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RETURN OF THE PIN-TAILED SANDGROUSE (*PTEROCLES ALCHATA*) TO THE MERGUEB NATURE RESERVE, ALGERIA: EVIDENCE OF MASS NOMADISM AFTER FIVE DECADES OF ABSENCE

Hadj Aissa Benelkadi[a], Khawla Ziouani[a*], Sara Hezil[a], Houria Kasmi[c], Oussama Ailam[b]

[a]Division of Combating Desertification and Land Degradation in Steppe Areas. Centre for Research in Agropastoralism, Djelfa, 17000, Algeria;
[b]Department of Nature and Life Sciences, Faculty of Science, University of M'sila, PB 166, M'sila 028000, Algeria;
[c]Division of Microbial Systems Biology and Food Science. Centre for Research in Agropastoralism, Djelfa, 17000, Algeria
*Corresponding author. Email: khawla.ziouani@crapast.dz
Hadj Aissa Benelkadi: https://orcid.org/0000-0002-2964-9343
Khawla Ziouani: https://orcid.org/0000-0002-3895-2096
Sara Hezil: https://orcid.org/0000-0002-1739-2448
Oussama Ailam: https://orcid.org/0000-0003-2649-1840

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Abstract. In 2022, an exceptional mass reappearance of the Pin-tailed Sandgrouse (*Pterocles alchata*) was recorded in the Mergueb Nature Reserve (Algeria), north central Algeria, marking the first occurrence of this species in the region since 1974. Thousands of individuals were observed between April and September, exhibiting active breeding behaviour and complete dispersal following juvenile fledging. The birds concentrated in open steppe habitats dominated by annual vegetation and situated in proximity to water sources, conditions favoured by above-average seasonal rainfall and increased food availability. This unprecedented nomadic influx underscores the remarkable ecological flexibility of *P. alchata* and its capacity to respond rapidly to episodic environmental changes. These findings provide the first modern evidence of large-scale sandgrouse nomadism in Algeria and highlight the importance of continued ecological monitoring to understand population dynamics, habitat use, and the effects of climatic variability on arid land bird communities.

INTRODUCTION

Sandgrouse (Pteroclidae) are emblematic inhabitants of arid and semi-arid ecosystems, known for their exceptional physiological and behavioural adaptations that enable them to survive under extreme environmental conditions (Del Hoyo et al. 1997; Hinsley et al. 1992). These birds possess cryptic plumage, specialized feather structures that allow water transport, and nomadic tendencies that enable them to exploit temporary habitats following rainfall events (Clulow et al. 2011). Among them, the Pin-tailed Sandgrouse (*Pterocles alchata*) is one of the most widespread species of the Western Palearctic, ranging from the Iberian Peninsula through North Africa to the Middle East (Cramp and Simmons 1980; Lenz et al. 2015). This species exhibits a high degree of mobility, often engaging in nomadic or irruptive movements in response to fluctuations in rainfall and food availability (Thomas 1984). Recent advances in non-invasive monitoring have improved the understanding of *P. alchata* populations, highlighting the challenges of detecting and estimating numbers in fragmented and steppe habitats (Sanz-Pérez et al. 2025). Moreover, recent physiological investigations, such as the renal histology of *P. alchata* in Iraq, have shed light on the species' adaptations to conserve water and tolerate desiccating environments (Obaid and Al-Bakri 2024).

Investigations of animal movement patterns provide essential insights into ranging behaviour and space utilization, which are crucial for understanding ecosystem functions (Lenz et al. 2015). Movement strategies, such as migration, nomadism, or residency, often arise from spatio-temporal variability in resource availability, particularly in arid environments (Clulow et al. 2011). In North Africa, *P. alchata* occurs mainly in semi-arid steppe regions of Morocco, Algeria, and Tunisia, breeding opportunistically after years of favourable rainfall (Isenmann and Moali 2000). Comparative studies of other *Pterocles* species, such as the Spotted Sandgrouse (*P. senegallus*), have demonstrated similar nomadic and pre-breeding scouting behaviours linked to ephemeral resource availability (Gur et al. 2020), suggesting that

