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The extension of the distribution range of the Rock Firefinch *Lagonosticta sanguinodorsalis* (Estrildidae, Passeriformes) to the Adamawa Plateau of Cameroon in the Congo Basin Forest

Abstract

The distribution range of *Lagonosticta sanguinodorsalis* was until today limited to Nigeria and north–west Cameroon, and therefore, this species was considered as endemic of these distribution areas. In its original description, this estrildid finch showed a multivarious plumages specially the red, grey, black and brown coloration. Ecologically, this sedentary species proved a high degree of fidelity to its range but no ornithological research had taken place in Northern Cameroon, and particularly in the Adamawa Plateau. This study aims to suggest a possible extension of the geographical range of *L. sanguinodorsalis*. In our bird survey, the Japanese mist nets have been used to capture and identify birds; moreover, measurements were taken before the specimens were released into their natural environment and muscle tissue was also taken for future molecular study. Furthermore, observations were made to characterize different habitats of the Adamawa Plateau and geographic coordinates were systematically recorded by GPS. A specimen of *L. sanguinodorsalis* was captured in the Adamawa Plateau at 1171 m altitude (07°37.723'N, 013°32.932'E) showing all diagnostic criteria of the species especially the blue–grey bill and bright reddish–brown back as well as the grey plumage at the top of the head. In addition, our measurements have given total size of 10.14 cm, beak length of 10.7 mm, length of tail of 46.5 mm and tarsal length of 11.8 mm. The main habitats highlighting in the Adamawa Plateau were mostly wooded environment, gallery forests, bushes, rocky outcrops, inselbergs and forestry valleys. Beyond the resemblance of their plumage coloration and also because of the similarities between the vegetation types in the Jos Plateau and the Adamawa Plateau, we suggest an extension of the range of *L. sanguinodorsalis* to the Adamawa Plateau. This would accordingly its endemism in large area from Nigeria to north–west and north–central Cameroon.

Keywords: endemism, range, measurements, mist nets method, sedentary bird

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Introduction

A large family of small passerines, the waxbills constitute a multicolored group with great specific diversity in the Afrotropical region.[1–4] It is an Old World family in which species are variously distributed in forest environments but also in savannah areas.[1,3,5,6] Typically, these small passerines are described as having a short but generally sturdy and conical bills.[2,7,8] Within this family, the shape of bills is very diverse for example small in *Nigrita*, massive and notched in *Spermophaga*, slender in *Parmoptila* but usually bright red or silvery or even pink as in *Lagonosticta*.[2] Most of the species within this large family are granivores; they eat ripe seeds, mainly small, and sometimes unripe but some of those are specialized for example taxa which feed only on insects.[2,3] In addition, these small passerines perch and nest in woody and herbaceous vegetation.[2] Their flight is often roaring and there are no migrants but many nomadic species.[2,9–11] The waxbills are mainly sedentary and some of them, especially African species, are parasitised by why dahs and indigo birds; nestlings of the host and the nest parasite regularly show similar mouth markings and identical juvenile plumages.[2,7,12] Among the parasitized taxa, *L. sanguinodorsalis* is listed with its main host *Vidua maryae*.[11,13,14] *L. sanguinodorsalis* is described until today as being present only in a well–defined and limited distribution range in Nigeria and north–west of Cameroon; more precisely, the species is found mainly in the Jos Plateau in central Nigeria even if recent studies have reported it near Cameroon in the Mandara Mountains.[7,13,15–17] According to some authors,[2,17] this species lives mainly in bushy and grassy rocky outcrops on the Plateau and grassy inselbergs; it is generally found in areas of 900 m above sea level. It moves single, in pairs or in small family groups along streams in the rainy season, and where small ponds remain in the dry season.[2] In a study carried out on the birds of the Adamawa Plateau of Cameroon, a transition area between forests and savannahs, we captured an individual of *Lagonosticta sanguinodorsalis* which expands the distribution range of the species by over than 17 300 sq km. To support this range extension, this study aims to provide diagnostic criteria (evidenced by photographs) which lead us to identify the species, and to compare the vegetation surrounding the capture site with information on its habitat in Nigeria.

