats_sky_islands.

In summary, based on the information presently available, we believe the distribution of Nilgiri Pipit at a large scale is shaped by mountain physiography and palaeoclimatic events, while at a smaller scale (within each mountain), anthropogenic habitat loss has impacted the distribution of the species. We suggest that restricted distributions may be more common than previously appreciated in the Western Ghats. For example, with the current distribution suggested in this article, Nilgiri Pipit would be one of the most restricted range birds from this region (based on distribution information from BirdLife International as of 16 February 2014).

Taken together, the declining status of its population, its limited distribution, habitat destruction and the possibility of being further affected by climate change, there appears to be strong support to highlight conservation efforts for this species and its habitat, starting with elevating the threat level to Endangered. Clearly the high-elevation grasslands, typified by specialists like the Nilgiri Pipit, face considerable conservation challenges and a systematic action plan, including ecological restoration of the grasslands needs to be undertaken to safeguard the habitat and its allied species.

Appendix 1. Published photo records of Nilgiri Pipit

Location	Number of images	Source*	Notes
Munnar	37	18 – OBI, 20-INW	One record in OBI was erroneously labelled as a lower elevation record and has been corrected after our communication with OBI and image author
Mukurthi	2	OBI	
Unknown	1	OBI	
Nilgiris/Ooty	8	INW	
Mahabaleswar	2	INW	Image title reads 'Nilgiri Pipit', but no features of Nilgiri Pipit; looks more like Paddyfield Pipit

*OBI, Oriental Bird Images, www.orientalbirdimages.org; INW, India Nature Watch, www.indianaturewatch.net

Appendix 2. Museum specimens of Nilgiri Pipit

Museum	Catalogue no.	Date	Location (as on label)	Latitude (inferred)	Longitude (inferred)
MCZ	57448	–	Palani Hills	10.250593	77.51692
YPM	YPM ORN 009950	1883	Kalhatti	11.476818	76.68041
AMNH	571004	1883	Ootacamund	11.402791	76.69924
AMNH	571005	1883	Ootacamund	11.402791	76.69924
UWBM	54980	1883	Kodikanal	10.235957	77.47673
UWBM	54981	1901	Nilgiris	11.505458	76.59734
UMMZ	179976	1937	Kodaikanal	10.231881	77.48108
FMNH	243000	1937	Kodaikanal	10.231881	77.48108
FMNH	243001	1937	Kodaikanal	10.231881	77.48108
FMNH	243002	1937	Kodaikanal	10.231881	77.48108
FMNH	243003	1937	Kodaikanal	10.231881	77.48108
FMNH	243004	1937	Kodaikanal	10.231881	77.48108
FMNH	243005	1937	Kodaikanal	10.231881	77.48108
FMNH	243006	1937	Kodaikanal	10.231881	77.48108
FMNH	243007	1937	Kodaikanal	10.231881	77.48108
FMNH	243008	1937	Ootacamund, Nilgiri Hills	11.354178	76.72972
FMNH	243009	1937	Ootacamund, Nilgiri Hills	11.354178	76.72972
TMNH	453	–	Kallimala?	Not mapped	Not mapped
TMNH	454	–	Devicolum	10.064527	77.10739
TMNH	2154	–	Devicolum	10.064527	77.10739
TMNH	2169	–	Devicolum	10.064527	77.10739
TMNH	2170	–	Devicolum	10.064527	77.10739
BNHS	No number	–	Parson valley, Avalanche	11.396105	76.69172
BNHS	18266	–	Anamudi	10.169692	77.06168
BNHS	26522	–	Western catchment	11.330178	76.60723
BNHS	26734	–	Mukurthi	11.251107	76.5535

(*Contd*)

Appendix 2. (*Contd*)

