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RESEARCH ARTICLE

Multiple colors in anteaters: review and description of chromatic disorders in *Tamandua* (Xenarthra: Pilosa) with reports of new and rare coat colorations

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ABSTRACT. *Tamandua* Gray, 1825 contains two species of anteaters: *Tamandua mexicana* (Saussure, 1860), which occurs in southern Mexico, throughout Central America and south to the west of the Andes in South America, and *Tamandua tetradactyla* (Linnaeus, 1758), widely distributed in South America, from Venezuela to northern Argentina, as well as Trinidad and Tobago. Historically, different coloration patterns have been attributed to the coat of *Tamandua*, with *T. mexicana* typically showing a partial or complete dark "vest" on the dorsal portion of the body, whereas *T. tetradactyla* can show a complete, partial, or absent vest and a coat varying from golden, pale yellow and pale gray to brown or black. These different coat colors are sometimes treated as inherent characteristics of subspecies of *Tamandua*. Here, we review color variation in *Tamandua* and describe six chromatic disorders for the genus: albinism, leucism, "brown" variation, melanism (partial and total), xanthochromism (partial and total) and, for the first time for anteaters, erythrism. In addition, we detail the morphological expression and geographic distribution of these anomalies in populations of *Tamandua* from Central and South America.

KEY WORDS. Coat color variation, hyperpigmentation, hypopigmentation, Mammalia, Vermilingua.

INTRODUCTION

Anteaters are xenarthran mammals included in the Neotropical order Pilosa and suborder Vermilingua. Currently, two families are recognized: Cyclopedidae, consisting of the silky anteaters, *Cyclopes didactylus* (Linnaeus, 1758), *Cyclopes dorsalis* (Gray, 1865), *Cyclopes ida* Thomas, 1900, *Cyclopes catellus* Thomas, 1928, *Cyclopes rufus* Miranda et al., 2018, *Cyclopes thomasi* Miranda et al., 2018, and *Cyclopes xinguensis* Miranda et al., 2018; and Myrmecophagidae, which includes the giant anteater, *Myrmecophaga tridactyla* Linnaeus, 1758, and the smaller vested anteaters, *Tamandua mexicana* (Saussure, 1860) and *Tamandua tetradactyla* (Linnaeus, 1758), which represent the focal genus of this study.

Both species of *Tamandua* Gray, 1825 share some distinctive biological and morphological traits, including medium size (3–7 kg); an elongated and tubiliform head; small black eyes bordered by bare skin or sparse white hairs; rounded ears; black nostrils; a dense coat with short or long hair; a prehensile tail; muscles of the forelimbs more developed than those of the hindlimbs; manus with four apparent digits and developed claws, mainly on the third digit; pes with small and discreet claws; and external genitalia without sexual dimorphism (sensu Wetzel 1975, 1982, Nowak and Walker 1999, Hayssen 2011).

Species of *Tamandua* occupy a variety of environments in South and Central America, such as tropical, riparian, cloud and transitional forests, savannas (including artificial grasslands) and mangroves (Cuarón 2005, Mares et al. 1996, Reid 1997, Tirira 2007, Meritt Jr 2008). Wetzel (1982) proposed that *T. tetradactyla* is distributed from Venezuela to northern Argentina, as well as Trinidad and Tobago, whereas *T. mexicana* occurs in southern Mexico, throughout Central America, and northern South America west of the Andes.

Wetzel (1975) classified these species based on some morphological characteristics, including coat color. *Tamandua mexicana* has black spots on its back that elongate and merge along the ventral portion of its body, forming a blackened "vest". The limbs and head are golden-yellow or pale-yellow in coloration, and the rostral portion of its head shows a blackish mask that extends from its nostrils to the perimeter around its eyes. *Tamandua tetradactyla*, in turn, has a complete or incomplete "vest", and the coloration of the rest of its pelage varies from golden-yellow to brown, black or pale gray (Allen 1904, Wetzel 1982). Coat color variations in *Tamandua* have historically been treated as inherent characteristic of subspecies in this genus and together with a few cranial and geographical data (see Wetzel 1975) constitute the only diagnostic criteria used to establish these taxa. Further information about chromatic variation in *Tamandua* remains scarce in the current scientific literature.

In this study, we review the records of chromatic anomalies in *Tamandua* and identify new and rare color variants. We also assess the nomenclature of such unusual phenotypes. In addition, we describe the morphological patterns of these color variations in individuals of *T. mexicana* and *T. tetradactyla* as well as their geographic occurrence and produce a set of diagnostic information for the recognition of these phenotypes in this genus.

Chromatic disorders in mammals

Coloration is a tool frequently used in species identification, with a variety of colors and patterns observed on the skin, pelage, and feathers of vertebrates (sensu Caro 2005). Coloration is the result of the joint action of more than 150 genes that determine pigmentation in vertebrates, with color anomalies occurring mainly due to excesses or deficits in melanin or other pigments, which may affect an animal's body partially or totally (Acevedo and Aguayo 2008, van Grouw 2013, Aximoff et al. 2021).

Albinism and melanism are the most frequently recognized coloration disorders in mammals. Albinism is a hypopigmentary condition related to mutations in the TYR gene, responsible for the biosynthesis of the enzyme tyrosinase. The alteration in this gene results in a defective tyrosinase that produces little or no melanin, resulting in reduced or absent pigmentation in the eyes, skin, and hair of albino individuals (Fertl and Rosel 2009). Melanism, in turn, is a hyperpigmentary chromatic anomaly present in many vertebrates, often associated with mutations in four genes: Agouti signaling protein (ASIP), Attractin (ATRN), Mahogunin (MGRN) and Melanocortin 1 receptor gene (MC1R – Kingsley et al. 2009). These genes participate in the production of types of melanin in melanocytes of the skin, hair, or feathers. Certain mutations in these genes result in reduced or absent production of pheomelanin (red/yellow pigment) and increased or independent expression of eumelanin (brown/black pigment), generating the dark coloration typical of melanism (sensu Majerus and Mundy 2003, Anderson et al. 2009, van Grouw 2017). In some mammals, such as wolves, the melanistic condition is associated with the K locus, a melanocortin pathway component that encodes a beta-defensin protein that acts as an alternative ligand for MC1R (Anderson et al. 2009). An incomplete black or brown pigmentation can also occur in vertebrates, sometimes known as "partial melanism". This condition is often caused by diseases, malnutrition or lack of sun exposure (van Grouw 2013, Lucatti and López-Baucells 2016).

Two distinct hypopigmentation disorders (sometimes referred to ambiuguously as "partial albinism") are "leucism" and "piebaldism" (sensu Lucati and López-Baucells 2016). In leucism, as compared to albinism, decoloration occurs only in parts of an animal's body, and the typical coloration of the iris, nails, and skin is preserved. The melanin deficits in leucistic mammals, as well as birds, are typically the result of a congenital (present at birth) and heritable (transmitted from parents to their offspring) failure of the pigment production of melanoblasts during their migration to some or all areas of the skin, such that these pigment cells are absent in areas where pigment is typically present (van Grouw 2013). This condition is often associated with environmental alterations, low-quality diets, and follicular damage (Brito and Valdivieso-Bermeo 2016). Piebaldism is another chromatic anomaly associated with a lack of melanin in parts of the body, affecting only the coloration of the skin, hair, or feathers. In piebaldism, genetic mutations cause the interruption of melanocyte development in specific areas, with affected animals showing well-marked spots on the body (Fertl and Rosel 2009, Lucati and Lópes-Baucells 2016, Mello et al. 2020).