P. alchata follows analogous ecological strategies.

In Algeria, six *Pterocles* species have been recorded: Pin-tailed Sandgrouse (*P. alchata*), Black-bellied Sandgrouse (*P. orientalis*), Spotted Sandgrouse (*P. senegallus*), Crowned Sandgrouse (*P. coronatus*), Lichtenstein's Sandgrouse (*P. lichtensteinii*), and Chestnut-bellied Sandgrouse (*P. exustus*) (Samraoui, Samraoui 2008; Farhi et al. 2019; Abdelhadi et al. 2018; Benali et al. 2021). These species reflect the diversity of Algeria's arid biomes, from Saharan dunes dominated by *P. senegallus* and *P. coronatus* to the high plateaus preferred by *P. orientalis* and *P. alchata*. Within the Mergueb Nature Reserve, located on the central Algerian high plateaus, historical records indicated the presence of *P. alchata* until 1974 (Ledant et al. 1981). Subsequent surveys failed to detect the species for nearly five decades, likely due to habitat degradation, increasing aridity, and anthropogenic disturbance (Bensaci et al. 2013).

Nomadism refers to unpredictable, unseasonal, and irregular movements across landscapes and regions, often reflecting fluctuating resources and opportunistic foraging, especially in desert environments (Dean 2004). The mechanisms underlying nomadic behaviour remain poorly understood (Krietsch et al. 2020). According to Delfino and Carlos (2021), nomadism involves species that move without a fixed spatial or temporal pattern, distinguishing them from migrants. Although the ecological drivers of nomadism are complex, understanding these movements is essential for elucidating life history strategies and for developing effective conservation measures. Many arid zone birds exhibit low site fidelity, with individuals rarely reoccupying the same site across years (Gibson et al. 2022). Several nomadic species are dietary specialists that depend on spatially and temporally heterogeneous resources, adjusting their ranges in response to dynamic environmental conditions (McCabe et al. 2021). The Pin-tailed Sandgrouse exemplifies this behavioural flexibility as a nomadic bird of the Saharan and sub-Saharan regions of North Africa (Dean 2004). However, spatially explicit studies on the ranging behaviour remain scarce, limiting our understanding of how its movements may influence ecosystem functioning. Nomadic behaviour was observed in *P. senegallus* during the pre-breeding and breeding seasons (Gur et al. 2020).

Although *P. alchata* populations are widespread, their local persistence has declined in several parts of their range due to increasing climate variability and habitat modification. The species is protected under the Bern Convention on the Conservation of European Wildlife and Natural Habitats and the EU Birds Directive, which recognizes it as of Community interest requiring strict habitat protection (Abdelhadi et al. 2018; Benali et al. 2021).

The reappearance of *P. alchata* in 2022 in the Mergueb Nature Reserve represents a significant ornithological event, marking the first recorded mass incursion since 1974. Thousands of individuals were observed during the breeding season, coinciding with above-average rainfall and high vegetation productivity conditions that likely facilitated this large-scale nomadic movement. Similar nomadic irruptions have been linked to rainfall-driven increases in seed abundance and ephemeral plant growth in other *Pterocles* species (Farhi et al. 2019; Gur et al. 2020), highlighting the group's capacity to respond rapidly to short-term ecological opportunities and their vulnerability to increasing climatic variability in North Africa (Thomas 1984).

Therefore, this study aims to (1) document the return and breeding activity of the Pin-tailed Sandgrouse (*Pterocles alchata*) in the Mergueb Nature Reserve after fifty years of absence, (2) characterize the habitat features selected by this species during the 2022 incursion, and (3) discuss the ecological and conservation implications of mass nomadism in the context of increasing climate variability. By integrating recent field observations with historical and regional data, this study contributes valuable baseline information for understanding the dynamics of *Pterocles* populations in Algeria and for guiding future ecological monitoring and conservation management of steppe avifauna.