Museum	Catalogue no.	Date	Location (as on label)	Latitude (inferred)	Longitude (inferred)
BMNH	1883.8.1.1	05/03/1883	Ootacamund, India	11.354178	76.72972
BMNH	1883.8.1.2	12/02/1883	Ootacamund, India	11.354178	76.72972
BMNH	1883.8.1.3	20/01/1883	Ootacamund, India	11.354178	76.72972
BMNH	1887.2.1.2780	09/04/1876	Coonoor, India	11.356665	76.799311
BMNH	1887.2.1.2781	08/03/1881	Coonoor, India	11.356665	76.799311
BMNH	1887.2.1.2782	30/05/1877	Palani Hills	10.250593	77.51692
BMNH	1887.2.1.2783	15/07/1874	Kotagiri, India	11.459665	76.871043
BMNH	1887.2.1.2784	19/08/1870	Kotagiri, India	11.459665	76.871043
BMNH	1887.2.1.2785	15/09/1874	Kotagiri, India	11.459665	76.871043
BMNH	1887.2.1.2786	08/01/1881	Ootacamund, India	11.354178	76.72972
BMNH	1887.2.1.2787	14/01/1881	Ootacamund, India	11.354178	76.72972
BMNH	1887.2.1.2788	14/01/1881	Ootacamund, India	11.354178	76.72972
BMNH	1887.2.1.2789	14/01/1881	Ootacamund, India	11.354178	76.72972
BMNH	1887.2.1.2790	08/01/1881	Ootacamund, India	11.354178	76.72972
BMNH	1887.2.1.2791	12/02/1881	Ootacamund, India	11.354178	76.72972
BMNH	1887.2.1.2792	12/02/1881	Ootacamund, India	11.354178	76.72972
BMNH	1887.2.1.2793	07/03/1881	Ootacamund, India	11.354178	76.72972
BMNH	1887.2.1.2794	15/03/1881	Ootacamund, India	11.354178	76.72972
BMNH	1887.2.1.2795	05/03/1881	Ootacamund, India	11.354178	76.72972
BMNH	1887.2.1.2796	05/03/1881	Ootacamund, India	11.354178	76.72972
BMNH	1887.2.1.2797	27/05/1881	Ootacamund, India	11.354178	76.72972
BMNH	1887.2.1.2798	27/05/1881	Ootacamund, India	11.354178	76.72972
BMNH	1887.2.1.2799	24/03/1881	Neddivutum, India	11.479460	76.573974
BMNH	1887.2.1.2800	26/03/1881	Neddivutum, India	11.479460	76.573974
BMNH	1887.2.1.2801	26/05/1881	Neddivutum, India	11.479460	76.573974
BMNH	1887.2.1.2802	09/06/1877	Palani Hills	10.250593	77.51692
BMNH	1887.2.1.2803	30/03/1877	Palani Hills	10.250593	77.51692
BMNH	1888.7.12.643	09/06/1877	Palani Hills	10.250593	77.51692
BMNH	1888.7.12.644	30/05/1877	Palani Hills	10.250593	77.51692
BMNH	1888.7.12.695	–	Malabar	Not mapped	Not mapped
BMNH	1898.10.20.948	–	Malabar	Not mapped	Not mapped
BMNH	1919.1.12.162	6/3/1918	Ootacamund, India	11.354178	76.72972
BMNH	1919.1.12.163	6/9/1918	Ootacamund, India	11.354178	76.72972
BMNH	1925.12.23.462	27/07/1894	Ootacamund, India	11.354178	76.72972
BMNH	1941.5.30.7457	/04/1883	Kodikanal, Pulni Hills, S. India	10.231881	77.48108
BMNH	1941.5.30.7458	04/05/1883	Pettui, Pulni Hills, S. India	Not mapped	Not mapped
BMNH	1949.Whi.1.6999	5/23/1935	Nilgiri Plateau, Madras, India	11.354178	76.72972
BMNH	1949.Whi.1.7001	6/29/1901	Ootacamund, India	11.354178	76.72972
BMNH	1949.Whi.1.7002	6/29/1935	Ootacamund, India	11.354178	76.72972
BMNH	1965.M.9191	11/10/1901	Coonoor, India	11.356665	76.799311
BMNH	1965.M.9192	11/10/1901	Coonoor, India	11.356665	76.799311
BMNH	1965.M.9193	11/10/1901	Coonoor, India	11.356665	76.799311

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