Another chromatic disorder occasionally reported for mammals is flavism, a hypopigmentation condition that according to some authors produces different shades of red and/or yellow hair, commonly due to a greater expression of pheomelanin in tissues as compared to eumelanin (sensu Holcová-Gazárková et al. 2017). This anomaly is also referred to as "rufous", "brown" or "yellow" color variations (Ruprechet 1965, van Grouw 2013, Canady 2016, Cichocky et al. 2017). The application of the term "flavism" is confused, and its diagnostic characteristics may be present in other chromatic disorders such as xanthochromism (syn. xanthism) and erythrism. Xanthochromism is an anomaly with atypical predominance of yellow pigments (e.g., xanthine, pheomelanin) in the skin, scales, hair, or feathers of vertebrates, producing a yellow or orange coloration in their tissues (Romero-Briceño 2018). Xanthochromism is rarely recognized in mammals and is better documented in other vertebrates, including fishes, amphibians, and "reptiles" (Quigley et al. 2017, Romero-Briceño 2018). Still, some cases can be exemplified.

Scorer (1980) commented on the occurrence of yellowish fur in primates of *Cercopithecus* (cited by the author as "flavistic" animals). Ge et al. (2012) reported a possible case of xanthochromism (referred by the authors as xanthism) in a museum specimen of plateau pika, *Ochotona curzoniae* (Hodgson, 1858). Gong et al. (2021) described cases of chromatic anomalies in martens, *Martes flavigula* (Boddaert, 1785), from seven provinces in China, identifying the individuals as "white spotted" and as "diluted/leucistic", which are possibly classifiable as cases of total or partial xanthochromism. Erythrism, in turn, is an anomaly characterized by reddish or reddish-brown coloration in the hair or feathers, probably generated by a recessive mutation in the "Extension" gene that causes increased production of red pigments (pheomelanin) in areas of the body and coat where black pigments (eumelanin) are typically present (Majerus and Mundy 2003, Peterschmitt et al. 2009, Pirie et al. 2016, van Grouw 2021). Animals with erythrism are often referred to by the adjective "strawberry" in formal and informal literature (e.g., Pirie et al. 2016). The differences observed in the origin and phenotype of xanthochromism and erythrism, as mentioned above, reinforce the fragility of grouping yellowish and reddish individuals as a single chromatic disorder, such as "flavism".

It is important to emphasize that many of these nomenclatures do not present a scientific consensus, mainly in mammal studies, and are often attributed to different animals from a superficial observation, without supplementary morphological and/or genetic data.

MATERIAL AND METHODS

Analysis of chromatic disorders in *Tamandua*

This study was carried out from January 2018 to April 2022, initially by evaluating color patterns in the skins of 33 museum specimens of *T. tetradactyla* available from these Brazilian institutions: Museu Nacional da Universidade Federal do Rio de Janeiro (UFRJ), Museu de Zoologia da Universidade de São Paulo (MZUSP), and Centro de Coleções Taxonômicas da Universidade Federal de Minas Gerais (UFMG). The following voucher specimens were analyzed: UFRJ: MN 3846, MN 4538, MN 5059, MN 5068, MN 5069, MN 5026, MN 5061, MN 5515, MN 73484, MN 79027, MN 79028, MN 79171, MN 79179, MN 79503, MN 79361, MN 79513; MZUSP: MZUSP 21329, MZUSP 31990; UFMG: UFMG 1037, UFMG 3107, UFMG 3108, UFMG 3884, UFMG 3939, UFMG 3984, UFMG 3985, UFMG 3986, UFMG 4171, UFMG 4172, UFMG 4338, UFMG 4526, UFMG 6014, UFMG 6077, UFMG 6165.

Posteriorly, an extensive investigation of chromatic disorders in species of *Tamandua* was made covering 2000 photographic samples in formal and informal publications (published on social networks and websites of zoological interest – including museum and zoo websites). We used isolated or combined keywords in online searches for chromatic disorders in formal and informal media. Searches were carried out in English, Spanish, and Portuguese, the most commonly used languages in publications on xenarthrans. General terms such as "tamanduá", "oso hormiguero", and "anteater", as well as the scientific names "*Tamandua tetradactyla*" and "*Tamandua mexicana*", were used in combination with the names of chromatic disorders (e.g., leucism, melanism). For searches of formal records of chromatic disorders in anteaters, we consulted articles and books found on the following platforms: Google Scholar, Scopus, SciELO, Web of Science, Semantic Scholar, Science Direct, Directory of Open Access Journals, Science.gov, ScienceResearch. Informal records were collected from photographs, posts, and data entries published on the following websites: iNaturalist, Google, Facebook, Instagram, and Twitter.

All chromatic disorders reported in this study were compared with records of the same disorders in other groups of mammals (e.g., Lucati and López-Baucells 2016, Dunlop et al. 2019, Dalapicolla et al. 2020, Gong et al. 2021) in pursuit of greater accuracy in the identification of these conditions.

All photographs used to illustrate chromatic disorders in species of *Tamandua* (Fig. 1) are from open access for scientific publications; their authors are cited throughout this article.

Geographic distribution of chromatic disorders in *Tamandua*

Geographical records of individuals of *Tamandua* with chromatic disorders were collected from formal and informal publications, with the exception of all the records of erythristic individuals, two melanistic individuals, two partially melanistic individuals and one xanthochromic individual, which are first published here. Records with a lack of collection or sighting data or with otherwise dubious information are not included.

Maps with location points were produced using QGIS software version 3.24.3 (https://qgis.org/en/site/).

Photographic records

Photographic records were mostly obtained from the articles and websites where they were originally published. Photographs of the individuals of *T. mexicana* with erythrism were taken by the second author of this study and by other staff and guests of the Canopy Family, Panama, and photographs of three melanistic, two partially melanistic and one partially xanthochromic individuals of *T. tetradactyla* were provided by the fourth author.

Nomenclature of chromatic disorders

The chromatic disorders presented here are referred to with terms conventionally attributed to these anomalies in the scientific literature (e.g., Caro 2005, van Grouw 2013, Lucatti and López-Baucells 2016, Gong et al. 2021). We consider the most common nomenclatural use in morphological and/or genetic studies with the aim of minimizing terminological mistakes and favoring a more accurate diagnosis for these disorders in our study. Some authors (e.g., Lucati and López-Baucells 2016) suggest that the terms "flavism", "xanthism", and "erythrism", as well as other terms associated with these disorders (e.g., "rufism"), should be grouped within a single category of hypopigmentation called hypomelanism, a hereditary pigmentation anomaly associated with insufficient pigmentation of the skin and hair that produces beige, golden, yellowish, and reddish color variants. In order to facilitate the diagnosis and interpretation of coloration patterns for each presented anomaly, we have kept the use of terms such as "erythrism", "xanthochromism (syn. xanthism)". Other terms, such as "flavism" and "rufism", are discarded by us and we do not recommend their use, since their identification is confusing and they are reported in individuals who possibly have other chromatic disorders (e.g., erythristic and xanthochromic animals described as flavistic), causing more misunderstandings in the diagnosis and expressiveness of abnormal colorations in mammals.

