

Distribution, Abundance, and Conservation Status of the Air Patas Monkey *Erythrocebus patas villiersi* Dekeyser, 1950 (Primates: Cercopithecidae) in the Air Massif-Gadabedji Region, Niger

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Abstract: The Air patas monkey *Erythrocebus patas villiersi* is regarded as isolated and endemic to the Air Massif of central north Niger, West Africa. The limits of the geographic range of *E. p. villiersi* are poorly understood, there is no detailed description of the coloration and pattern of its pelage, and its abundance, ecology, behavior, and threats remain unstudied. As a result, this subspecies is listed as ‘Data Deficient’ on The IUCN Red List of Threatened Species. Based on field observations and photographs, we describe the phenotype of the adult male *E. p. villiersi*. Spatial data were collected from the literature, museums, colleagues, naturalists, local experts, and online resources to assess its geographic range. The geographic range was overlaid with ArcGIS datasets for altitude, rainfall, temperature, and ecoregions.

Erythrocebus p. villiersi is phenotypically distinctive from the western patas monkey *Erythrocebus patas patas*, the main diagnostic traits being the shape and color of the browband and temporal bands, and color of the face and the sides of the base of the tail. We found that *E. p. villiersi* is not endemic to the Air Massif but occurs in five populations in rocky landscapes, vegetated valleys, and agricultural lands north of 15.02°N (Gadabedji) and south of 19.99°N (Gréboun). The confirmed geographic range is ~51,000 km². Altitudinal range is 415–2,022 m asl, mean annual rainfall range is 4–31 cm, and mean annual temperature range is 27–35°C. *Erythrocebus p. villiersi* appears to be highly reliant on perennial water sources. During the hot and dry season, it is most often encountered near villages, farms, and sources of water. *Erythrocebus p. villiersi* is the most common non-human primate in the Air-Gadabedji Region. There are currently about 2,000–3,500 individuals; 1,500–2,000 in the Air Region and 500–1,500 in the Gadabedji Region.

The root cause of all threats to the long-term survival of *E. p. villiersi* is the rapid growth of the human population in the Air-Gadabedji Region. While *E. p. villiersi* is not a target species for poachers, it is part of the by-catch of poaching, hunted by domestic dogs, and persecuted in response to crop raids. Access to perennial water is increasingly difficult for *E. p. villiersi*. About 63% of the geographic range is within a protected area or proposed protected area. Wildlife numbers seem to be recovering with the gazettelement of reserves and improved security. We suggest reassessing *E. p. villiersi* as ‘Near Threatened’.

Résumé: Le singe patas de l’Air, *Erythrocebus patas villiersi*, est considéré comme isolé et endémique du massif de l’Air dans le centre-nord du Niger, en Afrique de l’Ouest. Les limites de l’aire géographique de *E. p. villiersi* sont mal comprises, il n’existe aucune description détaillée de la couleur et de l’aspect de son pelage, et son abondance, son écologie, son comportement et les menaces qui pèsent sur lui n’ont pas été étudiées. En conséquence, cette sous-espèce est classée comme «Données insuffisantes» sur la Liste rouge de l’UICN des espèces menacées. Sur la base d’observations sur le terrain et de photographies, nous décrivons le phénotype du mâle adulte *E. p. villiersi*. Des données spatiales ont été collectées à partir de la littérature, des musées, des collègues, des naturalistes, des experts locaux et des ressources en ligne pour évaluer son aire géographique. L’aire géographique a été superposée avec une série de données ArcGIS pour l’altitude, les précipitations, la température et les écorégions.

Erythrocebus p. villiersi est phénotypiquement distinct du patas monkey occidental, *Erythrocebus patas patas*, les principaux traits diagnostiques étant la forme et la couleur de la bande frontale, la bande temporale, la couleur du visage et des côtés à

la base de la queue. Nous constatons que *E. p. villiersi* n'est pas endémique du massif de l'Aïr mais se trouve en cinq populations dans des paysages rocheux, des vallées végétalisées et des terres agricoles au nord de 15,02°N (Gadabedji) et au sud de 19,99°N (Gréboun). L'aire géographique confirmée est d'environ 51 000 km². L'altitude varie entre 415 et 2 022 m, les précipitations annuelles moyennes sont comprises entre 4 et 31 cm et la température annuelle moyenne est comprise entre 27 et 35°C. *Erythrocebus p. villiersi* semble être fortement dépendant des sources d'eau pérennes. Cette sous-espèce est souvent rencontrée autour des villages, des fermes et des points d'eau, particulièrement pendant la saison chaude et sèche. *Erythrocebus p. villiersi* est le primate non humain le plus commun dans la région Aïr-Gadabedji. Il y a actuellement environ 2 000 à 3 500 individus; 1 500 à 2 000 dans la Région de l'Aïr et 500 à 1 500 dans celle de Gadabedji.

La cause profonde de toutes les menaces sur la survie à long terme de *E. p. villiersi* est la croissance rapide de la population humaine dans la région Aïr-Gadabedji. Bien que *E. p. villiersi* ne soit pas une espèce ciblée par les braconniers, elle fait partie des prises accessoires de la chasse, est chassée par des chiens domestiques et persécutée en réponse aux raids sur les cultures. L'accès à l'eau pérenne devient de plus en plus difficile pour *E. p. villiersi*. Environ 63% de l'aire géographique se trouvent dans une zone protégée ou une zone protégée proposée. Les effectifs de la faune semblent se rétablir avec la création de réserves et l'amélioration de la sécurité. Nous suggérons de réévaluer *E. p. villiersi* comme «Quasi menacé».

Key Words: Agadez, Aïr and Ténéré National Nature Reserve, Dannet, *Erythrocebus patas sannos*, *Erythrocebus patas patas*, Gréboun, Mount Bagzane, Mount Egalagh Communal Nature Reserve, Sahara Desert, Teguidit

Introduction

Reliable information on the taxonomy, distribution, abundance, and conservation status of populations is not only of scientific interest, but also critical to setting science-based priorities for actions for the conservation of biodiversity (Grubb *et al.* 2003; Mace 2004; Zinner and Roos 2016; Vogel Ely *et al.* 2017; Gippoliti *et al.* 2018, 2024; Butynski and De Jong 2024). Patas monkeys *Erythrocebus* Trouessart, 1897, are medium-sized, semi-terrestrial primates with a complex and unresolved taxonomy. This genus, endemic to tropical Africa, ranges south of the Sahara Desert and north and east of the equatorial forests, from west Senegal and The Gambia, south Mauritania, Guinea Bissau, and north Guinea, eastward to South Sudan, west Ethiopia, and north Uganda, and southward to the Laikipia Plateau in central Kenya and the Serengeti Ecosystem in central north Tanzania (Fig. 1; De Jong *et al.* 2008, 2009, 2025; Oates 2011; Isbell 2013). Museum specimens and photographs of live individuals from most of the geographic range of *Erythrocebus* are limited or absent. As a result, the taxonomy of this genus is impeded, accurate assessments of the conservation status of each taxon are lacking, and the setting of priorities for conservation actions is difficult.

At least 19 taxa have been described within *Erythrocebus* (Elliot 1913; Schwarz 1927; Allen 1939; Grubb *et al.* 2003; Groves 2001, 2005; Gippoliti 2017; De Jong and Butynski 2021; De Jong *et al.* 2025). The most recent is the Aïr patas monkey *Erythrocebus patas villiersi* Dekeyser, 1950, a taxon regarded as isolated and endemic to the Aïr Massif (=Aïr Mountains) of central north Niger, West Africa (Hill 1966; Masseti and Bruner 2009; De Jong and Butynski 2022b; Figs. 1 and 2). A detailed description of the coloration and pattern of the pelage of the adult male holotype of *E. p. villiersi* has not been published [specimen CG IFAN

47-10-165, Institut Fondamental d'Afrique Noire (IFAN), Dakar, Senegal]. Dekeyser (1950) designated *E. p. villiersi* based on dental, skull, and body size differences when compared to the western patas monkey *Erythrocebus patas patas* (Schreber, 1775) from Casamance, west Senegal. He found pelage coloration differences and suggested that *E. p. villiersi* evolved in isolation in a very different environment from *E. p. patas*.

