Primate Conservation 2017 (31): 53-59

On the Taxonomy of *Erythrocebus* with a Re-evaluation of *Erythrocebus poliophaeus* (Reichenbach, 1862) from the Blue Nile Region of Sudan and Ethiopia

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Abstract: *Erythrocebus* taxonomy has been dormant for almost a century now, with the consequent costs in our understanding of the biology of the genus and for the conservation of these remarkable monkeys. New data on the distribution and physical appearance of patas monkeys in Ethiopia, together with a review of the old taxonomic literature, allows to us disentangle some questions concerning the taxonomy of *Erythrocebus* in northeast Africa. Specifically, I resurrect *Erythrocebus poliophaeus* (Reichenbach, 1862) as a valid species that is found along the Blue Nile Valley at the extreme northeastern portion of the range of the genus. The still little-known, but certainly limited, extent of the range of the species is a cause for conservation concern, but it may be that *Erythrocebus poliophaeus* could serve as a flagship species for conservation in the biologically rich Western Ethiopian Escarpment region and adjoining Sudan. The proposed common English names for the new species are Heuglin's patas monkey (Heuglin was the famous German explorer who discovered it) or the Blue Nile patas monkey.

Keywords: Benshangul Gumuz State, Ethiopia, Sudan, Primates, Cercopithecidae, patas monkey, taxonomy

Introduction

Schwarz (1927) carried out the last taxonomic revision of *Erythrocebus* Trouessart ninety years ago. His arrangement of *Erythrocebus* as a monotypic genus, with three subspecies—*patas* (Schreber, 1774), *pyrrhonotus* (Hemprich and Ehrenberg, 1829), and *baumstarki* Matschie, 1905)—was widely adopted. Dekeyeser (1950) subsequently added the subspecies *villiersi* from the Air Massif, Niger. As already critically noted by Allen (1925), previous taxonomic decisions regarding *Erythrocebus* were often based on single specimens of unknown origin or only on immature individuals; yet, as argued by that author, this does not mean that some of the historically described taxa are not valid. Nearly one century later, this taxonomic problem has still to be resolved, and this is not an isolated case as far as most large African mammals are concerned (Gippoliti and Carpaneto 1995). In 1971, Pierre Dandelot remarked on the confusion in African primatology regarding species and subspecies, and that taxonomists, "at the risk of being treated as 'splitters' by the advocates of simplification," should recognize a greater diversity than was customary at the time. This is just one more taxonomic question which could possibly be answered by applying modern (molecular) methods to available museum collections, integrated by the study of photographic materials of patas monkeys from known localities (cf. De Jong and Butynski 2010).

Groves (2001) and Grubb *et al.* (2003) did not recognize subspecific taxa in *Erythrocebus*, retaining just one species, *E. patas*; this probably reflects more the scarcity of hypodigms in museums than any satisfaction with this taxonomic arrangement. Given the huge distributional range of *Erythrocebus*, it seems unlikely that the current monotypic classification describes the diversity of the genus correctly, all the more since other savannah dwelling African primate genera, such as *Papio* and *Chlorocebus*, comprise multiple species.

Erythrocebus taxonomy was also probably negatively affected by an overemphasis on the nose color (black or white). Awareness of nose color changes due to age or physiology (Loy 1974) and belief in a clinal variation from the black nose of true patas to the white nose of eastern *pyrrhonotus* (Schwarz 1960, cited as a pers. comm. in Hill 1966) combined initially to instill confusion, which subsequently resulted in disinterest in the issue.

Conservation Implications

Until recently, *Erythrocebus patas*, assessed in 2008 as a monotypic genus with no subspecies, was classified as Least Concern on the IUCN Red List of Threatened Species (Kingdon *et al.* 2017), undoubtedly the result of the deficient current taxonomy, the ample geographic range and the scarcity of research. Further, savannah primate species are generally believed to be less at risk than forest primates, but this is clearly an oversimplification that may be encouraged by an excessively-lumped alpha taxonomy (Gippoliti *et al.* 2017). Where the species has received attention, as in Kenya, it has been found to have suffered an historical range decline of about 50% (De Jong *et al.* 2008). The taxon *baumstarki* of northeastern Tanzania may well be in need of more research and conservation efforts (De Jong *et al.* 2009), but subspecies of widespread savannah primates have never received much attention—part of the 'subspecies problem' in conservation (Gippoliti and Amori 2007). The unique recognized species is listed in Appendix II of CITES, and international trade is thus allowed regardless of possible conservation problems among cryptic taxonomic units. *Erythrocebus patas* was reassessed in 2016 as 'Near Threatened' on the IUCN Red List, and the conservation status of the three subspecies recognized by Schwarz (1927) were assessed for the first time, with the following results: *patas* – 'Near Threatened'; *baumstarki* – 'Critically Endangered'; and *pyrrhonotus* – 'Vulnerable' (Y. A. de Jong and T. M. Butynski 2016, unpubl.).