MATERIALS AND METHODS

Study Area

This study was conducted in the Mergueb Nature Reserve, located in north-central Algeria, within the M'sila region, especially near the locality of Sidi Hadjres (Figure 1a). The reserve was officially designated as a protected area in 1983 by Executive Decree No. 83-509 of 20 August 1983. It covers an area of approximately 16,481 hectares, representing a predominantly steppe ecosystem within an arid bioclimatic zone characterized by cool winters and hot, dry summers. The site extends between latitudes 35°36'12.6"N-35°35'05.7"N and longitudes 03°56'23.8"E-03°58'08.7"E at altitudes ranging from 600 m to 650 m a.s.l. (Benelkadi et al. 2021).

Climatic data obtained from NASA POWER (1994–2024) indicates an average annual precipitation of 357.4 mm. The wettest months are January and April (≈ 40 mm each), whereas July is the driest (≈ 5 mm). The coldest month is January (mean min = 3.4 °C), and the hottest is July (mean max = 44.8 °C). Ombrothermic analysis (Gaussen–Bagnouls diagram; Figure 1b) reveals a prolonged dry period of approximately 4 months and 10 days, typically from mid-May to late October. According to Emberger's climagram (Figure 1c), the region falls within the arid bioclimatic zone with a cold winter.

The Mergueb landscape consists of undulating plains and shallow depressions that temporarily retain water after rainfall, forming key foraging and drinking sites for steppe birds. The vegetation is dominated by xerophytic and halophytic species, primarily *Artemisia herba-alba*, *Artemisia campestris*, *Salsola vermiculata*, *Anabasis articulata*, and *Stipa tenacissima*, interspersed with a rich assemblage of annuals and biennials. Soils are sandy clay loam to sandy loam, with low organic matter content (Adjabi et al. 2019; Kaabeche 2003).

Field Surveys and Observation Protocol

Fieldwork was conducted from April to September 2022, corresponding to the appearance of the Pin-tailed Sandgrouse (*Pterocles alchata*) in the Mergueb Nature Reserve. The objectives were to record the presence, abundance, and breeding activity of the species during its exceptional nomadic incursion and to predict the emergence of another wave of similar nomadism within the next two years (2023–2024).

Observations were carried out using simple field survey methods, combining direct visual counts and photographic documentation. Photographs and short video sequences were taken to confirm species identification and document breeding activity. Surveys were conducted on foot and by vehicle along accessible tracks and open areas of the steppe, covering the main vegetation types and water sources. Each area was visited several times per month, mainly during the early morning hours (05:30–09:30), when bird activity was the highest. High-resolution photographs and short video sequences were taken to confirm species identification and breeding behaviour.

Additional information on the historical presence of *P. alchata* was obtained from interviews with local residents and reserve staff in Sidi Hadjres. They provided accounts of past sightings, particularly referring to a similar mass occurrence recorded in 1974. These testimonies were used to compare present observations with historical patterns and to assess the species irregular occurrence in the region.