Hill (1966), Napier and Napier (1967), Dandelot (1974), Cardini *et al.* (2021), De Jong and Butynski (2021, 2022b), and De Jong *et al.* (2025) recognized *villiersi* as a subspecies, while Groves (2001), Grubb *et al.* (2003), Kingdon *et al.* (2008), Isbell (2013), and Kingdon (2015) considered it a synonym of *E. patas*. Additional information concerning the taxonomic arrangement of *Erythrocebus* is provided by Gippoliti (2017), De Jong and Butynski (2021), and De Jong *et al.* (2025). A comprehensive taxonomic review of *Erythrocebus* is required (De Jong and Butynski in prep.). Until then, we treat *villiersi* as a subspecies of *E. patas*.

Erythrocebus p. villiersi is known to occur in the larger valleys in the southern Aïr Massif, a set of granitic mountains protruding from the Sahara Desert (Dekeyser 1950; Masseti and Bruner 2009; J. Newby, T. Rabeil, and T. Wachter pers. comm. 2019). The limits of the geographic range of *E. p. villiersi* are, however, poorly understood and, as a result, this subspecies is listed as 'Data Deficient' on The IUCN Red List of Threatened Species (De Jong and Butynski 2022b).

Erythrocebus p. villiersi, locally called 'awirked zagaghan', occupies drier, hotter, and rockier landscapes than other *Erythrocebus*. The ecology and behavior of *E. p. villiersi* remain unstudied but are presumed to be similar to that of other taxa within *Erythrocebus* (Hall 1965; Struhsaker and Gartlan 1970; Chism *et al.* 1984; Chism and Rowell 1986, 1988; Harding and Olson 1986; Nakagawa 1992,

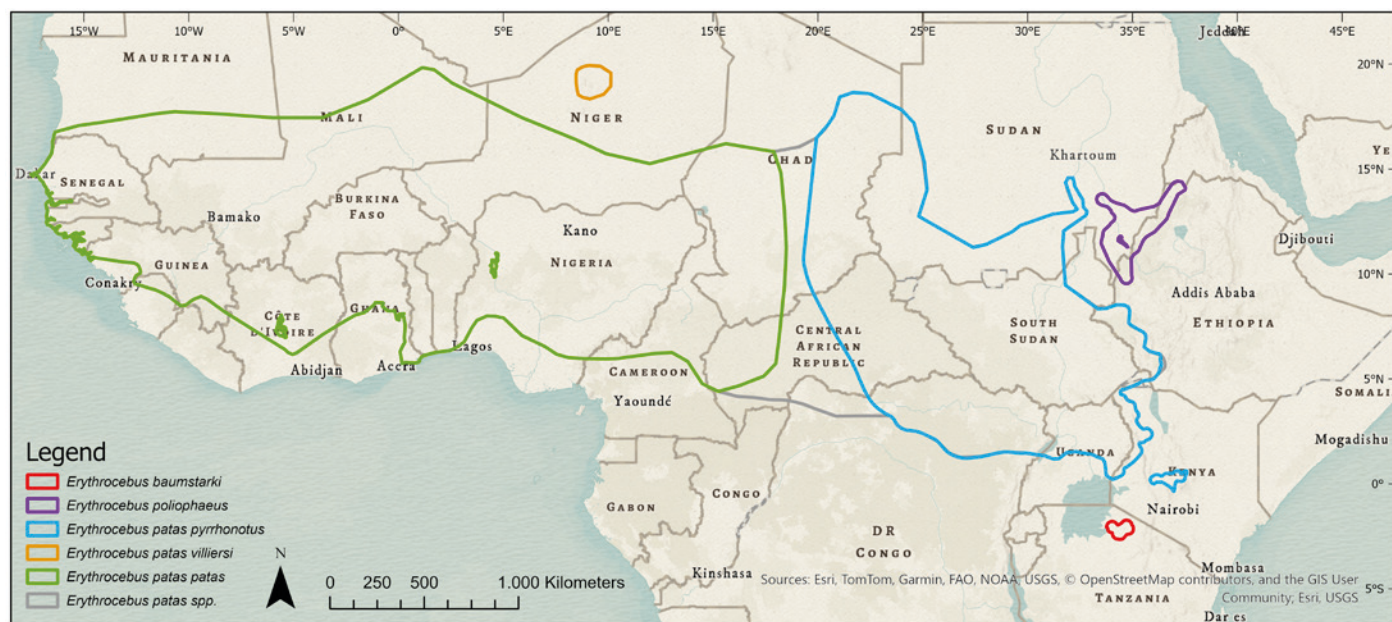


Figure 1. Geographic ranges of the three species and three subspecies of patas monkey *Erythrocebus*. Map based on De Jong and Butynski (2021, 2022b), De Jong *et al.* (2025), and Wallis *et al.* (2025).

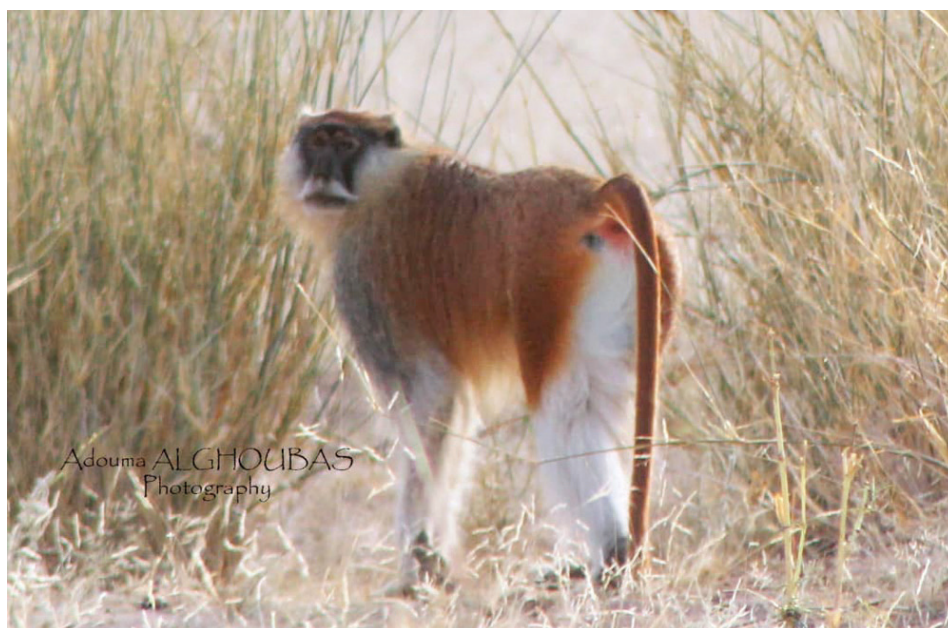


Figure 2. Adult male Aïr patas monkey *Erythrocebus patas villiersi*, Aïr and Ténéré National Nature Reserve, central north Niger. The monkey in this photograph is Paratype 1 for *Erythrocebus patas villiersi*. Photograph by Adouma Alghoubas.

1999, 2000; Ohsawa *et al.* 1993; Chism and Rogers 1997; Isbell and Enstam 2002; Nakagawa *et al.* 2003; Isbell *et al.* 2009; Rogers and Chism 2009; Oates 2011; Isbell 2013; Henty and McGrew 2014).

In this paper we provide the first detailed description of the coloration and pattern of the pelage of the adult male *E. p. villiersi*, designate two paratypes, and present what is known about this species' geographic range, abundance, ecology, and threats. In addition, we put forth priorities for research on *E. p. villiersi* and for conservation actions.