Historical Background to *Erythrocebus* taxonomy

At the beginning of the 20th century, the number of recognized species in the genus *Erythrocebus* ranged from one to 12 (Pocock 1907; Elliot 1913; Matschie 1912). When Pocock subsumed all East African patas monkeys into the subspecies *pyrrhonotus* Hemprich and Ehrenberg, 1829, he did it admittedly on the basis of very few specimens, and most were of unclear provenance (Pocock 1907: 745). On the basis of intraspecific variability, as found in two adult males from the same locality belonging to *Erythrocebus whitei* Hollister, 1910, Allen found it reasonable to follow Pocock's proposal (Allen 1925). Although it is possible that here Allen was not aware that minor differences could be due to the different social status of adult males (adult harem-living males and younger solitary males), he was certainly right in stating that, considering the poor materials at hand, "it is hardly probable that the three forms recognized by Matschie from Togoland will all prove tenable, or that there are two good forms in the Uele drainage of the Upper Congo or that the form from that region is really sufficiently different from *pyrrhonotus* of the Upper Nile region to require a special name" (Allen 1925: 429). He was, however, surely not right regarding his last point, given that the type locality of *pyrrhonotus*, Darfur and Kordofan (Sudan), is isolated from most of the other members of what are supposedly the same subspecies by formidable barriers to the east such as the White and Blue Niles or even the Rift Valley.

In the account of *Erythrocebus patas* by Isbell (2013) in a recent major treatise on African mammals, Kenyan patas monkeys serve to describe the characters of *Erythrocebus patas pyrrhonotus*. The author evidently followed the taxonomic account proposed by Pocock (1907) and Schwarz (1927), but the hypothesis that a name proposed for the patas monkey of Kordofan applies to a Kenyan patas should be tested if we wish to avoid further confusion in an already chaotic issue. Anchoring a name to its type locality seems a particularly valuable action if we want to disentangle decades of 'taxonomic inertia' and excessive lumping. Particularly as concerns the eastern part of the range, the presence of important river barriers (cf. Cotterill 2003) such as the two Nile rivers has been completely overlooked in assessing *Erythrocebus* taxonomy. Setzer (1956), for example, found that his unique Darfur specimen was much paler compared to other Sudanese specimens. Koch (1969) was aware of the extensive variability existing among Sudanese *Erythrocebus* and thought that a taxonomic revision was overdue. Given this, and after observing photos of patas monkeys from Southern Kordofan, it seems reasonable to restrict usage of *pyrrhonotus* at the subspecific level to the Darfur-Kordofan population west of the Nile, as also implied by Koch (1969). Hopefully, the validity of the proposed taxa for East African patas monkeys (*baumstarki* Matschie; *formosus* Elliot, 1909; *whitei* Hollister, 1910; and *albosignatus* Matschie, 1912) should be assessed by a thorough taxonomic revision that should also use molecular genetic analyses. Although museum materials remain scarce, with the ultimate goal of attracting more attention to the alpha taxonomy of the genus *Erythrocebus*, I here review the taxonomic literature on the genus and, with the help of recent literature and photos of wild patas monkeys, re-evaluate an old, forgotten species from the northern-eastern margin of the distribution of the genus in Sudan and Ethiopia.