RESULTS

We found 64 records of individuals of *Tamandua* with some chromatic disorder. Diagnoses of chromatic disorders in the formal records discussed below (Table 1) follow their identifications or suggested identifications in the original publications, when available, except as regards the record from Hayssen (2011), which does not identify chromatic disorders. For the informal photographic records, some were published with comments on chromatic anomalies, whereas others needed to be identified by us based on the observable evidence in the photographic material. The erythristic individuals of *Tamandua* were first sighted and identified by our research group and represent the first records of this anomaly for the genus.

Records and descriptions of chromatic disorders in *Tamandua*

Melanism

Melanistic forms are historically recognized for *Tamandua* and have been assigned to a subspecies, *Tamandua tetradactyla nigra* (É. Geoffroy Saint-Hilaire, 1803). The geographic distribution of melanistic individuals of *T. tetradactyla* is restricted to eastern Colombia, Venezuela, Trinidad and Tobago, the Guianas, and the east-central and northern Amazon basin of Brazil (Wetzel 1975, Gardner 2008).

Aside from the classic records of black variants of *Tamandua* (e.g., É. Geoffroy Saint-Hilaire 1803, Wetzel 1975), we recorded two melanistic individuals of *T. tetradactyla* and found nine additional reports of melanism in the formal literature (N = 6) and three in informal media (N = 3). The first record was made in 1996 (unidentified month) in Lago Piratuba Biological Reserve, municipality of Serra do Navio, Amapá, Brazil (1°41'7.440"N, 49°55'58.800"W, photograph taken by Leandro Silveira). The second and third record, corresponding to the same melanistic individual, were obtained in February, 2019 in the municipality of Ferrreira Gomes, Amapá, Brazil (0°49'15.960"N, 51°11'9.600"W and 0°33'11.160"N, 51°8'44.160"W, photographs taken by Francisco Carneiro). Marks on the coat and scars on the rostrum of this individual allowed for its recognition in both records.

Other melanistic individuals – three free-living individuals and three museum specimens – are reported by Ríos-Alvear and Cadena-Ortiz (2019). According to the au-

Figure 1. Chromatic disorders in *Tamandua*: (A) Melanism (by javatru), (B) Partial melanism (by shrike2), (C) Xanthochromism (by pfaucher), (D) Partial xanthochromism (by kenchamberlain), (E) "Brown" variation (by chartuso), (F) Leucism (More et al. 2021), (G) Albinism (Ríos et al. 2019), (H) Erythrism (by Slifkin). A–F originally published on iNaturalist.

Table 1. Records of chromatic disorders in *Tamandua*.

Chromatic disorder	Record location	Sighting date	Reference
	Tamandua tetradactyla		
Melanism	Lago Piratuba Biological Reserve, municipality of Serra do Navio, Amapá, Brazil (1°41'7.440"N, 49°55'58.800"W)	1996 (no month)	Authors' data
	Municipality of Ferrreira Gomes, Amapá, Brazil (0°49'15.960"N, 51° 11'9.600"W and 0°33'11.160"N, 51°8'44.160"W)	February, 2019	Authors' data
	Ouanary River, Cayenne, French Guiana	Museum specimen	Menegaux (1902); Wetzel (1975)*
	Yurac Yacu, San Martín, Peru	Museum specimen	Wetzel (1975)*
	San Juan de Río Manapiare, Amazon region of the Venezuela	Museum specimen	Wetzel (1975)*
	Surroundings of San Luis waterfall, Porvenir del Carmen, Zamora Chinchipe, Ecuador	March 9, 2018	Ríos-Alvear and Cadena-Ortiz (2019)
	Loja–La Balsa (E682) road, Zamora Chinchipe, Ecuador	October 10, 2018	Ríos-Alvear and Cadena-Ortiz (2019)
	E45 road, Limón Indanza, Morona Santiago, Ecuador	October 23, 2018	Ríos-Alvear and Cadena-Ortiz (2019)
	General Leonidas Plaza Gutiérrez, Limón Indanza, Morona Santiago, Ecuador	February 2, 2009	Ríos-Alvear and Cadena-Ortiz (2019)
	San Juan Bosco, Morona Santiago, Ecuador	March 2016	Ríos-Alvear and Cadena-Ortiz (2019)
	Surroundings of Cerro Plateado Biological Reserve, Alto Nangaritza, Zamora Chinchipe, Ecuador	August 27, 2012	Ríos-Alvear and Cadena-Ortiz (2019)
	La Mar, Peru	August 15, 2009	Photographed by "javatru" (https://www.inaturalist.org/observations/46126423)
	Coronel Portillo, Peru	July 25, 2017	Photographed by "marilimbu" (https://www.inaturalist.org/observations/100116810)
	Camopi, Guiana Amazonian Park, Guyane Française	January 30, 2021	Photographed by "sebsantpag" (https://www.inaturalist.org/observations/96791450)
Partial melanism	Sooretama Biological Reserve, Sooretama, Espírito Santo, Brazil (19°0'38.160"S, 40°0'35.640"W)	December, 2019	Authors' data
	municipality of Tartarugalzinho, Amapá, Brazil (1°26'31.200"N, 50°53' 24.000"W)	October, 2019	Authors' data
	Captive in Buffalo Zoo, New York, USA	Identified on July 20, 2020	Hayssen, 2011 (Fig. 1)
	municipality of Hato Corozal, Casanare, Colombia	May 13, 2018	Photographed by "haider_adrian_ibarra_blanco" (https://www.inaturalist.org/observations/12472204)
	Atalaia do Norte, Amazonas, Brazil	January 15, 2019	Photographed by "shrike2" (INaturalist website)
Dark brown	Regions of the Amazon adjacent to Venezuela and Suriname	Museum specimen	Wetzel (1982)*
	Peru	No date	Ríos-Alvear and Cadena-Ortiz (2019)
	Río Napo region, Shushufindi, Ecuador	December 25, 2013	Photographed by "chartuso" (https://www.inaturalist.org/observations/38378297)
	municipality of Uarini, Amazonas, Brazil	March 21, 2019	Photographed by "miguelmonteiro" (https://www.inaturalist.org/observations/22237402)
Partially brown	Santa Marta, Colombia	No date	Allen (1904)
Albinism	Isla Umbú, near the city of Pilar, Department of Ñeembucú, Paraguay	June 19, 2018	Ríos, Díaz and Smith (2019)
Leucism	Province of Chaco, Argentina	July, 2007	Photographed by "walterprado" (https://www.inaturalist.org/observations/34552966)
Xanthochromism	Podocarpus National Park, Ecuador	October 10, 2018	Ríos-Alvear and Cadena-Ortiz (2019)
	Orellana, Ecuador	July 18, 2000	Photographed by "diego_naranjo" (https://www.inaturalist.org/observations/53684563)
	Tarumã, Manaus, Brazil	August 13, 2000	Photographed by "franciele_xingu" (https://www.inaturalist.org/observations/70848582)
	Mapalfa, alto Purus, Peru	September 24, 2002	Photographed by "muir" (https://www.inaturalist.org/observations/26543)
	Xapuri, Acre, Brazil	June 1, 2006	Photographed by "edson_guilherme" (https://www.inaturalist.org/observations/72441097)
	Maynas, Peru	June 25, 2013	Photographed by "edu_bal" (https://www.inaturalist.org/observations/45934402)
	La Joya de Los Sachas, Ecuador	June 14, 2017	Photographed by "nilsondanilocastellanossnchez" (https://www.inaturalist.org/observations/42753190)
	Tame, Arauca, Colombia	June 9, 2017	Photographed by "diego_naranjo" (https://www.inaturalist.org/observations/48983696)
	Sucumbíos Province, Ecuador	November 6, 2017	Photographed by "pfaucher" (https://www.inaturalist.org/observations/8751817)