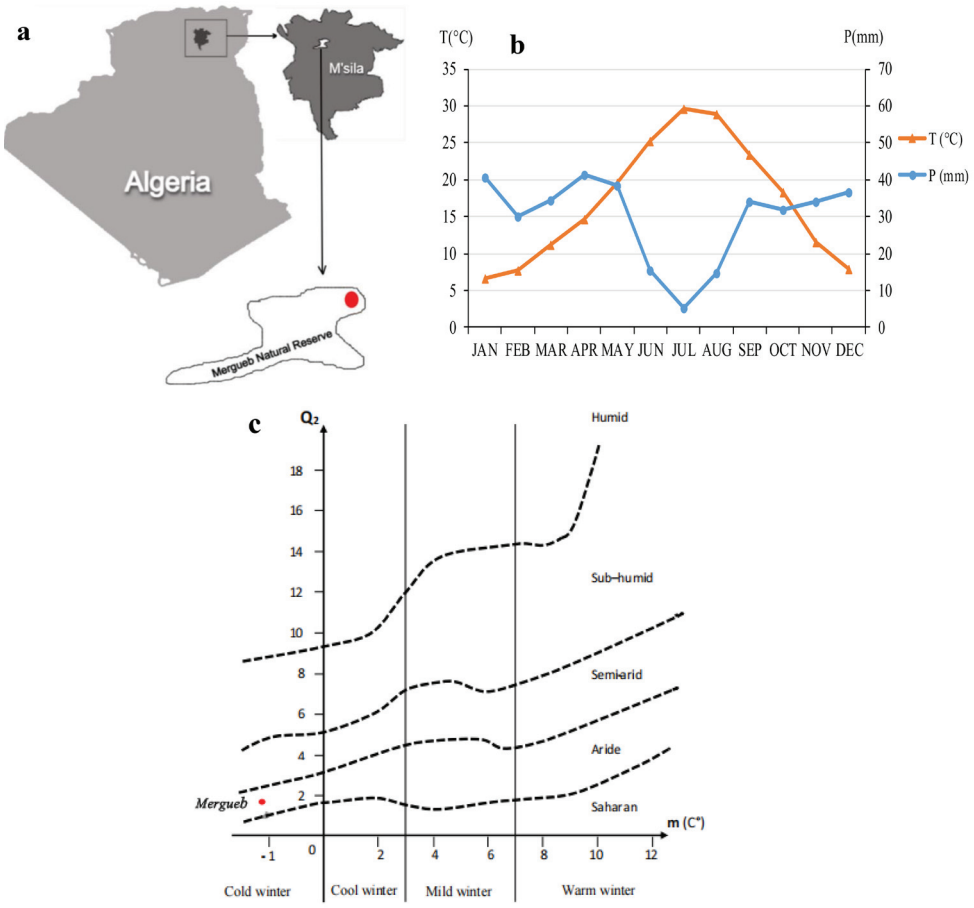

Figure 1. (a) Geographical location of the Mergueb Nature Reserve (M'sila, Algeria) showing the main observation sites of the Pin-tailed Sandgrouse. (b) Ombrothermic diagrams illustrating the monthly temperature and precipitation patterns for the Mergueb station. (c) Localization of the Mergueb study site on Emberger's pluviometric diagram. The Y-axis (Q_2) represents Emberger's pluviothermic quotient, which integrates annual precipitation and thermal amplitude, and the X-axis (m) corresponds to the mean minimum of the coldest month (°C). Each curve classifies a bioclimatic stage: humid, sub-humid, semiarid, arid, and Saharan. The Mergueb site is indicated by a red dot.

RESULTS

A remarkable case of mass nomadism of the Pin-tailed Sandgrouse (*P. alchata*) was recorded in the Mergueb Nature Reserve (M'sila, Algeria) during the spring and summer of 2022. Flock counts suggested that the population exceeded several thousand individuals over six months (April–September). This irruptive event was not observed in the subsequent two years (2023–2024), confirming its episodic and unpredictable nature.

Local testimonies and archival information indicated that a similar large-scale occurrence had last been recorded in 1974, suggesting the absence of nearly five decades. In most years, only small groups (fewer than a dozen individuals) are typically observed in the region.

Breeding activity was confirmed during the 2022 event. Nesting began in April and continued through late July, with eggs and chicks observed by early summer (Figure 2c). Juvenile fledged by late August, and complete dispersal occurred by the end of September (Figure 2d).

Sandgrouses concentrated in open steppe habitats located approximately 2–3 kilometres from artificial water retention ponds (El Gao – Sidi Hadjres), which served as their main watering sites during the early morning (Figure 2a, 2b). Nesting grounds were sparsely vegetated, dominated by *Hammada scoparia, Eruca visicaria, Peganum harmala, Artemisia herba-alba,* and adjacent cereal cultivation fields, covering several hundred hectares.

Activity was restricted primarily to early morning, with birds rarely observed at midday, indicating a behavioural adaptation to high summer temperatures typical of the semi-arid steppe.