Aïr-Gadabedji Region

The Aïr Massif (hereafter, 'Aïr'), Agadez Region, central north Niger, lies within the Sahara Desert in the Palearctic Biogeographic Realm (Olson *et al.* 2001). The highest peak is Mount Bagzane (= Mont Idoukal-n-Taghès; 2,022 m asl). Aïr is composed of mountains, plateaus, large valleys, small-scale irrigated horticultural areas, and stony or sandy desert (Figs. 3 and 4). Compared to the vast and largely abiotic Sahara Desert (200–500 m asl), drainage features with

relatively dense vegetation are prominent. Aïr presents a complex mosaic of arid and hyper-arid environments that support sub-desert grasslands and sparse acacia *Vachellia* (*Acacia*) woodlands and bushlands and, thereby, serves as a biodiversity refuge.

The climate in Aïr is generally hot and arid with temperatures ranging from around freezing in January to 50°C in May–June. Annual rainfall varies from 4 cm to 14 cm (WorldClim 2.1, Fick and Hijmans 2017), but the water that runs off the rocky slopes of Aïr, even after small showers, is substantial. Aïr supports a complex of perennial and seasonal streams (or wadis), oases, and marshes (Ramsar 2018). Standing water is seasonally present throughout (Birdlife International 2024). The vegetation of the larger river valleys is comparable to areas that receive higher rainfall (De Mire and Gillet 1956).

The Aïr and Ténéré National Nature Reserve (77,360 km²) is also a World Heritage Site, Important Bird Area, and Key Biodiversity Area. The Aïr et Ténéré Addax Sanctuary (12,800 km²) and the Gueltas et Oasis de l’Aïr Ramsar Site (49,241 km²) occur within this nature reserve. Contiguous to the west lies the proposed Mount Egalagh Communal Nature Reserve (3,713 km²), with Mount Egalagh, the highest point (1,874 m asl; Fig. 5).

The south boundary of Aïr is contiguous with the Termit Tin Toumma National Nature Reserve (97,000 km²; Fig. 5), the largest terrestrial reserve in Africa. This reserve receives a mean annual rainfall of <20 cm (WorldClim 2.1, Fick and Hijmans 2017) and mainly consists of sand dunes with a sparse covering of grasses and shrubs (Sillero-Zubiri *et al.* 2013).

To the southwest of Aïr, in the Afrotropical Biogeographic Realm (Olson *et al.* 2001), lies the Gadabedji Biosphere Reserve (hereafter, ‘Gadabedji’; Fig. 5). This reserve receives a mean annual rainfall of ~30 cm (Abdoulaye *et al.* 2023) and lies in a semi-arid climatic transition zone between the Sahara and the Sahel. Gadabedji is characterized by low-lying plains interspersed with sand dunes and depressions that hold seasonal water. Dominant tree species include umbrella thorn acacia *Vachellia* (*Acacia*) *tortilis*, Senegal acacia *Senegalia senegal*, and desert date *Balanites aegyptiaca*.

The only two non-human primates in the Aïr-Gadabedji Region are *E. p. villiersi* and olive baboon *Papio anubis* (Lesson, 1827), the latter being the less common. The tantalus monkey *Chlorocebus tantalus* (Ogilby, 1841) is, apparently, absent (Abdoulaye *et al.* 2023). The nearest record for *Chlorocebus* relative to the range of *E. p. villiersi* is at



Figure 3. Air patas monkeys *Erythrocebus patas villiersi* near Taganjir-Ajirou Spring in the proposed Mount Egalagh Communal Nature Reserve, Aïr Massif, central north Niger. Photograph by Adouma Alghoubas.



Figure 4. Timia Oasis at Tassalwet Village in the proposed Mount Egalagh Communal Nature Reserve, Aïr Massif, central north Niger. The Aïr patas monkey *Erythrocebus patas villiersi* relies on the seasonal and perennial streams, oases, and marshes that are supported by the watersheds of the Aïr Massif. Photograph by Ousmane Alghoubas.

Madarounfa, ~190 km south of the Central Zone of Gadabedji (Fig. 5).

Potential mammalian predators of *E. patas* in this region include African wolf *Canis lupaster* Hemprich and Ehrenberg, 1832, domestic dog *Canis familiaris* Linnaeus, 1758, caracal *Caracal caracal* (Schreber, 1776), and cheetah *Acinonyx jubatus* (Schreber, 1775). The leopard *Panthera pardus* (Linnaeus, 1758), probably once the primary predator of *E. p. villiersi*, has been extirpated. Other larger mammals in the Aïr-Gadabedji Region include dama gazelle *Nanger dama* (Pallas, 1766), Dorcas gazelle *Gazella dorcas* (Linnaeus, 1758), scimitar-horned oryx *Oryx dammah* (Cretzschmar, 1827), Barbary sheep or aoudad *Ammotragus lervia* (Pallas, 1777), West African (= Niger) giraffe *Giraffa camelopardalis peralta* Thomas, 1908, and Cape hare *Lepus capensis* Linnaeus, 1758.

Methods

This study includes the Aïr-Gadabedji Region (~125,000 km²; Fig. 5). To identify the subspecies of *E. patas* in Gadabedji, and to facilitate future phenotypic comparisons of *E. p. villiersi* with other taxa of *Erythrocebus*, we describe the coloration and pattern of the pelage of the adult male. This is based on field observations, photographs, and literature.

Spatial data for *E. p. villiersi* were collected using direct observations, photographs, camera-trap photographs [Sahara Conservation Fund methods as described in Zabeirou (2022)], literature, and communications with colleagues,

naturalists, local experts, and others. Data stored in digital repositories were also used [i.e., Global Biodiversity Information Facility (GBIF; <https://www.gbif.org/>) and iNaturalist (<https://www.inaturalist.org/>)]. The above sources of data derive from 1950–2025, but mostly from 2020–2025.

Spatial data (‘presence only’) were imported into a Microsoft Access database (hereafter, ‘AirPatasBase’). AirPatasBase is a ‘living’ database as localities for encounters continue to be added as they become available. AirPatasBase forms the basis for the *E. p. villiersi* distribution maps. As of 1 July 2025, AirPatasBase held 121 records.

AirPatasBase was projected in ArcGIS Pro 2.7.2. To gain insights into altitudinal variables, the ‘Summarize Elevation’ tool was applied in ArcGIS Pro (DEM resolution 30 m). To assess climatological variables, AirPatasBase was overlaid, in ArcGIS Pro, with Bioclimatic Variable 12, mean annual rainfall (resolution 30 arc-second; WorldClim 2.1, Fick and Hijmans 2017), Bioclimatic Variable 1, mean annual temperature (resolution 30 arc-second; WorldClim 2.1, Fick and Hijmans 2017), and ecoregions (Olson *et al.* 2001; Burgess *et al.* 2004).

Patas monkeys have large home ranges and travel long distances each day. Home ranges of three groups of *E. p. pyrrhonotus* on the Laikipia Plateau, central Kenya, ranged from 23 km² to 40 km² (Chism and Rowell 1988; Enstam and Isbell 2004). A group in Murchison Falls National Park, northwest Uganda, had a home range of 52 km² (Hall 1965). Home range size for *E. p. patas* is less well known, but one group in Kala Maloue National Park, north Cameroon, had a