Continues

Table 1. Continued.

Chromatic disorder	Record location	Sighting date	Reference
	Hato Corozal, Casanare, Colombia	January 23, 2018	Photographed by "carlosyaya77" (https://www.inaturalist.org/observations/12848745)
	Yopal, Casanare, Colombia	January 23, 2018	Photographed by "franciscorueda" (https://www.inaturalist.org/observations/12684040)
	Reserva Natural La Palmita, Casanare, Colombia	January 25, 2018	Photographed by "vireolanius" (https://www.inaturalist.org/observations/9828806)
	Trinidad, Casanare, Colombia	June 09, 2018	Photographed by "jhonjairoalvarezgomez" (https://www.inaturalist.org/observations/13774788)
	Caracaraí, Roraima, Brazil	November 30, 2018	Photographed by "fernandofarias" (https://www.inaturalist.org/observations/18744674)
	La Aurora, Hato Corozal, Casanare, Colombia	August 31, 2019	Photographed by "jokari" (https://www.inaturalist.org/observations/35883803)
	Gonzalo Pizarro, Sucumbíos Province, Ecuador	October 5, 2019	Photographed by "vkcruzjumbo" (https://www.inaturalist.org/observations/37999370)
	Paz de Ariporo, Casanare, Colombia	February 20, 2020	Photographed by "navtombros" (https://www.inaturalist.org/observations/48345355)
	Jardim de Alah, Rio Branco, Acre	June 15, 2020	Photographed by "edson_guilherme" (https://www.inaturalist.org/observations/50041904)
	Rionegro, Ecuador	April 30, 2021	Photographed by "reggioameliadecimoajuliandavid" (https://www.inaturalist.org/observations/76334641)
	Shushufindi, Ecuador	May 18, 2021	Photographed by "calva_oswaldo" (https://www.inaturalist.org/observations/84067583)
	Santa María, Boyacá, Colombia	May 26, 2021	Photographed by "belcy_burbano" (https://www.inaturalist.org/observations/80520413)
	Napo Wildlife Center Ecolodge, Quito, Ecuador	Jul 16, 2021	Photographed by "guido113" (https://www.inaturalist.org/observations/103170774)
	Brasso Seco Village, Trinidad and Tobago	October 30, 2021	Photographed by "kyma" (https://www.inaturalist.org/observations/99945953)
	Trinidad, Casanare, Colombia	March 2, 2022	Photographed by "gabo_utria" (https://www.inaturalist.org/observations/108403440)
Partial xanthochromism	Virua National Park, municipality of Caracaraí, Roraima Brazil (1°39'9.720"N, 61°11'9.240"W)	September, 2020	Authors' data
	Saint-Elie, French Guiana	February 6, 2008	Photographed by "merav" (https://www.inaturalist.org/observations/16104381)
	Trinidad, Casanare, Colombia	Dec 12, 2018	Photographed by "jhonjairoalvarezgomez" (https://www.inaturalist.org/observations/21700120)
	Control Post of Añangu (MAE), Francisco de Orellana, Ecuador	January 1, 2019	Photographed by "felipecampos" (https://www.inaturalist.org/observations/34299081)
	Bosque Bavaria, Villavicencio, Meta, Colombia	February 5, 2019	Photographed by "kenchamberlain" (https://www.inaturalist.org/observations/21233809)
	Madre de Díos, Peru	August 20, 2019	Photographed by "rumeltr" (https://www.inaturalist.org/observations/31185369)
Partial xanthochromism or xanthocromism	Falcón, Capatárida, Venezuela	Museum specimen	Wetzel (1975)*
	Dadanawa Ranch, Rupununi, Guyana	Museum specimen	Wetzel (1975)*
	Tamandua mexicana		
Leucism	Campesina Community of San Antonio de Salas, Lambayeque, Peru	May 26, 2018	More et al. (2021)
Erythrism	Adjacent regions of the Semaphore Hill Road in Soberanía National Park, Panama	February 14, 2020	Authors' data
	Adjacent regions of the Semaphore Hill Road in Soberanía National Park, Panama	April 01, 2020	Authors' data
	Adjacent regions of the Semaphore Hill Road in Soberanía National Park, Panama	March 11, 2022	Authors' data
	Adjacent regions of the Semaphore Hill Road in Soberanía National Park, Panama	March 18, 2022	Authors' data
	Adjacent regions of the Semaphore Hill Road in Soberanía National Park, Panama	April 28, 2022	Authors' data

*Wetzel (1975, 1982) comments that a wide variety of coloration patterns are found across the range extending from Peru to the Guyanas, with uniformly yellow, black and dark brown individuals being distributed together with others forms with complete or partial vests. However, without accurate information about vouchers and sightings.

thors, the first record was made by camera trap on March 9, 2018 in a mountain forest in the surroundings of the San Luis waterfall, Porvenir del Carmen, Zamora Chinchipe, Ecuador (4°32'56.36"S, 79°3'18"W). The second record was made in October 10, 2018, at a straight-line distance of 21 km from the first record on the Loja-La Balsa (E682) road, Zamora Chinchipe, Ecuador (4°43'31.77"S, 79°7'19.13"W). The third record is of a roadkilled individual on the E45 road, Limón Indanza, Morona Santiago, Ecuador (4°43'31.77"S, 79°7'19.13"W) from October 23, 2018. Of the three museum specimens, two were collected dead, with the first found on February 2, 2009 in the region of General Leonidas Plaza Gutiérrez, Limón Indanza, Morona Santiago, Ecuador, and the second in San Juan Bosco, Morona Santiago, Ecuador, in March 2016. The third specimen was collected on August 27, 2012 near the Cerro Plateado Biological Reserve, Alto Nangaritza, Zamora Chinchipe, Ecuador. Informal photographic records of melanistic specimens of *T. tetradactyla* were found on iNaturalist, posted by three different users. The first user (javatru) photographed a melanistic *T. tetradactyla* on August 15, 2009 in the road to San Antonio town, La Mar, Peru; the second user (marilimbu) photographed a melanistic *T. tetradactyla* on July 25, 2017 in Coronel Portillo, also in Peru; and the third user (sebsantpag) photographed a melanistic *T. tetradactyla* on January 30, 2021, in Camopi, Guiana Amazonian Park, French Guiana.