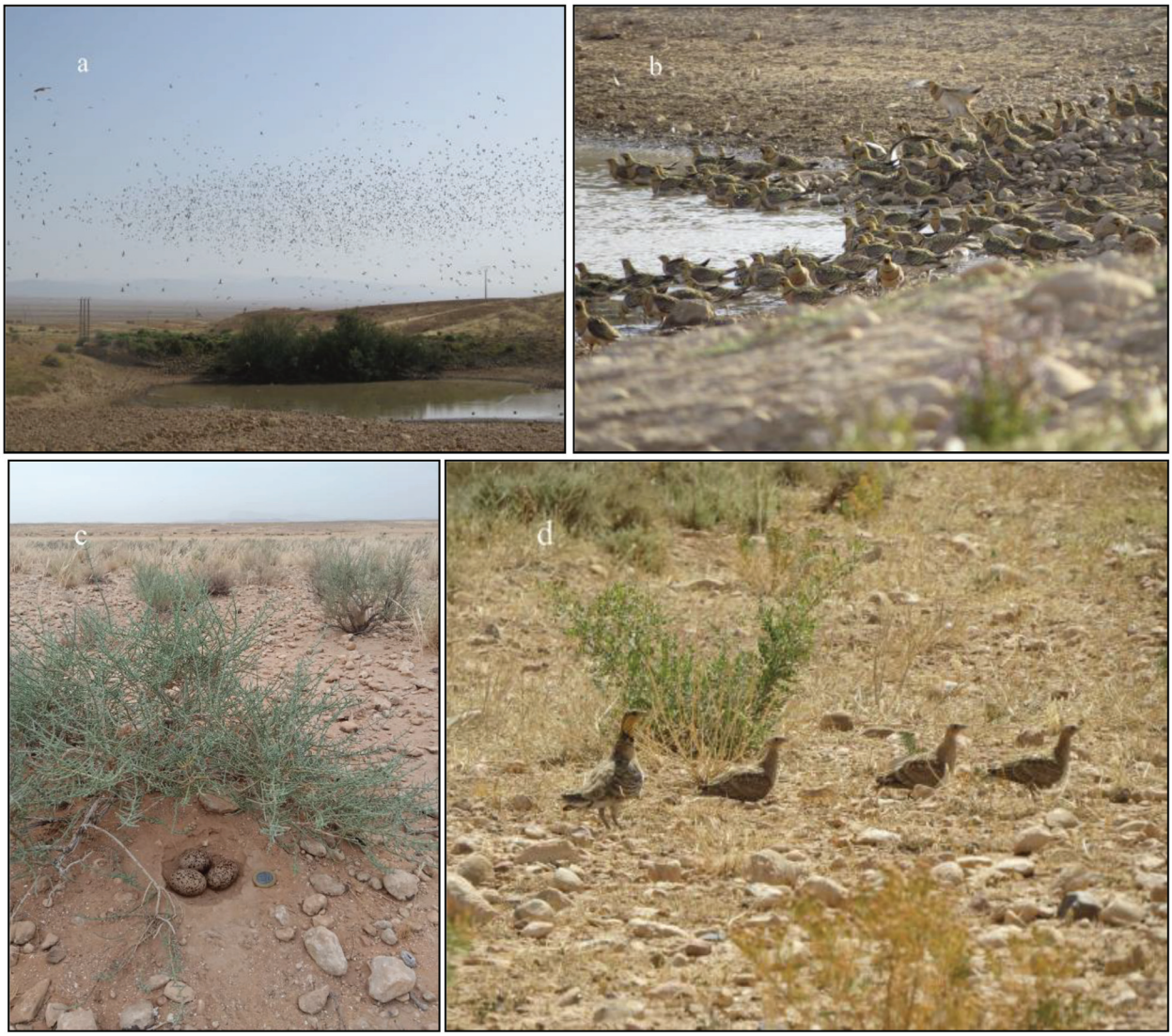

Figure 2. Pin-tailed Sandgrouse in the Mergueb Natural Reserve in Algeria: (a) Water sources. (b) Morning watering. (c) Nesting. (d) Juvenile Pin-tailed Sandgrouse. Photo by Benelkadi H.A.