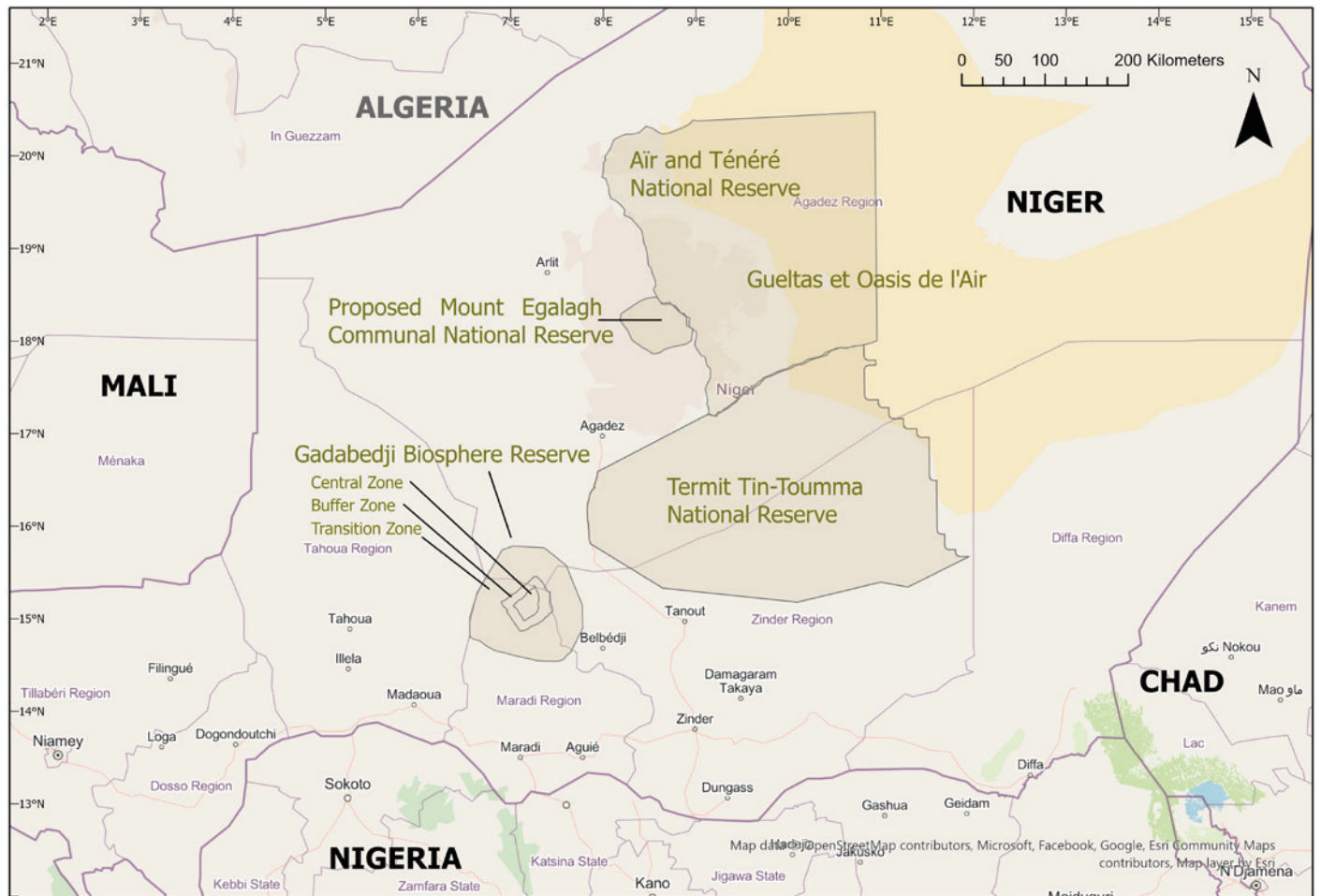


Figure 5. Protected areas of central Niger.

home range of $\sim 9.6 \text{ km}^2$ (Nakagawa 1999). Daily travel distances of three groups of *E. p. pyrrhonotus* on the Laikipia Plateau ranged from 1.4 km to 7.5 km (Chism and Rowell 1988; Enstam and Isbell 2007). For one group of *E. p. patas* in Kala Maloue National Park, the daily travel distance ranged from 3.0 km to 6.2 km (Nakagawa 1999). Given these big home ranges and long daily travel distances, we applied a ‘buffer zone’ with a radius of 30 km around each site point to simulate the geographic range of *Erythrocebus* (De Jong *et al.* 2008, 2009; De Jong and Butynski 2021). Areas within this buffer zone outside the known altitudinal limits were deemed to comprise unsuitable habitat (see below) and, therefore, were not included in the geographic range.

Results

Description of the adult male Erythrocebus patas villiersi

Medium-sized, long-legged, semi-terrestrial monkey (Figs. 2 and 6). Crown rufous with faint, thin, blackish parietal lines. Browband (= superciliary) broad, jet-black. Temporal-bands broad, jet-black, extending to the ears. Cap rufous, partly covering the ears, intermixed with whitish hair on the ears. Cheeks white with rufous wash. Pink skin around eyes. Remainder of face, including muzzle, nose,

and lower lip, jet-black. Moustache broad and white, covering the entire upper lip, reaching the nostrils, and extending laterally to the corners of the mouth. Ears black with white tufts. Chin and throat white. Chest dirty white with longish hair. Dorsum and flanks rufous. Shoulders rufous with steel-grey intermixed with long white hairs onto the outer upper front legs. Lower front legs, inner front legs, and inner hindlegs whitish. Upper outer hindlegs rufous achieving bright rufous on the thighs. Lower outer hindlegs, back of the hindlegs, hands, and feet white. Ventrums off-white to faint buff. Tail bi-colored, rufous above and on sides, buff to pale grey below. Top of base of tail with rusty red spot. Sides of the base of the tail rufous. Ischial region covered with long white hair. Callosities pale grey. Anus bright pink. Testicles turquoise, surrounded by longish white hair. Based on photographs, we have not identified any variability in the coloration and pattern of the pelage among adult males.

Erythrocebus p. villiersi is most readily distinguished from *E. p. patas* (Fig. 7) based on the pelage characters provided in Table 1, where *E. p. villiersi* is compared with *E. p. patas* in Senegal, the country from which the holotype for *E. p. patas* was obtained. There is no detailed type locality for *E. p. patas*. The main diagnostic traits for *E. p. villiersi* are color of the face and sides of the base of the tail, and shape and color of the browband and temporal bands (Table 1).



Figure 6. Adult male Aïr patas monkey *Erythrocebus patas villiersi*, Wallak, Timia, central north Niger. The monkey in this photograph is Paratype 2 for *Erythrocebus patas villiersi*. Photograph by Adouma Alghoubas.

Designation of two paratypes for Erythrocebus patas villiersi

Here we designate two paratypes for *Erythrocebus patas villiersi*.

Paratype 1. Adult male in the photograph in Figure 2 in this paper. Locality: Ténéré National Nature Reserve, central north Niger (Fig. 8 in this paper).

Paratype 2. Adult male in the photograph in Figure 6 in this paper. Locality: Wallak, Timia, central north Niger (Fig. 8 in this paper).

Geographic range of Erythrocebus patas villiersi

Erythrocebus p. villiersi occurs from Mount Gréboun, north Aïr, southward through at least the Central Zone of Gadabedji Biosphere Reserve. It appears that *E. p. villiersi* occurs in five populations, some of which might connect during wetter periods. These are referred to here as the Aïr Massif, Gréboun, Dannet, Teguidit, and Central Gadabedji populations (Fig. 8; Table 2). Together, these five populations have a geographic range of ~50,850 km² (including the 30 km-radius buffer zones; 15.02°N–19.99°N; 07.12°E–09.72°E). 'Extent of Occurrence' (IUCN 2012) of at least 72,800 km² (IUCN 2012) and a known altitudinal range of 415–2,022 m asl.

The north limit of the geographic range of *E. p. villiersi* (Gréboun and north half of Aïr) lies within the Palearctic Biogeographic Realm, a region where other species of non-human primates are few or absent. The west and south limits

of the geographic range (south half of Aïr Massif, Dannet, Teguidit, Central Gadabedji) lie within the Afrotropical Biogeographic Realm, a region with a high diversity of primate species and subspecies.

The five populations of Erythrocebus patas villiersi

Gréboun population. The Gréboun population (Fig. 8; Table 2) of *E. p. villiersi* is known from only two records. Located in the rugged north Aïr, this is the northernmost population. This population lies well within the South Saharan Steppe and Woodlands Ecoregion (also known as the South Sahara Desert). With a mean annual rainfall of only 5–7 cm, this is the most arid ecoregion where this monkey is known to occur. This ecoregion is comprised of scattered woodlands dominated by species of acacia along drainages and wadis. This is a transitional ecoregion between the Sahara Desert Ecoregion (the Sahara's ultra-arid center) to the north and the wetter Sahelian Acacia Savanna Ecoregion to the south, where the other four populations of *E. p. villiersi* occur. Mount Gréboun (1,944 m asl), the highest site in this part of Aïr, serves as a 'water tower', and provides relatively cool air compared to the surrounding Sahara.