The melanistic individuals of *Tamandua* have a uniformly dark coat over most of the body, with the exception of the manus, pes, part of the head, ears, and tail (Fig. 1A). The heads of these individuals are mostly covered with black hair, with the exception of the rostrum and the ears. The rostral region is hairless from the perimeter around the nostrils and mouth to the perimeter around the eyes, forming a well-defined mask. This mask is elliptical and elongated when observed laterally and forms a "V" when observed superiorly. The skin of the hairless rostral region is pale to dark gray. The ears have very short hairs and are hairless in the margin that surrounds and delimits the helix region. The plantar region of the manus and the dorsal and plantar regions of the pes are grayish, conspicuous against the more blackened coat and claws. The mid to distal segment of the tail of the melanistic individuals is markedly hairless, and the skin is light gray, with some individuals showing scattered spots on the skin and/or a blackened tip to the tail (Fig. 1).

An individual of *T. tetradactyla* with partial melanism is observed in a photograph published in Hayssen (2011: 64, fig. 1). The chromatic anomaly in this animal, a *T. tetradactyla* individual from Buffalo Zoo, New York, USA, was not diagnosed by the author of this paper. This individual is mostly yellowish in the posterior portion of its body and shows irregular black spots on its back, extending through its forelimbs and neck. The rostral region of this animal shows a marked black mask, and its manus and pes show asymmetrically distributed blackish coloration. The tail of this specimen, in turn, is yellowish and whitish in the dorsal portion of its anteromedian segment and blackish in the dorsal portion of the posteromedian segment and throughout its ventral portion.

We recorded two additional partially melanistic individuals of *T. tetradactyla*, one in December, 2019, in the Sooretama Biological Reserve, Sooretama, Espírito Santo, Brazil (19°0'38.160"S, 40°0'35.640"W, photograph taken by Lucas Gonçalves) and the other in October, 2019, in the municipality of Tartarugalzinho, Amapá, Brazil (1°26'31.200"N, 50°53' 24.000"W, photographs taken by Leandro Silveira). These individuals have coloration similar to the melanistic pattern reported above, with the exception of the inner and outer surfaces of their limbs and the ventral portion of their body, which are mostly gray with some sparse yellow hairs. In addition, the skin of these individuals is beige in color, rather than the grayish color observed in the melanistic individuals.

Other records of partially melanistic individuals of *T. tetradactyla* are observed in photographs posted to iNaturalist by users haider_adrian_ibarra_blanco and shrike2 (Fig. 1B). On May 13, 2018, the first informal record (by haider_adrian_ibarra_blanco) was obtained in the municipality of Hato Corozal, Casanare, Colombia. This individual has a pale black coat throughout the dorsal and ventral regions of its body, with white and golden hairs sparsely distributed in this region. The blackened coat extends to the proximomedial region of the forelimbs and hindlimbs of this animal. The manus and pes have black claws, and the coat adjacent to these regions is pale black. The upper surface of the rostrum of this individual has a black spot that extends from the mid-rostral portion to its nostrils. The head of this animal is whitish and grayish, without a defined "mask". The tail has blackish spots that are irregularly distributed over the light gray skin. The second informal record (made by shrike2) was obtained in the region of Atalaia do Norte, Amazonas, Brazil, on January 15, 2019. The limbs and head of this individual are brownish to black with sparse yellowish hairs, in contrast to the yellowish pattern commonly observed in these regions in other specimens of *T. tetradactyla*. The black vest on the back of this animal is poorly defined in its boundaries, with the black color extending to the limbs and gradually becoming lighter in these regions of the body. The tail is also dark, with a dark gray, partially hairless mid-distal portion and assymmetrical black spots distributed across the skin.

Xanthochromism

Yellowish individuals of *Tamandua* are known in the literature (e.g., Wetzel 1975, 1982) and usually attributed to *T. tetradactyla*. However, none of these records are described as instances of xanthochromism, such that this condition has remained formally unreported for anteaters, as well as for other xenarthrans. In this study, we recorded one xanthochromic individual of *Tamandua* in Virua National Park, municipality of Caracaraí, Roraima Brazil (1°39'9.720"N, 61°11'9.240"W, photograph taken by Tainara Sobroza). In the scientific literature, one xanthochromic individual of *Tamandua* was identified in the article of Ríos-Alvear and Cadena-Ortiz (2019), described by the authors as "yellowish coloration", as well as informal records of 24 xanthochromic and five partially xanthochromic individuals (Table 1). The individual photographed by Ríos-Alvear and Cadena-Ortiz (2019) was recorded in the southern part of Podocarpus National Park, Ecuador, in 2018. The other individuals were recorded in several regions of southern Central America and northern South America (Table 1). The authors of these records did not specifically identify the chromatic anomaly in the reported animals, either neglecting to comment on their unusual color or referring to them as "yellowish individuals". Thus, this is the first time that xanthochromism has been formally reported for *Tamandua*.

The xanthochromic individuals reported here all pertain to *T. tetradactyla*. These specimens are all almost entirely yellow to yellow-orange, except for the manus, pes, rostral mask, and internal surface of the ears, which are mostly black (Fig. 1C). The rostral mask on the head of the xanthochromic individuals is extended from the posterior portion of the nostrils to the surroundings of the eyes (Fig. 1). A few individuals have a brownish or grayish rostral mask, and one has an asymmetrical and poorly defined whitish mask. In addition, some individuals have white hairs surrounding the perimeter of their eyes. The tail of these individuals is hairless in the middistal portion, as is typical of the genus.

The partially xanthochromic individuals of *T. tetradactyla* are paler yellow when compared with the xanthochromic individuals and show some scattered white or black hairs, forming asymmetrical spots in the otherwise yellowish coat (Fig. 1D).

"Brown"

Brownish coloration is described in the classical literature as a color variation of some subspecies of *Tamandua*, such as *T. tetradactyla nigra* (Wetzel 1975). Allen (1904) described the presence of partially brown specimens of *T. tetradactyla* in the Santa Marta district of Colombia (Table 1). This author reports that the coloration in the dark areas of the coat of these specimens, primarily in the "vest", varies from light reddish-brown to dark brown. Wetzel (1982), in turn, corroborates the presence of dark brown individuals of *T. tetradactyla* in South America, mainly in regions of the Amazon adjacent to Venezuela and Suriname (Table 1). Recently, Ríos-Alvear and Cadena-Ortiz (2019) comment on the occurrence of individuals of *T. tetradactyla* with dark brown coloration in Peru and attribute them to crosses between yellowish and black individuals of this species.