Taxonomy of *Erythrocebus* in Ethiopia

Historical records of *Erythrocebus* in Ethiopia indicate two geographic clusters (Yalden *et al.* 1977): one in the northwest and one in the southwest, apparently separated by the Blue Nile gorge. A uniquely dark form of patas monkey has been recently reported from Western Ethiopia (Yirga *et al.* 2010), and precisely two groups were encountered at almost the same time at 9°48.5'N, 34°42.6'E in agricultural lands around the Garabiche/Songa woodlands and at 9°53.76'N, 34°40.27'E near bamboo forest along the main road to Assosa and its adjacent cultivation sites—Bambesi Woreda (Benshangul Gumuz National Regional State). Two photos show features of the adult male, especially the long dark-gray/black fur on the withers that extends to the upper forelimbs, the black facial mask with a black nose, and ventral parts that are pinkish rather than pure white, and these clearly distinguish patas in the study site (Fig. 1) from other *Erythrocebus* seen

Figure 1. *Erythrocebus poliophaeus* (Reichenbach, 1862) from western Ethiopia (from Yirga *et al*. 2010).

elsewhere in East Africa and even in southwest Ethiopia (Fig. 2). A photo of an adult male near the Alatish National Park, not far from the village of Gelego (12°13'N, 35°53'E) (Heckel *et al*. 2007), perfectly agrees with the above, and both have the characters described for *poliophaeus* Reichenbach, 1862 (Fig. 3), of which *albigenus* Elliot, 1909, is certainly a junior synonym. In his description of *albigenus* (one adult captive male, type locality unknown but "somewhere in Sudan"), Elliot remarked that the face and nose were black, lacking a band between ear and eye, and the shoulder covered with very long black hairs annulated with cream color; he remarked also on the very long, mane-like hair on the hind neck and shoulders (Elliot 1909, 1913). The photos from Yirga *et al*. (2010) also show the species in an atypical habitat for the genus (close to bamboo forest). We might postulate that this species survived an arid period in a montane refugium in western Ethiopia.

Although *poliophaeus* is *de facto* unstudied in its natural range, the observations of Loy (1974) regarding changes in color of the faces in female *Erythrocebus* from Ethiopia must be referred to this taxon (and certainly not to *E. patas sensu strictu*, as supposed by Isbell 2013), as confirmed by Loy's remark that "our Ethiopian adult males are problematical with their black noses" (Loy 1974: 255). This can be further confirmed by comparing photos of adult females in Loy (1974: plate 1) with those from Nigeria in the study of Palmer *et al*. (1981: 375), which found ontogenetic changes in nose color but never observed dark facial skin in their patas

Figure 2. The typical patas monkeys from Gambela National Park, provisionally referable to *Erythrocebus pyrrhonotus formosus* Elliot, 1909. Courtesy of Ludwig Siege.

Figure 3. Adult male *Erythrocebus poliophaeus*, Beijing Zoo. Courtesy of Jonas Livet.

monkeys, which certainly belong to a different species. The skull of the holotype of *albigenus* is quite distinctive according to Elliot (1913), but this obviously requires the study of much more material.

Butler (1966) reported on the distribution of patas monkeys along the Dinder and Blue Nile in Sennar (Sudan) from 13°N and 33°E. Patas monkeys were reported for the Dinder National Park in Sudan (Happold 1966 and pers. comm. 2017) without much detail, and for the southern tip of the Alatish National Park in Ethiopia (Mengesha and Bekele 2008).

Photographs provided by Jonas Livet (pers. comm.) indicate that pure breeding groups of *poliophaeus* are housed in the zoos of Beijing (China) (Fig. 3), Al Ain (Dubai), and Kuwait. Patas monkeys in Ethiopia or Sudan are evidently still being commercially traded. The species may be hunted for medical purposes in the Kafta-Humera District, Tigray National Regional State, specifically Hlet-Coca sub-district in Northern Ethiopia, about 560 km to the west of Mekelle (Tigray, Ethiopia) (Yirga *et al.* 2011), but these records await confirmation.

Considering the geographic separation and distinctive external appearance, I have no hesitation in considering *poliophaeus* to be a distinct species. Its closest taxon in appearance seems to be *baumstarki*, for which species' status is also warranted. The recognition of these patas monkeys as species, highlights the need for field surveys to assess their geographic range and conservation status in both Ethiopia and Sudan.

Erythrocebus poliophaeus (Reichenbach, 1862)

Heuglin's or Blue Nile patas monkey

Syn.*Cercopithecus poliophaeus* Reichenbach, 1862
Cercopithecus poliolophus Heuglin, 1877, renaming of *poliophaeus*
Erythrocebus albigenus Elliot, 1909

The lectotype of *E. poliophaeus* is a young male in the Vienna Natural History Museum, NMW 743/ST 1567. Four-year-old male, skull, skeleton, mounted: Fazoglo, Africa (Reichenbach 1862); T.v. Heuglin leg. et vend. (AV 1856/III/1 *Cercopithecus poliophaeus*) (Ellenberger 2010) (Fig. 5).