Aïr Massif population. *Erythrocebus p. villiersi* was described by Dekeyser (1950) from Ighalablaban (= Irabelablan), in the south part of the Aïr Massif. This is the largest of the five *E. p. villiersi* populations recognized here (Fig. 8; Table 2), both in terms of geographic range (~36,000 km²)



Figure 7. Adult male western patas monkey *Erythrocebus patas patas* near Sangako Forest, west Senegal. Photograph by Yeray Seminario, Birding the Strait.

Table 1. Primary characters that distinguish the adult male Aïr patas monkey *Erythrocebus patas villiersi* from the adult male western patas monkey *Erythrocebus patas patas* in Senegal (Figs. 2, 6 and 7). Based on literature, museum specimens, field observations, and photographs.

Body part	Aïr patas monkey <i>Erythrocebus patas villiersi</i>	Western patas monkey <i>Erythrocebus patas patas</i>
Browband	Vertically broad, jet-black	Vertically narrow, dark grey or blackish, black hairs of center of browband marginally connected with blackish nose
Temporal bands	Vertically broad, jet-black	Vertically narrow, diffused grey or black
Face	Center of face jet-black, pink around eyes	Pinkish-white
Sides of base of tail	Rufous	Whitish to off-white

and population. This monkey is common in the rugged parts of the Aïr and Ténéré National Nature Reserve (>560 m asl) but appears to be absent from the east part (<560 m asl), which lacks perennial water and is mostly comprised of sand

dunes and flat desert. In this reserve, *E. p. villiersi* is most abundant at 700–1,100 m asl but occurs up to 2,022 m asl on Mount Bagzane (S. Djibrila pers. comm. 2024). A large part of this population occurs in the West Saharan Montane Xeric Woodland Ecoregion. Dominant trees here include desert date and species of acacia.

The south part of the Aïr Massif population is, as for the Dannet, Teguidit, and Central Gadabedji populations, in the Sahelian Acacia Savanna Ecoregion. In June, the mean high temperature in Agadez, a town on the south edge of the Aïr Massif population, is 41°C, and the mean low is 27°C. In January, the mean high is 28°C and the mean low is 14°C. In Agadez the temperature is rarely <10°C or >43°C (Weatherspark.com).

About 52% (~18,900 km²) of the geographic range of the Aïr Massif population occurs in the Aïr and Ténéré National Nature Reserve, ~10% (~3,775 km²) in the proposed Mount Egalagh Communal Nature Reserve, and ~38% (~13,450 km²) in the region southwest of the Aïr and Ténéré National Nature Reserve. These estimates include the 30-km-radius buffer zone.

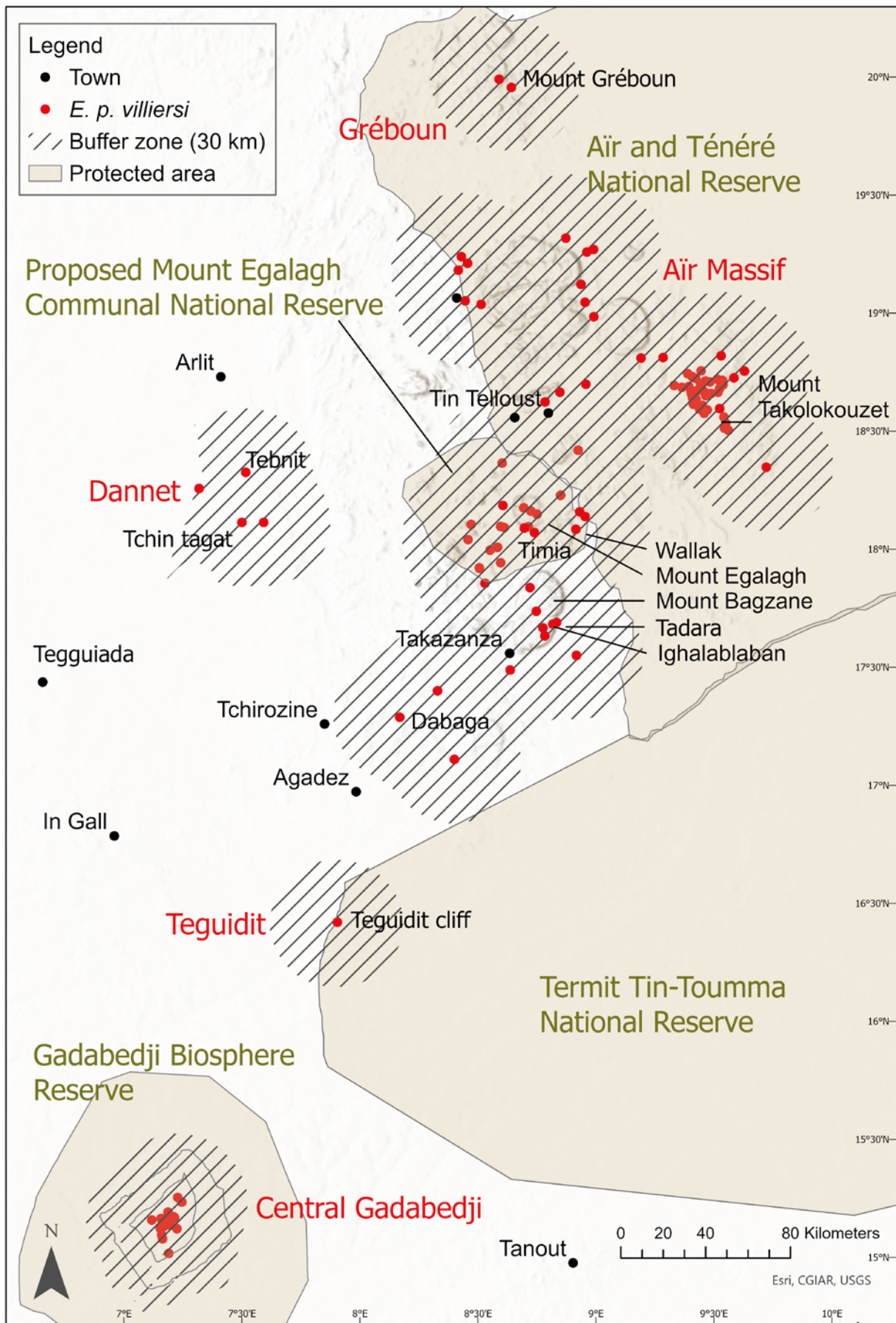


Figure 8. Sites and estimated geographic ranges of five populations of Aïr patas monkey *Erythrocebus patas villiersi* in central north Niger. Names of the populations are in red font.

Table 2. Altitudinal range, geographic range (including 30 km-radius buffer zones), mean annual rainfall range, mean annual temperature range, and ecoregions for the Aïr patas monkey *Erythrocebus patas villiersi* in five populations in Niger.

Population	Geographic range (km ²)	Altitude (m asl)	Mean annual rainfall (cm)	Mean annual temperature (°C)	Ecoregion(s) (Olson <i>et al.</i> 2001)
Gréboun	3,300	1,200–1,944	5–7	28–30	South Saharan Steppe and Woodlands
Aïr Massif	36,000	560–2,022	4–14	27–34	West Saharan Montane Xeric Woodlands; Sahelian Acacia Savanna
Dannet	4,350	420–490	6–7	35	Sahelian Acacia Savanna
Teguidit	2,900	520	14	34	Sahelian Acacia Savanna
Central Gadabedji	4,300	415–480	27–31	34	Sahelian Acacia Savanna
Overall	50,850	415–2,022	4–31	27–35	South Saharan Steppe and Woodlands; West Saharan Montane Xeric Woodlands; Sahelian Acacia Savanna

The Aïr Massif population is ~75 km south of Gréboun. Nonetheless, given that the area between these two populations of *E. p. villiersi* is >800 m asl, some individuals might move between them, particularly during wetter times.