In addition to the aforementioned records, we found two dark brown individuals of *T. tetradactyla* informally reported on iNaturalist by users chartuso and miguelmonteiro (Table 1). The first record (by chartuso) was made on December 25, 2013 in the Río Napo region, Shushufindi, Ecuador. The brownish color pattern in the coat of this individual is very homogeneous, presenting a well-defined "chocolate" tone. The rostral region has a slightly lighter shade, with the exception of the "rostral mask", which in this individual has a pale black color. The nostrils and claws are also black, similar to the melanistic individuals (Fig. 1E). The second record (by miguelmonteiro) occurred on March 21, 2019 in the municipality of Uarini, Amazonas, Brazil. This individual of *T. tetradactyla* is pale brown, with some scattered yellowish hairs. This animal also shows black coloration in its rostral mask, nostrils, and claws.

Albinism

Albinism in *Tamandua* is also rare. We found only one record of albinism in *Tamandua*, attributed to *T. tetradactyla*, recorded by Ríos et al. (2019) on June 19, 2018 in the locality of Isla Umbú, near the city of Pilar, Department of Ñeembucú, Paraguay (approximate coordinates 27°00'S, 58°18'W; Fig. 1G). This individual has a markedly white coat and slightly pinkish skin. The claws on the manus of this animal are also mostly white. The tail and the pes are not visible in the photograph published in Ríos et al. (2019). The eye color cannot be ascertained with a high degree of confidence due to the quality of the photograph, but it appears to have a lighter brownish hue than that seen in non-albino specimens of *T. tetradactyla*; we do not rule out the possibility that the eyes have a reddish color.

Leucism

Leucistic specimens of *Tamandua* are rare and poorly documented formally and informally. More et al. (2021) report a possible albino or leucistic individual of *T. mexicana* recorded on May 26, 2018 in a woodland area of the Campesina Community of San Antonio de Salas, Lambayeque, Peru (6°20'S, 79°34'W, 560 m; Fig. 1F). This individual shows a more yellowish white color than the albino individual of *T. tetradactyla* reported by Ríos et al. (2019). In addition, we observe that this animal apparently has a blackish rostral mask, as well as a grayish, hairless middistal portion of its tail. The limbs of this individual of *T. mexicana* may show a light beige coloration, but it is difficult to confirm this characteristic due to the quality of the photograph and the position of the animal. The eye color of this individual is also not determinable from the photograph. However, the observable color pattern in this individual is most consistent with leucism.

A second possible leucistic specimen of *Tamandua* was photographed and posted to iNaturalist by the user walterprado. This record was made in July 2007 in the Province of Chaco, Argentina. This specimen is whitish to slightly yellow in color, with light orange hairs across its neck and head. The rostral mask is completely white in this individual, extending from the dorsoposterior portion of its nostrils to the surroundings of its eyes. The perimeter of this mask around the eyes has a circular appearance, forming a "V" when observed superiorly. We observe that this animal has brownish eyes. However, we also emphasize that many characteristics of this individual appear abnormal, including an unusually long and dense coat, a shorter neck, and a smaller head, mainly in its snout, than other analyzed individuals of *T. tetradactyla* and *T. mexicana*.

Erythrism

Erythrism is poorly known and rarely reported in mammals. Some authors report variations of reddish colorations in mammals with erythrism. Laacke et al. (2006) report a North American badger, *Taxidea taxus* (Schreber, 1777), with intense red coloration in its coat and comment on another erythristic specimen of *T. taxus* described by Grinnell et al. (1937) with a pale reddish-brown coat. Pirie et al. (2016), in turn, report the presence of erythristic leopards in different regions of South Africa, and describe them as having pale yellow and pinkish coat patterns (mainly in their rosettes, as evident from published photographs). For anteaters, the occurrence of erythrism has never been described.

Herein we describe five photographic records of erythristic individuals of *T. mexicana*, all found along Semaphore Hill Road in Soberanía National Park, Panama (9°04'38.8"N, 79°39'07.9"W) (Fig. 1H). The first two records occurred on February 14 and April 01, 2020. The other three records occurred in the same locality on March 11 and 18, and April 28, all in 2022. For the first four records, only one individual of *T. mexicana* was observed during arboreal or terrestrial locomotion. However, the fifth sighting registered two erythristic individuals of *T. mexicana* occupying branches of the same tree and moving towards each other (Fig. 2).

The erythristic individuals of *T. mexicana* are pinkish-orange in the posterior portion of the head and neck. An elliptical spot with pale yellow hairs and a few pinkish-orange hairs extends from the superoposterior portion of the head to near the posterior portion of the rostrum (Fig. 1). The rostrum of these individuals, in turn, shows a pale yellowish "mask" that extends from the nostrils to the perimeter around the eyes, occurring in the same region as the black rostral mask typically observed in *T. mexicana*. The nostrils are predominantly pink. These animals show a "vest", as is commonly observed in *T. mexicana* (Fig. 1H), but with a mostly pinkish-orange color and with some pale yellowish hairs dispersed and mixed with the rest of the coat in this region. The forelimbs and the laterodistal and medial-distal portions of the hindlimbs of these individuals are pale yellow. The anterodorsal portion of the tail is pinkish-orange, continuous with the rest of the coast, whereas the anteroventral, middle, and distal portions of the tail are mostly hairless and whitish-pink. The claws of the erythristic individuals of *T. mexicana* are whitish-pink rather than the typical black found in this species (Fig. 1H). Both the individuals present an external morphology and total size consistent with adults of *T. mexicana*. The sex of these individuals cannot be ascertained.

No other records of *T. mexicana* with this color pattern were made in Soberanía National Park from 2020 to 2022, although typical "vested" individuals are regularly observed there. Furthermore, no comparable record was discovered in formal or informal media.

DISCUSSION

Color variations in mammals are still little discussed in the literature as compared to other groups of vertebrates, such as birds (van Grouw 2006). Therefore, much remains unknown about chromatic disorders in Mammalia. Our study collects new information about color variations in both species of *Tamandua*, allowing for the recognition both of well-marked morphological patterns for the identified chromatic disorders and of distributional patterns for some of these phenotypes across Central and South America. The knowledge shortfall regarding mammalian

Figure 2. Record of the two erythristic individuals in the same tree and without agonistic behavior. (A) individual 1 climbing the tree, (B, C) individuals 1 and 2 seeing each other, (D, E) individual 1 and 2 moving towards each other (photographs taken by Canopy Family staff).

chromatic disorders is especially pressing for Vermilingua, in part because of the scarcity or incompleteness of museum skins of anteaters in collections. This makes it difficult to recognize color variations. In *Tamandua*, color variations are sometimes treated as intrinsic characteristics of subspecific taxa (Wetzel 1975, 1982) or reported as chromatic disorders (e.g., Ríos-Alvear and Cadena-Ortiz 2019, More et al. 2021), but without a clear description of morphological patterns associated with these anomalies.

Melanistic and xanthochromic individuals of *Tamandua* are the most frequent anomalies reported in our study, accounting for 78% of the records. We observe that melanistic individuals of *Tamandua* are mostly distributed in marginal forests as the western Amazon near the Andes, covering almost all of Peru and southwest Ecuador, although some were also present in southern Venezuela and French Guiana. Partially melanistic individuals, in turn, were recorded in locations in western and southeastern Brazil and northern Colombia (Fig. 3). Xanthochromic individuals of *Tamandua* are mostly recorded in the northern portion of Ecuador and Colombia, with a few individuals dispersed in areas of northeast and southeast Peru, western and northern Brazil, and Trinidad and Tobago (Fig. 3). The xanthochromic individuals from Ecuador occur in regions partially overlapping with the melanistic individuals, with both color patterns ocurring in the border region between southern Ecuador and northwestern Peru.