DISCUSSION

The mass nomadism of the Pin-tailed Sandgrouse (*Pterocles alchata*) observed in 2022 at the Mergueb Nature Reserve represents a rare ecological event occurring nearly five decades after the last known occurrence in 1974. As a species that typically nests at low densities, *P. alchata* is known to undertake large-scale displacement when conditions in its core range become unfavourable, temporary colonizing more productive habitats with greater food availability (Watson and Keren 2019).

Nomadic migrations of sandgrouses occur unpredictably in space and/or time (Robart et al. 2022), reflecting adaptive responses to ephemeral resources in arid ecosystems. This explains the rarity of mass influxes towards the Mergueb Reserve and variability in direction, route, and destination across years as settlement decisions rely heavily on localized ecological cues. The 2022 irruption was marked by periods of residence (Delfino and Carlos 2021) corresponding to months of favourable rainfall (19 mm in February, 35 mm in March, and 30.8 mm in April), which promoted ephemeral vegetation and abundant seed resources essential for breeding success. Such resource-driven movements are characteristic of many arid-zone birds that exploit temporary increases in food and water availability (Dean 2004).

The favourable rainfall recorded in early 2022 likely triggered a localized vegetation bloom, providing abundant seeds and nesting cover. The birds established temporary breeding colonies in open steppe habitats dominated by *Artemisia herba-alba*, *Hammada scoparia*, and adjacent cereal fields, generally within 2–3 km of water sources – an essential factor for successful reproduction. Historically, *P. alchata* has been distributed discontinuously across Algeria's High Plateaus and Saharan fringes (Isenmann and Moali 2000; Ledant et al. 1981), yet the Mergueb region appears to serve as a transitional refuge during favourable climatic windows.

Temperature and photoperiod fluctuations are known to influence migratory timing and settlement behaviour in many steppe birds (Pretorius et al. 2020), and they may have also contributed to the 2022 nomadic incursion. In the context of global climate change, understanding how individuals disperse and populations reorganize in response to extreme weather events is increasingly critical (Macario et al. 2021). Algeria has faced persistent drought over the past 25 years, with an estimated 30% rainfall deficit (Dahlab et al. 2023), conditions that may intensify the irregularity of nomadic patterns (Dahlab et al. 2023).

Comparable reappearance phenomena have been recorded for other steppe specialists such as the Little Bustard (*Tetrax tetrax*), which reappeared in Algeria after more than three decades of apparent extinction (Cheikh et al. 2024). Both species share similar ecological requirements and exhibit opportunistic, rainfall-driven movements that underline the resilience and plasticity of steppe avifauna. These episodic returns most likely represent temporary responses to short-lived ecological opportunities rather than stable recolonizations, emphasizing the need for continuous, long-term monitoring.

Overall, the 2022 nomadic event demonstrates how *P. alchata*, a species highly adapted to environmental unpredictability, can respond dynamically to resource pulses in arid landscapes. Future research should integrate long-term field surveys, remote sensing of vegetation productivity, and climate data analysis to identify the drivers of nomadism, assess population connectivity, and forecast similar events. Understanding these mechanisms is essential for anticipating the effects of climate variability and guiding effective conservation strategies for steppe ecosystems in Algeria and across North Africa.

CONCLUSION

The remarkable return of the Pin-tailed Sandgrouse (*Pterocles alchata*) to the Mergueb Nature Reserve after nearly five decades highlights the species' exceptional ecological adaptability and nomadic behaviour in response to transient environmental conditions. This event underscores the importance of steppe habitats as temporary refuges during favourable climatic periods and illustrates how episodic rainfall can drive large-scale avian movements in arid ecosystems. Our findings provide the first modern evidence of mass sandgrouse nomadism in Algeria, offering valuable insight into the dynamics of steppe bird populations under increasing climatic variability. Continued long-term monitoring and integrative ecological studies are essential to better understand these movements and to guide conservation efforts for steppe biodiversity across North Africa.

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