Material and methods

Details on the study site

Located in north–central Cameroon, the Adamawa Plateau borders the Benue plain to the north, the western highlands to the southwest, and the South Cameroonian Plateau to the south.[18] The Adamawa Plateau rises to an altitude of between 900 and 1500 m with some summits reaching 2000 m above sea level. The whole Plateau covers an area of more than 100000 sq km.[19] This area has a humid tropical climate of altitude defined by two main seasons including a long rainy season that extends over seven to nine months and the Plateau is covered by tropical vegetation showing a set of plants from forest and savannah.[19–22] Furthermore, the altitude of the Adamawa Plateau and its relief generate some particular climatic conditions with annual

precipitation of between 1200 and 2000 mm and monthly relative humidity averages of 40 to 50% during the dry season and 70 to 90% during the rainy season.[22] Temperatures fluctuate depending on the seasons with average monthly values between 10 and 34°C.[22]

Bird sampling method

We used the Japanese mist nets to sample birds during our investigations in the forest–savannah transition zone of the Adamawa Plateau. In Ornithology, mist nets are undoubtedly the most common method used to capture small and medium–sized birds for research purposes.[23,24] In the field, mist nets were opened early in the morning (5: 00 AM) and closed late at sunset (6: 30 PM). The mist nets were attached with the mounting poles but it was also interesting to choice an appropriate mist–netting site for the success of the capture. The ensuring success of the capture in the field was closely linked to some basic elements such as the birds' preferred flight patch, their foraging areas, roosts and shady sites. The rounds of the nets were made after every 40 minutes and the captured birds were immediately removed from the nets and identified, sometimes measured, and then released into the wild after muscle tissue removal for future molecular studies.

Identification, measurements and geographical coordinates

Our identifications followed international standard, and were based on the main morphological characteristics such as the size, the plumage coloration, the shape of the beak, the color of the eyes, the color of the beak and legs, and the arrangement of the fingers, among others, but also on geographic distribution of birds captured.[7,12] To complete these basic identifiers, some measurements were made (to the nearest 0.1 mm) using a caliper to measure some key parts of the species such as tarsal length, beak size, tail length as well as the total length of the specimen. The geographical coordinates of the investigated sites were systematically recorded using a handheld device (GPS).

Results

Bird species collected and identified in the Adamawa Plateau

We captured 186 bird specimens belonging to 61 species according to Gill and Donsker[25] (Mahamat *et al*. in preparation). Several waxbills were identified, but the most important in our sample was without a doubt *Lagonosticta sanguinodorsalis*.

Diagnostic criteria for the identification of *Lagonosticta sanguinodorsalis*

We captured one specimen of *Lagonosticta sanguinodorsalis*. Given it was collected out of its known geographical range, we proceeded morphologically to take in–depth measurements following the diagnostic criteria in birds as defined by international standards for the morphological description of a species. Thus, the specimen captured in the Adamawa Plateau and identified as a specimen of *L. sanguinodorsalis* presented a total length of 10.14 cm with a mixed–colored plumage of grey, red, black, brown and white spots (Figure 1).

This specimen had a blue–grey, hard and conical beak with a length of 10.7 mm. Between the eyes and the basis of the beak, there were brilliant red lores (Figure 2A). The upper wing coverts and back of the specimen showed brownish plumage and the lower parts from throat to chest to upper belly were greyish red (Figure 1), whereas the crown from head to face showed light gray plumage (Figure 2B). We also noted many white spots on the plumage along of flanks (Figure 2C). The eye–ring was light gray, the iris dark brown (Figure 2D). However, in the backside part of the specimen, from the rump to the upper tail coverts, the plumage was deep red; additionally, the tail was black with red edges corresponding to rectrices which had a length of 46.5 mm (Figure 2E). The specimen's feet were dark grey with an anisodactyl arrangement of the fingers and the tarsus measured 11.8 mm (Figure 2F).

Figure 1 Specimen captured in the Adamawa Plateau in Cameroon and identified as a Rock Firefinch, *Lagonosticta sanguinodorsalis* (photo by first author).

Figure 2 Diagnostic criteria for the identification of the Rock Firefinch, *Lagonosticta sanguinodorsalis*, captured in the Adamawa Plateau, Cameroon: beak (A), head (B), flank plumage (C), eyes (D), couple rump-tail (E) and feet (F) (photo by first author).