Dannet population. The Dannet population, located ~90 km west of the Aïr Massif population, lies entirely within the Sahelian Acacia Savanna Ecoregion and includes one of the lowest recorded localities for *E. p. villiersi* (420 m asl; Fig. 8; Table 2). This ecoregion consists of a mix of grasslands and scattered trees, where acacias are the dominant tree species. Almost certainly the Dannet population lies at the west limit for *E. p. villiersi*. The region west of there appears to be unsuitable habitat (<415 m asl) in the Sahara Desert.

The Dannet population has the highest mean annual temperature at 35°C. Arlit, a town on the extreme north of the Dannet population, has a mean high of 43°C and a mean low of 28°C in June. In January, the mean high is 29°C and the mean low is 11°C. The temperature in Arlit is rarely above 45°C or below 7°C (Weatherspark.com). The gap between the Dannet and Aïr Massif populations holds what seems to be suitable habitat including wooded valleys and seasonal sand rivers. It is likely that these populations are, or were until recently, contiguous.

Teguidit population. The Teguidit population is based around the (permanent) Ighanyan Spring at Teguidit Cliff (Tadres), ~60 km south of Aïr (Agadez) and ~140 km north-east of the Central Zone of Gadabedji (Fig. 8; Table 2). Ighanyan Spring lies in a narrow strip of vegetation that is surrounded by desert on the west edge of the Termit Tin-Toumma National Nature Reserve and is frequented by wildlife, particularly *E. p. villiersi* (A. Katcha pers. comm. 2024). There are no specimens or photographs available for this population. Nonetheless, since Teguidit Cliff lies between two *E. p. villiersi* populations, there is little doubt that the subspecies at Teguidit Cliff is *E. p. villiersi*. Teguidit lies within the Sahelian Acacia Savanna Ecoregion. At an elevation of ~520 m asl, this region receives a mean annual

rainfall of 14 cm. This is more than the mean annual rainfall for the Gréboun, Aïr Massif, or Dannet populations.

Central Gadabedji population. *Erythrocebus p. villiersi* is common in the Central Zone of Gadabedji Biosphere Reserve but has been rarely reported in the Buffer Zone and seems to be absent in the Transition Zone (Fig. 8; Table 2). The Central Gadabedji population receives, by far, the most rainfall of the five populations (mean annual rainfall 27–31 cm) and lies entirely within the Sahelian Acacia Savanna Ecoregion.

Erythrocebus patas in south Niger

An additional 37 *E. patas* records from Niger were obtained for sites outside of the Aïr-Gadabedji Region. The subspecies of *E. patas* at these sites is not known due to the lack of specimens or suitable photographs (Fig. 9):

- Chadoua, ~75 km southeast of the south-most confirmed *E. p. villiersi* record.
- Keita (Tahoua), ~150 km west of the west-most confirmed *E. p. villiersi* record.
- Akali, ~155 km southwest of the south-most confirmed *E. p. villiersi* record.
- Jikata, ~166 km southeast of the south-most confirmed *E. p. villiersi* record.
- Madarounfa, ~190 km south of the south-most confirmed *E. p. villiersi* record.
- Koutous Massif, Kellé, and Goure, ~315–350 km south-east of the south-most confirmed *E. p. villiersi* record.
- Oudou, ~535 km southeast of the south-most confirmed *E. p. villiersi* record.
- Kabalewa and Toumour, ~635–655 km southeast of the south-most confirmed *E. p. villiersi* record.

Twenty-six records for *E. patas* were obtained from southwest Niger, including Niamey and Dosso, excluding the many records provided by Rabeil (2003) for W National Park, extreme southwest Niger (Fig. 9). *Erythrocebus patas* west of the Niger River phenotypically resembles *E. p. patas*.

It remains unclear, however, as to whether *E. patas* north and east of the Niger River is *E. p. patas* or *E. p. villiersi*.

The subspecies of *Erythrocebus patas* at Chadoua, ~75 km southeast from the south limit of the Central Zone of Gadabedji, remains to be determined. The interlying area has an altitudinal range of 386–457 m asl, receives a mean annual rainfall of 32–36 cm, has a mean annual temperature of 33–34°C, and lies within the Sahelian Acacia Savanna Ecoregion. As a geographic barrier seems absent, it is likely that this is *E. p. villiersi*. Habitat along the seasonal Anoeur River, which divides Gadabedji and Chadoua, might be a refuge for *E. patas* during the drier periods. As concerns *E. p. villiersi*, the nearest confirmed record for *E. p. patas* is ~560 km to the southwest, on the west bank of W National Park (Fig. 9).

Habitats of *Erythrocebus patas villiersi*

Habitats used by *E. p. villiersi* are acacia woodlands and bushlands on the edge of water courses, vegetation mosaics, hillsides, bases of granitic outcrops, crop lands, and

pastures. *Erythrocebus p. villiersi* is limited by the distribution of perennial water sources. Groups are widespread during the cold season (November–February) but more restricted during the hot season (March–June) when they rely on water points (gueltas, springs, wells, pumping stations) that are typically located on the outskirts of villages and on farmlands. This monkey uses cliffs and boulders while foraging and resting (Fig. 10) but is only known to use trees as night-time sleep sites. Some sleeping trees, such as mango *Mangifera indica*, are located within gardens.

Group size and composition of *Erythrocebus patas villiersi*

Erythrocebus p. villiersi is the most abundant non-human primate in the Aïr-Gadabedji Region, with groups comprised of up to at least 50 individuals. Groups of 5–10 animals are most common in Aïr, while groups of 20–30 animals are most common in Gadabedji. During the hot and dry season, when large numbers of *E. p. villiersi* meet at water sources, up to three adult males occur in close proximity without any apparent aggression (Fig. 11). Six adult