Melanism is much less frequent in other anteaters when compared to the *Tamandua*, being represented by only one record for *Myrmecophaga tridactyla* Linnaeus, 1758 (Cotts and Prestes 2022). Xanthochromism, in turn, is unknown in the rest of Vermilingua, as far as we are aware.

Dark brown individuals were observed in northern Peru, northern Ecuador, and northern and northwestern Brazil (Fig. 3). The distribution of these individuals corresponds to that observed by Wetzel (1975, 1982). In fact, Wetzel (1982) reported a wider distribution of melanistic, brown and "yellow" individuals of *T. tetradactyla* from the central and northern regions of Peru, across the northern portion of the Brazilian Amazon, and into French Guiana.

Ríos-Alvear and Cadena-Ortiz (2019) hypothesize that dark brown individuals from Peru possibly represent crosses between melanistic and "yellow" individuals of *T. tetradactyla*. The occurrence of black individuals and yellow individuals in southern Ecuador and northwestern Peru, as reported here, reinforces the possibility of crosses between small groups of xanthochromic and melanistic individuals of *Tamandua* in these regions, resulting in a dark brown phenotype. Likewise, records of brown variations (brown and partially brown individuals) in the northern portion of Amazonia (Fig. 3), an area also occupied by melanistic and xanthochromic variants, indicates the possibility of these crossings occurring in this region. Partially xanthochromic individuals, in turn, are mostly present in the areas that the xanthochromic individuals are reported. Partial xanthochromism may occur due to a partial deposition of yellow pigments in the tissues during the development of vertebrates, favoring the occurrence of a yellow to pale yellow coloration together with black, gray or brown spots on the fur, feathers or scales (e.g., Palacios-Salgado and Rojas-Herrera 2012). Thus, we suggest that the partially xanthochromic individuals possibly belong to groups of xanthochromic individuals or typically colored individuals (with vest) rather than crosses between phenotypically distinct individuals, as hypothesized for the brown specimens of *Tamandua*.

We note records of melanistic and xanthochromic individuals in South America along a relatively large time series, mostly in the northwestern and northern portions of the continent. This suggests a continuous presence of melanistic and xanthochromic conditions in the same areas of South America for more than 100 years, especially considering records such as those of Menegaux (1902) and Allen (1904). The recurrence of these color variations in individuals of *Tamandua* from South America, mainly in northern groups, suggests that these chromatic disorders are fixed in some populations as a stable polymorphism, similar to the chromatic conditions observed in other American mammals, e.g., black squirrels: *Sciurus carolinensis* Gmelin, 1788 and *Sciurus niger* Linnaeus, 1758 (Creed and Sharp 1958, Schorger 1949). The cause of melanism in anteaters remains unknown, but their occurrence in other mammals is commonly associated with mutations in some key genes responsible for regulation of skin and hair pigmentation, such as Agouti, Melanocortin 1 receptor (MCI1R), and K locus. Xanthochromism, in turn, occurs due to a higher production of yellow pigments in the tissues. It is likely that these color variations in anteaters and other xenarthrans have similar origins.

Other chromatic anomalies are represented in our study by only a few records. We found two records of leucism and one of albinism for *Tamandua*, all widely separated geographically. In other anteaters, white individuals are also very uncommon, being known one record of albinism for *M. tridactyla* (Cotts and Prestes 2022) and none for *Cyclopes* Gray, 1821 species. It is well-documented in mammals that leucism and albinism have negative consequences for affected individuals, including eye disorders (in albinos), making them more vulnerable to predation as well as unattractive for reproduction, which can lead to intraspecific exclusion (Caro 2005, Fertl and Rosel 2009, Cuxim-Koyoc et al. 2019, Dunlop et al. 2019, Nations et al. 2020). Some authors propose that the low incidence of abnormally white mammals indicates that these color patterns are deleterious and do not have adaptive significance, being rapidly removed from populations (Caro 2005, Dunlop et al. 2019). This hypothesis is consistent with the scarcity of records of both albinism and leucism in *Tamandua*. However, records of albino mammals are more abundant in certain parts of the world. For example, there are records of several albino mammals in Southeast Asia, including Hairy-nosed Otter, *Lutra sumatrana* (Gray, 1865) (O'Brien and Kinnaird 1996); Slow Loris, *Nycticebus coucang* (Boddaert, 1785) (International Animal Rescue 2018); Bornean Orangutan, *Pongo pygmaeus* (Linnaeus, 1760) (Katz 2020); and Sumatran Mountain Maxomys, *Maxomys hylomyoides* (Robinson & Kloss, 1916) (Nations et al. 2020), in addition to several folkloric stories reporting the interaction of people with birds and white rodents near mountains in this region (e.g., Mount Singgalang) (Nations et al. 2020). These reports may indicate the stable presence of albinism in isolated populations. Although we cannot corroborate that similar conditions occur in South American mammals, this possibility cannot be ruled out and we recommend that this issue be considered and better analyzed in future studies on chromatic variations. We add that in the scientific literature, leucism is sometimes used as a synonym for piebaldism, but this nomenclatural equivalence is inconsistent and should be carefully evaluated. Some factors are considered to differentiate leucism from piebaldism, such as the association of the latter with genes responsible for white spots in mammals (e.g., Piebald gene) (Zalapa et al. 2016, van Grouw 2021).

Erythrism in anteaters, in turn, is restricted to the two individuals of *T. mexicana* reported here. Both individuals were found in the same locality in Panama (Fig. 3) and the two animals interacted without apparent agonistic behavior. *Tamandua mexicana* is a solitary and territorial species (Navarrete and Ortega 2011) and the occurrence of these individuals together, as well as their apparently similar age (both adults), indicates that these individuals are possibly siblings. The survival of erythristic individuals of *T. mexicana* to adulthood is unexpected, since these animals, like leucistic and albino individuals, are conspicuous in their habitat and presumably are more exposed to predation and hunting.