Some characteristics of the habitat of Rock Firefinch captured in the Adamawa Plateau

Our specimen of *Lagonosticta sanguinodorsalis* was captured at an altitude of 1171 m at 07°37.723'N, 013°32.932'E. The site was a biotope made of wooded savannah, opened in some places revealing large bushes and rocks strewn with small shrubs. Present in the Vina Department over an area of 17300 sq km, this site is also surrounded by rocky outcrops, inselbergs and forest valleys showing a few pockets of tropical rainforest (Figure 3).

Discussion

Main morphological features of *L. sanguinodorsalis*

The specimen captured in the Adamawa Plateau and examined in this study showed many of the diagnostic features corresponding to

Lagonosticta sanguinodorsalis such as beak form, presence of lores, and the coloration patterns of the plumage (Figures 1, 2A–2B). All these morphological characteristics highlighted in our results have been mentioned in several other studies on the Rock Firefinch from the original description until ecological and breeding behaviour, population density and genetic structure studies.[2,7,11,13,15,26–28] For instance, the combination of the blue–grey beak in the adult and the predominantly reddish–brown and shiny back in the female allow *L. sanguinodorsalis* to be easily identified and distinguished from other finches as already revealed by some authors.[2,7,13] Thus in *L. sanguinodorsalis*, morphological characteristics of identification based on the plumage coloration such as white spots in flanks (Figure 2C), the dark red covering its rump until the upper tail (Figure 2E), the black tail with red edges on the outer rectrices (Figure 2E) and the dark grey of their legs (Figure 2F) have also been mentioned by several authors.[2,7,12,13,26] However, some colors in this specimen could bring it closer to an immature of *L. umbrinodorsalis*; only beyond the plumage coloration, the measurements obtained on the captured specimen go in the same direction as well Mills[15] who had already observed the Rock Firefinch in Northern Cameroon but unlike us who captured it in our nets. Thus, based on the tissues of the specimen captured in the field, a future molecular study with other specimens of the same locality will clarify observations made in this study.

Figure 3 Vegetation surrounding the capture site of *L. sanguinodorsalis* within the Adamawa Plateau.

Analysis of some measurements taken on the specimen of the Rock Firefinch captured on the Adamawa Plateau

The measurements taken on the specimen collected in the Adamawa Plateau gave a general body size of 10.14 cm (Figure 1). According to Borrow and Demey[7,12] and Fry and Keith[2], the size in length of the adult specimens of *Lagonosticta sanguinodorsalis* is between 10 and 11 cm in length confirming that the overall measured size of the captured specimen was that of *L. sanguinodorsalis*. The measurements of its tail be 46.5mm (Figure 2E) and its tarsus be 11.8 mm (Figure 2F) were appeared quite close to those suggested by some authors[2,13] for which the length of the tail as well as that of the tarsus in female of *L. sanguinodorsalis* were 48 mm and 14 mm respectively while in male of Rock Fire finch, these lengths were 51 mm and 15 mm respectively. Otherwise, our results provided a value of 10.7 mm for the length of its beak (Figure 2A); however, the beak size that we measured was longer than what previous studies reported be 8.0 mm for the female and 9.0 mm for the male.[2,13] in this case, the differences observed in measurements could be due to the different stages of development of the species. But comparing the length of the beak in the specimen captured in the Adamawa Plateau (10.7 mm; Figure 2A) to that of individuals of the populations from the Jos Plateau (i.e. 8.0 mm), this difference should be an adaptation to its diet in the Adamawa Plateau which offers many various types of vegetation and therefore many types of food resources. Brandt and Cresswell[11] reveal that the long and slender beak of this estrildid finch should be an adaptation in order to obtain seeds buried between rocks.

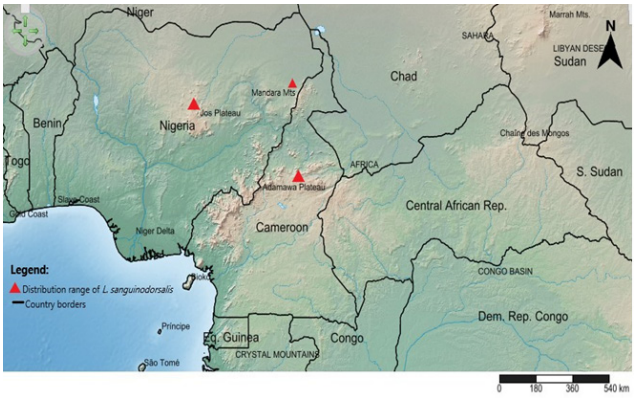

Figure 4 Distribution of the locations of *L. sanguinodorsalis* in Nigeria and Cameroon.