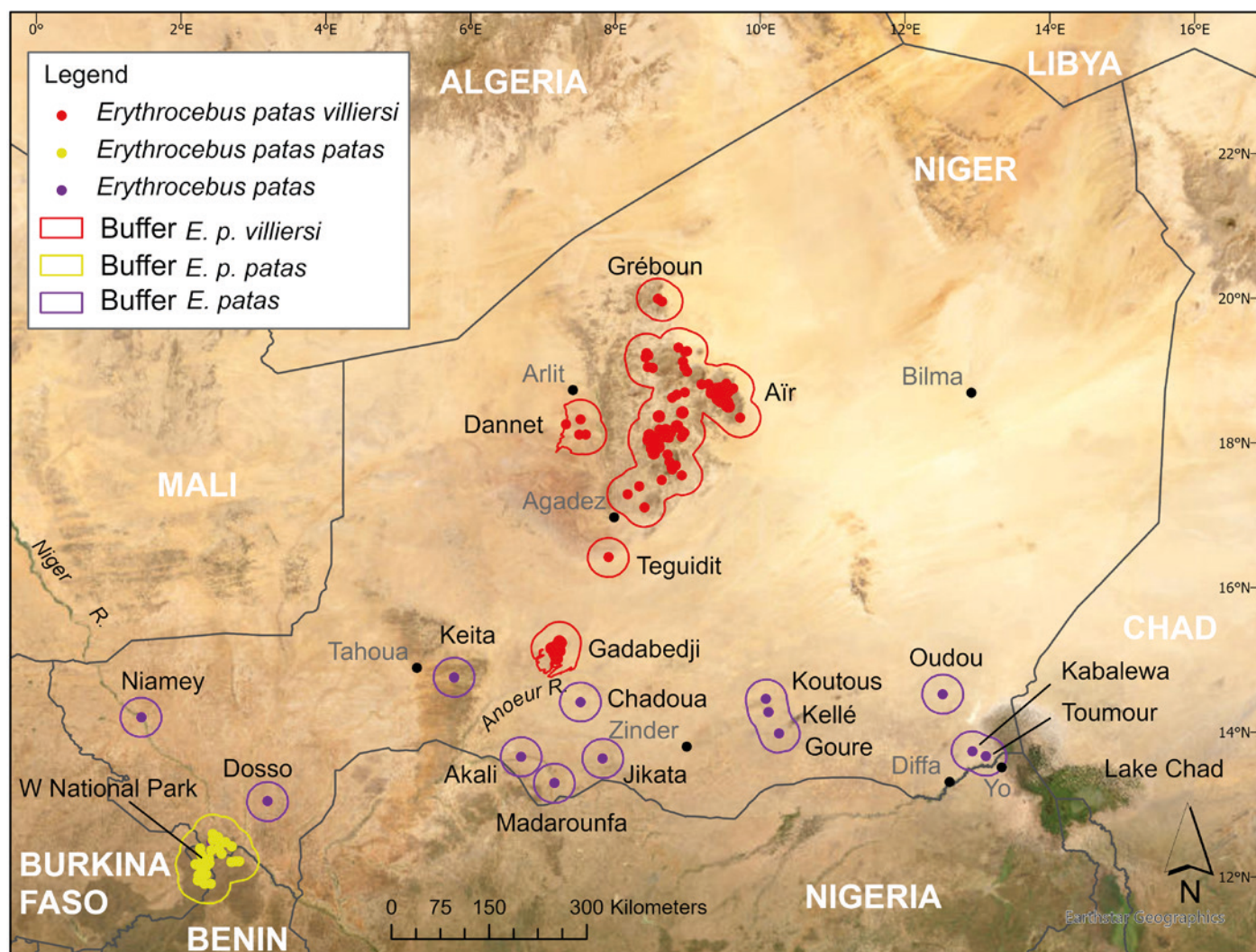


Figure 9. Sites and estimated geographic ranges of Aïr patas monkey *Erythrocebus patas villiersi*, western patas monkey *Erythrocebus patas patas*, and unidentified patas monkeys *Erythrocebus patas* in Niger.

male *E. p. villiersi* were observed feeding together on raddiana acacia *Vachellia [Acacia] tortilis raddiana* and prosopis *Prosopis juliflora* in the proposed Mount Egalagh Communal Nature Reserve (Fig. 10).

In Kellé, southeast Niger (Fig. 9), groups of *E. patas* as large as ~100 individuals enter common ostrich *Struthio camelus* Linnaeus, 1758, enclosures for water and food during the hot and dry season. As soon as the first rain arrives these monkeys no longer visit these enclosures (M. I. Mamadou pers. comm. 2024).

Discussion

Dekeyser (1950) stated, in his description of *E. p. villiersi*, that this monkey was common and endemic to Aïr, inhabiting the larger valleys to the south of this massif between 600 m asl (Dabaga) and 1,600 m asl (Baguezans = Bagzane). He believed that *E. p. villiersi* was endemic to Aïr based on the absence of encounters by A. Villiers with *E. patas* between Zinder and Agadez. We now know that *E. p. villiersi* is not endemic to Aïr as it occurs on the west boundary of Termit Tin Toumma National Nature Reserve (Teguidit Cliff) and at least as far south as the Central Zone of Gadabedji (15.02°N; Fig. 8). Records of *E. patas*

unidentified to subspecies-level were obtained from areas south and southeast of Gadabedji. *Erythrocebus p. patas* appears to be the subspecies on the west bank of the Niger River in W National Park where it is common (Poche 1973, 1976; Rabeil 2003; Fig. 9). Our findings contradict what is stated in De Jong *et al.* (2025), “*Erythrocebus p. patas* is common in the Gadabedji Biosphere Reserve, central Niger (T. Rabeil pers. comm. 2019).”

Comparative phenotypic, morphological, and molecular research across the geographic range of *Erythrocebus* in east Mali, south Niger, north Nigeria, and west Chad is required to help ascertain whether *villiersi* is a subspecies of *E. patas* or a synonym. It should be noted, however, that after *E. p. patas*, the taxon nearest to the geographic range of *villiersi* is *Erythrocebus patas sannio* (Thomas, 1906). *Erythrocebus p. sannio* is currently taken to be a synonym of *E. p. patas* (Dandelot 1974; Groves 2001, 2005; Isbell 2013). The type locality for *E. p. sannio* is Yo, extreme northeast Nigeria, roughly 690 km southeast of the geographic range of *villiersi* (Fig. 9). The description of *E. p. sannio* by Thomas (1906), and our examination of the holotype (an adult male at the Natural History Museum, London; ZD.1907.7.8.1), indicate that it differs from *villiersi* and *patas* in several respects. The most noticeable differences are that its thighs



Figure 10. Four of the six adult males in an all-male group of Aïr patas monkeys *Erythrocebus patas villiersi* at Timia in the proposed Mount Egalagh Communal Nature Reserve, central north Niger. Photograph by Adouma Alghoubas.



Figure 11. Air patas monkeys *Erythrocebus patas villiersi*, Central Zone of Gadabedji Biosphere Reserve, central south Niger. Note the two adult males in this association. Photograph by Mahamane Hassane.

are entirely pure white whereas the thighs of *villiersi* and *patas* are rufous, and that the upper parts are more pallid (Elliot 1913; Hill 1966). Given the differences in the pelage, together with the apparent isolation of *villiersi* from *sannio*, it is highly doubtful that *villiersi* is a synonym of *sannio*. We are aware of seven records for *Erythrocebus* across the vast region that lies between the known geographic ranges of *E. p. villiersi* and *E. p. sannio* (Fig. 9), but we have not located any specimens or photographs of the *Erythrocebus* on which these records are based.

Erythrocebus p. villiersi appears to occur in five populations from Mount Gréboun through at least the Central Zone of Gadabedji Biosphere Reserve (Fig. 8; Table 2). Although data are lacking, some of these populations might be connected during wetter periods when drinking water is sometimes available. The geographic range of *E. p. villiersi*, as we understand it at this time, is restricted to rocky landscapes, vegetated valleys, and crop lands north of 15.02°N (Gadabedji) and south of 19.99°N (Gréboun). This subspecies has a confirmed geographic range of at least 51,000 km² (including the 30-km-radius buffer zone) and an ‘Extent of Occurrence’ of at least 72,800 km² (IUCN 2012).

Erythrocebus p. villiersi is not known to occur at altitudes <415 m asl or >2,022 m asl, where the mean annual rainfall is <4 cm or >31 cm, or where the mean annual temperature is <27°C or >35°C (Table 2). For *E. p. villiersi*, the upper altitudinal limit (2,022 m asl) approaches the upper limit reported for other taxa of *E. patas* (2,050 m asl), the lower mean annual rainfall limit (4 cm) is considerably below that reported for other taxa of *E. patas* (10 cm), and

the upper mean annual temperature limit (35°C) is much higher than reported for other taxa of *E. patas* (31°C) (De Jong and Butynski 2021).

Masetti and Bruner (2009, p. 52) suggest that *Erythrocebus* is “apparently capable of surviving for long periods without water”. Their statement is based on Kennedy Shaw *et al.* (1936) who reported that one *Erythrocebus* specimen was collected north of Wadi Hawar, northwest Sudan, 480 km from any surface water. *Erythrocebus p. patas* in one group in Kala Maloue National Park, north Cameroon, drank water 2–4 times per day (Nakagawa 1999). Here, the ranging pattern was influenced by the availability both of temporal and perennial water sources. Hall (1965) reported that *E. p. pyrrhonotus* in Murchison Falls, northwest Uganda, did not drink daily. Chism and Rowell (1988) and Isbell and Chism (2007), however, found that *E. p. pyrrhonotus* drank daily on the Laikipia Plateau, central Kenya. Here, *E. p. pyrrhonotus* relies heavily on the man-made water troughs and dams that are scattered across the landscape of large cattle ranches. These perennial sources of water enable *E. p. pyrrhonotus* to reach relatively secure foraging and sleeping sites (Chism and Rowell 1988; De Jong 2004; Isbell and Chism 2007; De Jong *et al.* 2008; Butynski and De Jong 2014).