The holotype of *E. albigenus* is an adult male, Natural History Museum London 1908.6.15.1, skin and skull. Captive at Giza Zoo, Cairo, and originating from "Anglo-Egyptian Sudan."

Geographic distribution. Available records refer to this species in Ethiopia as very scarce. Heuglin (1857) was the first to report patas monkeys from the then Wochni District (= Uahni 12°40'N, 36°42'E), but only a century later Blower (1968) added two more records, 30 km south of Metemma (12°45'N, 36°10'E; northern known limit), and 5 km east of

Figure 4. *Erythrocebus poliophaeus* as figured by Reichenbach (1862) number 309. Incidentally, figures 311 to 313 show *E. pyrrhonotus* from Sudan.

Figure 5. Lectotype of *Erythrocebus poliophaeus* (Reichenbach, 1862) in the Vienna Natural History Museum. Courtesy of the Vienna Natural History Museum.

Gubba (11°15'N, 35°17'E). The data and photographs of Yirga *et al.* (2010) are critical to assessing the southern limit of *E. poliophaeus* in Bambesi Woreda (Benshangul Gumuz State), well south of the Blue Nile at 9°48.5'N, 34°42.6'E and at 9°53.76'N, 34°40.27'E. As patas monkeys tend to be lowland dwellers, up to 1000 m above sea level (Assosa/Bambesi has an altitude of 1400−1600 m asl), it is postulated that there is an altitude barrier between *Erythrocebus poliophaeus* in Benishangul and the Gambela *Erythrocebus* taxon, as, in the Oromiya region along the Sudanese border, between Benishangul and Gambela, the Ethiopian highlands stretch up to the Sudanese border reaching higher elevations (Fig. 6).

Erythrocebus pyrrhonotus formosus Elliot, 1909

The scanty photographic material available (Fig. 2) indicates a different taxon of red monkey in southwest Ethiopia, in Gambela National Park (Fig. 6). This may be ascribed to the taxon *formosus* Elliot, 1909, described from "Uganda", and is here provisionally treated as a subspecies of *pyrrhonotus*. It is clearly much less blackish than *poliophaeus*, and has a black band from eye to ear that is absent in *poliophaeus*. The nose is white in adult males. This is probably the species found over most of Uganda. A better knowledge of phylogeographic structure among the various forms of white-nosed patas of East Africa is urgently needed.

Conclusions

As anticipated by Allen (1925), some of the named forms of *Erythrocebus* could be valid taxa if more evidence came to light. The main aim of the article was to revive interest in the topic and highlight some conservation priorities in East Africa. A species first described over 150 years ago is re-evaluated; it is known from the Blue Nile basin in western Ethiopia and adjoining Sudan, and separated from another *Erythrocebus* taxon by the Sudd swampy region in Sudan and the Ethiopian highlands, which stretch up to the Sudanese border north of Gambela. It is an obvious focus for further research and conservation. Monkeys of the genus *Erythrocebus* are potential flagships for important African ecosystems, and may well be at greater risk than is generally believed.

The western Ethiopian escarpment flora has received due scientific attention only in this century, and a number of new endemic species have been discovered in Benshangul Gumuz in recent years (Sebsebe Demissew *et al.* 2005). A revised taxonomy of the genus *Erythrocebus* is also fundamental to analyze the available data concerning the natural history and biology of the different taxa. With the recognition of the Heuglin or Blue Nile patas monkeys *Erythrocebus poliophaeus* we have now two taxa with a black face and nose (at least in the adult male)—the other being *Erythrocebus baumstarki*—at the fringe of the genus's range in East Africa, and possibly representing ancient surviving lineages that have been