Habitats and ecological behaviour of *L. sanguinodorsalis*

We collected *Lagonosticta sanguinodorsalis* in the forest/savannah transition area of the Adamawa Plateau, in a wooded area with rocky outcrops not far from fluent small river between rocks and valleys (Figure 3). In Nigeria, this species has been observed in various vegetation types such as grassy inselbergs, woods, bushes, rock outcrops, thickets, bushy savannah, gallery forest, etc.[2,7,11,13,17,26] Mills[15] and Languy[33] reported repeatedly sighting *L. sanguinodorsalis* in Northern Cameroon where the vegetation is predominantly sahelian; the Adamawa Plateau offers various types of vegetation which could explain its presence in this part of Cameroon. Several authors[9,11,29] have noted that *L. sanguinodorsalis* showed a high degree of site fidelity and does not respond to changes in the availability of food and water by moving to different areas like some nomadic birds in the desert or in savannah habitats where occurrence of rain and food is unpredictable. Moreover, this species prefers inselberg habitat for the nest–site requirements, and the rocky boulders might provide shelter from predators as nests are well hidden from view and serve as shade against direct sunlight and high temperatures.[11,30] Brandt and Cresswell[11] noticed that in order to avoid the strong inter–specific competition for food resources, *L. sanguinodorsalis* also appears to favor inselbergs particularly during the non–breeding season, which allows it to quietly feed on the seeds that accumulate between rocks.

Similarity between the different ranges of *L. sanguinodorsalis*

Both in Nigeria and Cameroon, there are similar characteristics in the sites occupied by *Lagonosticta sanguinodorsalis*. In our study on the Adamawa Plateau, *L. sanguinodorsalis* was captured at an altitude of 1171 m while Payne[13]reported captures at an altitude of 1280 m in the Toboru hill on the east of the Jos Plateau; Brandt and Cresswell[11] reported captures at altitudes between 1280 and 1320 m in the Amurum Reserve, north–east of the Jos Plateau (Table 1). Other mentions in the Mandara Mountains[26] correspond at altitudes comprised between 1200 and 1494 m (Table 1).

Extension of the distribution area

The main result of this study, it is diagnostic criteria used for the identification of the specimen of *Lagonosticta sanguinodorsalis* captured in the Adamawa Plateau (Figures1, 2A–2F). For many years

to date, this species has been considered endemic to several parts of Nigeria but to Cameroon only in northwest because no ornithological survey previously carried out in the Adamawa Plateau reported the presence of *L. sanguinodorsalis*.[19,31,32] Our study thus allows us to formally suggest the extension of the distribution area of the Rock Fire finch, *L. sanguinodorsalis* to the Adamawa Plateau in Cameroon. But a future molecular study with other specimens of this species in the Adamawa Plateau will have to confirm this presence.

Table 1 Geographical coordinates and altitudes of the sites where *L. sanguinodorsalis* individuals were captured or observed in Nigeria and Cameroon

Observation/Capture site	Geographical coordinates	Altitude (m)	Reference
Nigeria: Jos Plateau,Toboru hill	09°53'N, 08°59'E	1 280	Payne[13]
Nigeria: Jos Plateau,Amurum reserve	09°87'N, 08°98'E	1 280 - 1 320	Brandt and Cresswell[11]
Nigeria : Mandara Mountains	11°02'N, 13°44'E	1 200- 1 494	Abalaka et al.[26]
Cameroon:Adamawa Plateau	07°38'N, 13°33'E	1 171	This study

Conclusion

Morphological descriptions and measurements carried out have allowed identification of specimen of *Lagonosticta sanguinodorsalis* within the Adamawa Plateau. The presence of *L. sanguinodorsalis*, a sedentary bird, on the Adamawa Plateau must be considered as an essential argument to support from now the extension of its distribution range from Nigeria to north–west and north–central Cameroon. *L. sanguinodorsalis* would develop preferences for the high altitudinal areas but further investigations in the Adamawa region would be necessary to confirm this hypothesis as well as those which require a better understanding of how it occupies the landscape, the state of its population density, its relationship with its common brood–parasite, *Vidua maryae*, or another within this part of the Congo Basin Forest.

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Conflicts of interest

Authors declare that there is no conflict of interest.

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