It appears that *E. p. villiersi* is also highly reliant on sources of perennial water as it is often encountered around water points near villages and agriculture, particularly during the hot and dry season. Pastures, with perennial water and livestock densities that do not degrade the habitat, are used by *E. p. villiersi*.

Conservation of *Erythrocebus patas villiersi*

Threats

The root cause of all threats to the long-term survival of *E. p. villiersi* is related to the rapid growth of the human population in Niger. The ‘Rate of Natural Increase’ of the human population in Niger is 3.7%, compared to an African rate of 2.4% and a worldwide rate of 0.9% (PRB 2024). There were 26.2 million people in Niger in 2023. This is projected to increase to 37.4 million by 2035, and to double (52.5 million) by 2050 (World Population Review 2024). Given this trend, and the rapidly increasing demand for natural resources such as land, water, and wood, it is inevitable that all threats to Niger’s biodiversity will intensify.

Recurring droughts and desertification, in combination with anthropogenic pressures, are changing the ecology of Niger and its ability to support biodiversity and people (Poche 1976; Ramsar 2018). During the first half of 2024, the mortality of *E. p. villiersi* was higher in Gadabedji compared to previous years due to the effects of drought (K. Liman pers. comm. 2024). Die-offs of *E. p. patas* during droughts have been observed in Kala Maloue National Park, north Cameroon (Nakagawa 1999) and in W National Park, Niger (Poche 1976).

Poaching is a serious threat to the region’s wildlife and is particularly intense during droughts and times of insecurity. Poachers now use automatic weapons, 4-wheel-drive vehicles, and advanced trapping systems. Bushmeat is sold locally but also exported to neighboring countries (UNEP 2017; Abdoulaye *et al.* 2023).

In Gadabedji, several large mammal species have already been extirpated, including large predators [*P. pardus*, lion *Panthera leo* (Linnaeus, 1758), African wild dog *Lycaon pictus* (Temminck, 1820), and striped hyaena *Hyaena hyaena* (Linnaeus, 1758) (Abdoulaye *et al.* 2023)]. In addition, several other species of large mammal are close to being extirpated, including *A. lervia*, *G. dorcas*, *N. dama*, *O. dammah*, and *A. jubatus*.

Biodiversity in Niger is threatened by the effects of habitat degradation, loss, and fragmentation due to agricultural expansion, over-grazing, over-browsing, civil war, insecurity, gold panning, lowering of the water table, invasive species (including *P. juliflora*), climate change, and insufficient environmental protection (Mortimore 1972; Anthelme *et al.* 2006, 2008; UNEP 2017, Anonymous 2018; Zabeirou 2022; Abdoulaye *et al.* 2023). We suspect that all the above threats have adverse impacts on *E. p. villiersi*.

Water for drinking is essential for *E. p. villiersi*, particularly during hot and dry times. Although man-made water sources, often established for agricultural purposes, are important to *E. p. villiersi*, both natural and man-made sources of water are increasingly difficult to access. Some have been lost due to the expansion of human and livestock populations and the degradation of the catchments. This is probably having a severe negative impact on *E. p. villiersi*, particularly during droughts (Nakagawa 1999; Poche 1976).

Erythrocebus p. villiersi raids crops in Aïr, including citrus, maize, dates, tomatoes, and watermelons—and is persecuted in response. Among wild animals, *E. p. villiersi* is said to be the most notorious crop raider (A. Oufen pers. comm. 2024). In fact, when Dekeyser (1950, p.423) described this subspecies he stated, “Patas cause very significant damage to maize plantations and date palms and the children of the villages are obliged to provide permanent guard to avoid their incursions.” (translated from French with Google Translate). In Gadabedji, crop-raiding appears to be less intensive but human-patas conflict is expected to intensify with the growing human population. In addition, domestic dogs and *C. lupaster* occur in this landscape and kill *E. p. villiersi*.

The people of the Aïr-Gadabedji Region have a tradition of not eating primates. According to a Tuareg myth in Aïr, “Monkeys are humans that have been cursed by God because they killed his camel—‘Fâkrou’.” While *E. p. villiersi* is not a target species for poachers in the Aïr-Gadabedji Region, it is probably part of their by-catch.

The growing human population in the Aïr-Gadabedji Region means that people are in increasingly close contact with *E. p. villiersi*. This raises the risk of bi-directional transmission of diseases and parasites causing health concerns both for people and *E. p. villiersi*.

Conservation status

Of the known geographic range of *E. p. villiersi*, 63% is within a protected area or proposed protected area. Large sections of these protected areas are, however, in human-dominated landscapes that experience influxes of pastoralist and labor immigrants, bush fires, and the unsustainable harvesting of firewood and medicinal plants (UNEP 2017; Abdoulaye *et al.* 2023). The Aïr and Ténéré National Nature Reserve was designated an UNESCO World Heritage Site in 1991 (UNESCO 2025a). UNESCO (2025b), however, inscribed this reserve on the list of “World Heritage in Danger” in 1992 due to “political instability and dissension among the populations”. Although security has improved since 2014, this site continues to be listed.

Erythrocebus p. villiersi is the most widespread and common non-human primate in the Aïr-Gadabedji Region. This subspecies was estimated at ~500 individuals in 1990 (Magin 1990; UNEP 2017). Our rough estimate is that there are currently 2,000–3,500 individuals: 1,500–2,000 in Aïr and 500–1,500 in Gadabedji. Wildlife numbers are reported to be recovering in central and north Niger due to the gazettelement of reserves and improved security.

Due to its poorly known geographic range, population size, natural history, and threats, *E. p. villiersi* is currently listed as ‘Data Deficient’ on The IUCN Red List of Threatened Species (De Jong and Butynski 2022b). Based on the above findings, we suggest that the degree of threat status (IUCN 2012) of *E. p. villiersi* be changed to ‘Near Threatened’. *Erythrocebus p. villiersi* does not meet the criteria for ‘Vulnerable’, although its abundance, Extent

of Occurrence (EOO), and Area of Occupancy (AOO) are expected to decline due to the severe and ongoing threats that are unlikely to be reversed.

Recommendations for Research and Conservation

Erythrocebus p. villiersi has never been the focus of detailed research or conservation measures, and none are currently planned. Here are our recommendations for research and for mitigating the threats:

1. Establish a network of people who will help locate 5–10 groups of *E. p. villiersi* in the Aïr-Gadabedji Region and closely monitor group size, age/sex composition, home ranges, and threats. Enter these data into AirPatasBase.

2. Determine which subspecies of *Erythrocebus* occurs south and southwest of Gadabedji in order to better understand the geographic range of *E. p. villiersi*.

3. Conduct detailed surveys of *E. p. villiersi* every 5 years to reassess geographic range, abundance, population structure, conservation status, and threats, and to establish a rigorous baseline for long-term monitoring. These surveys should include interviews with local people to gain insights into habitat and water source use, crop-raiding, and impacts of domestic dogs, poaching, livestock grazing/browsing, and other threats.

4. Undertake a detailed, long-term, ecological, and behavioral study of *E. p. villiersi*.

5. Develop a habitat suitability model for *E. p. villiersi*. Model the impacts of climate change on the extent and connectivity of suitable habitat. This model will help guide recommendations for the long-term, science-based, conservation of *E. p. villiersi*.

6. Conduct comparative morphological and molecular research across the geographic range of *Erythrocebus* to further our understanding of the evolution, phylogeography, and taxonomic arrangement of this genus.

7. Produce an ‘*Erythrocebus patas villiersi* Conservation Action Plan’ and ensure that this plan is implemented by those authorities responsible for the conservation of Niger’s biodiversity.

8. Take the actions necessary to increase the security of Aïr and Ténéré National Nature Reserve so that UNESCO (2025b) is able to remove it from the ‘World Heritage in Danger’ list.

If you have encountered *E. p. villiersi*, please provide us with the details at www.wildsolutions.nl/research/record or by sending an e-mail to the corresponding author, Yvonne de Jong.

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