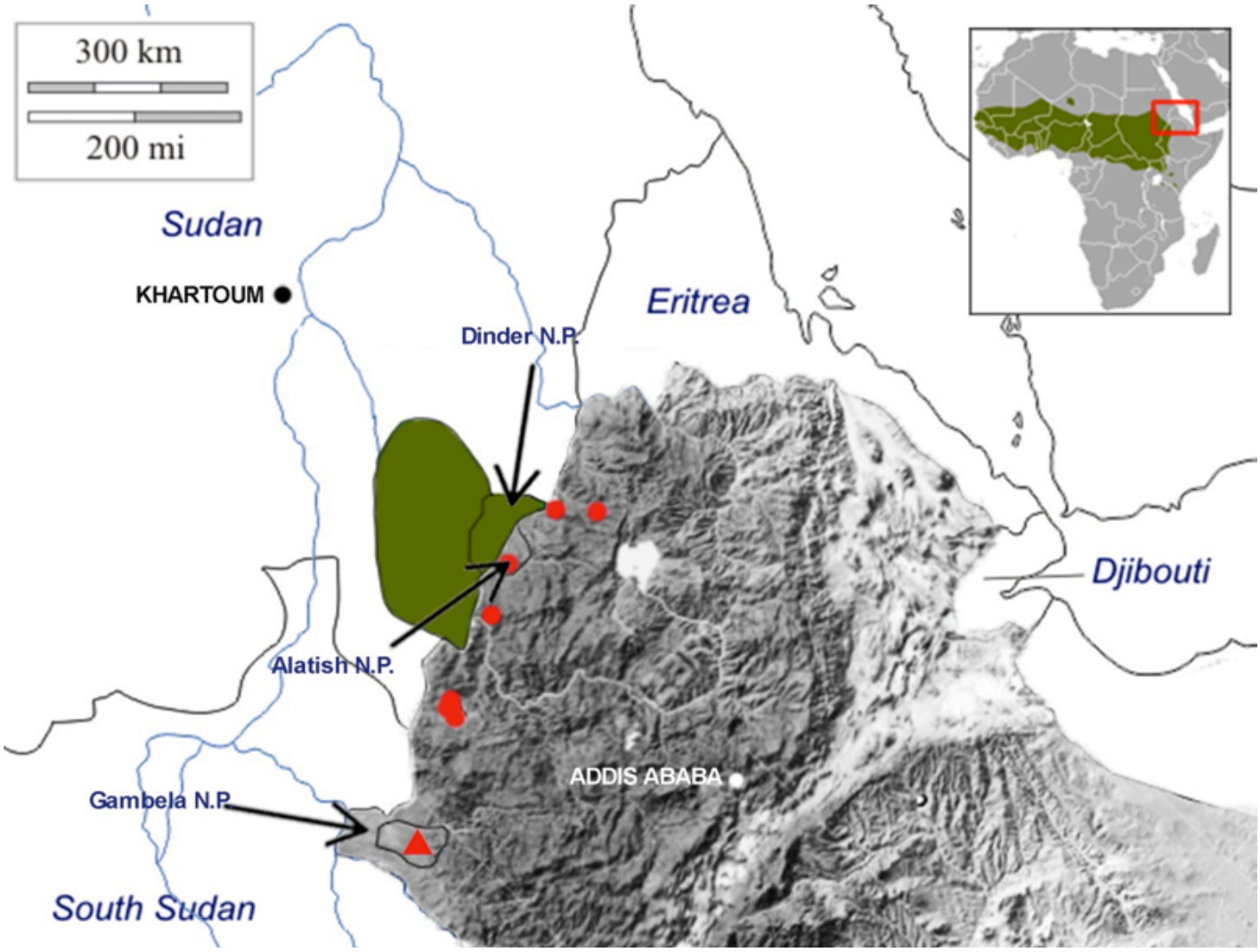

Figure 6. Approximate distribution of *Erythrocebus* in Ethiopia and East Sudan. Green = approximate distribution of *Erythrocebus poliophaeus* in Sudan according Butler (1966); red dots = Ethiopian records of *E. poliophaeus*; red triangle = approximate distribution of *Erythrocebus pyrrhonotus formosus* Elliot, 1909, in southwest Ethiopia. Insert; the entire range of the genus *Erythrocebus*.

supplanted by a white-nosed species elsewhere in East Africa that is provisionally referred as *Erythrocebus pyrrhonotus*, with *E. p. formosus* and a number of other subspecies occurring over its range.

Acknowledgments

I thank Simon Ellenberger (NMW) for his valuable assistance with old German references. Dietmar Zinner read and criticized a previous version of the manuscript, as did Colin P. Groves. Christof Herrmann provided some unpublished observations on patas monkeys in Benshangul Gumuz, and Giuliano Milana helped with the preparation of the map. Ludwig Siege and Jonas Livet kindly allowed me to use of their photographs. I am grateful to Anthony Rylands, Russell A. Mittermeier and an anonymous referee for useful comments on the original manuscript.

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Received for publication: 13 July 2017
Revised: 24 July 2017