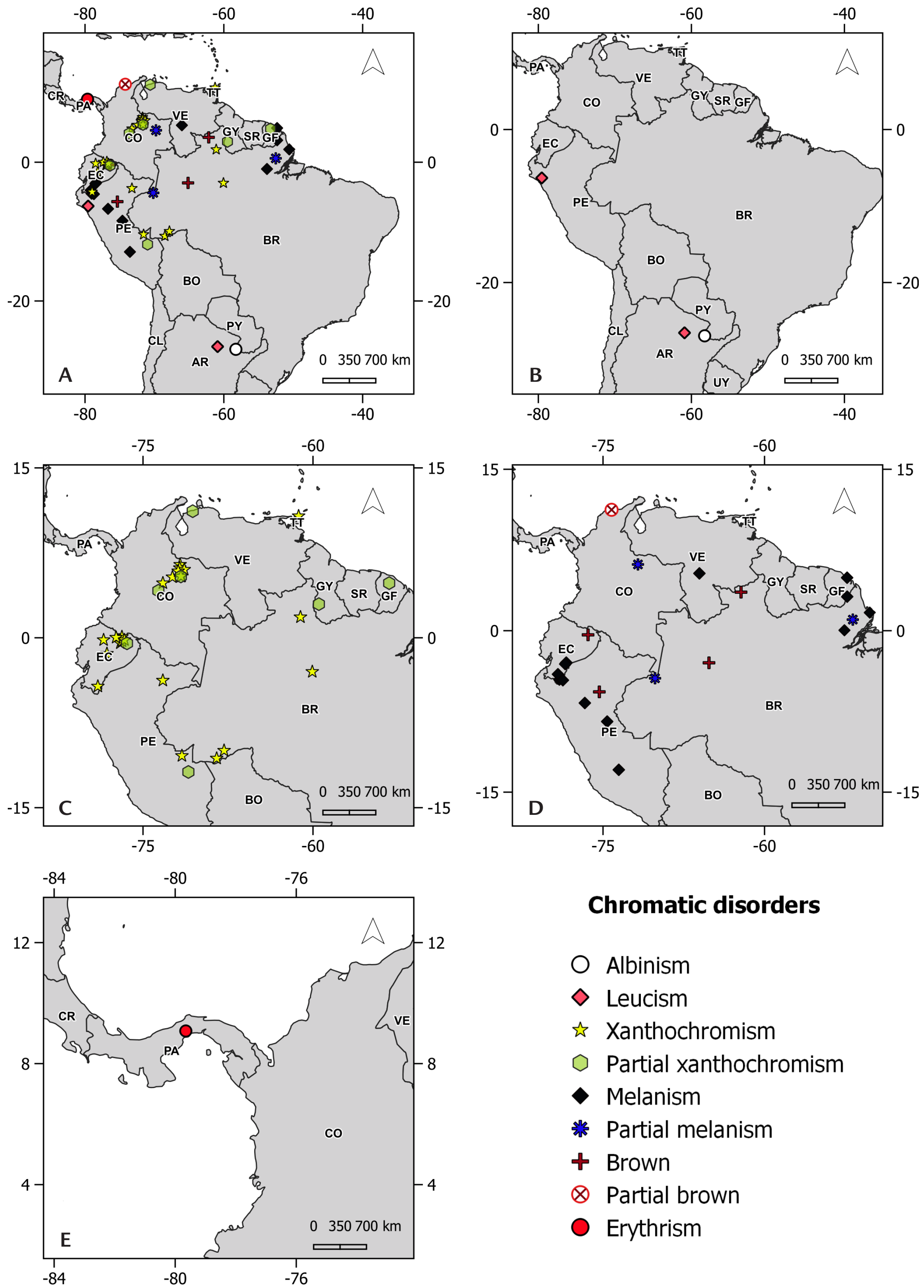

Figure 3. Distribution of chromatic disorders in *Tamandua* in Central and South America. (A) record locations of all chromatic disorders, (B) albinism and leucism, (C) xanthochromism and partial xanthochromism, (D) melanism, partial melanism, "brown" and partial "brown", (E) erythrism.

Erythrism is generally rare and poorly understood in mammals, having been previously reported in only a few species, such as the North American badger, *T. taxus* (Laacke et al. 2006) and leopard, *Panthera pardus* (Linnaeus, 1758) (Pirie et al. 2016). Pirie et al. (2016) suggest that the occurrence of erythristic leopards, for example, can be linked to fragmentation and isolation, which reduce the effective size of populations, favor inbreeding, and contribute to the expression of a "de novo" mutation or increase the frequency of rare alleles in isolated populations of this species. These authors comment that similar events of inbreeding result in the presence of rare mutations in other big cats, as in the "king cheetah" pattern, whereby individuals of *Acinonyx jubatus* (Schreber, 1775) show a cream-colored coat with large and smudged spots which extend to form elongated stripes. These conditions in cheetahs are well documented and supported by different biological data, such as evidence of a reduction in the general genetic variation of this species through multiple genomic markers, decreases in the size of their natural populations, and evidence of a marked inbreeding depression (Dobrynin et al. 2015). However, the erythristic *T. mexicana* individuals occur in an area where vested individuals of this species are also frequently recorded, weaking the assumption that this chromatic disorder is associated with habitat fragmentation and isolation.

We hypothesize that the phenotype expressed by these animals corresponds to a rare genetic variation that emerged randomly in an otherwise typical population of *T. mexicana*, rather than to a deleterious condition caused by other biological and environmental events such as isolation and inbreeding. However, more morphological and genetic data are needed to understand the origin of erythrism in *Tamandua*. Finally, we note that the absence of reported cases of erythrism in *Tamandua* in the regions of occurrence of brown individuals fails to suggest a connection between brown color variations and erythrism in the genus. Indeed, our findings highlight the potential drawbacks of grouping reddish, brownish, and even yellowish color variations within a single category, such as "flavism".

Erythristic individuals of *T. mexicana* continue to be monitored locally, and we hope that more information regarding their biology, geographic distribution, and social behavior will be forthcoming.

Finally, we add that the recognition of chromatic disorders in *Tamandua* indicates an evident fragility in the use of color variations to establish subspecies within this genus. Wetzel (1975) proposed *T. mexicana* and *T. tetradactyla*, as well as its subespecies, based on color variations and on some anatomical characters, as the size of the ears, robustness of the skull and its structures (e.g., jugal), presence and shape of foramina (e.g., orbital and infraorbital foramina), distance between borders of the palatine and lacrimal bones and number of caudal vertebrae (*T. mexicana* = 40–42; *T. tetradactyla* = 31–39). Wetzel (1975) also reported that *T. mexicana* always have a black vest in their coat, whereas *T. tetradactyla* could have a varied coloration, with individuals uniformly golden to pale being found in Suriname and northern Venezuela, black-vested in the southeastern portion of this range, and uniformly golden, black, brown, vested and partially vested individuals ocurring between these regions, mainly in the Amazon. However, many of these morphological characteristics are subjective and can be influenced by other biological events, such as developmental and ecomorphological changes. This also proves to be problematic when we observe that the species and subspecies of *Tamandua* do not have a clear geographic delimitation, favoring that many color patterns are attributed to more than one subspecies of *Tamandua*. In this way, the recognized subspecies of *T. mexicana*: *T. mexicana instabilis* Allen, 1904, *T. mexicana mexicana* (Saussure, 1860), *T. mexicana opistholeuca* Gray, 1873 and *T. mexicana punensis* Allen, 1916; and of *T. tetradactyla*: *T. tetradactyla nigra* (Geoffroy Saint-Hilaire, 1803), *T. tetradactyla quichua* Thomas, 1927, *T. tetradactyla straminea* (Cope, 1889) and *T. tetradactyla tetradactyla* (Linnaeus, 1758) are established from discontinuous and ambiguous morphological and geographic characteristics, not allowing a clear delimitation of these taxa. Thus, the use of subspecies of *Tamandua* as classically proposed seems invalid and inadequate. Although this study is not focused on taxonomy, we recommend that color variations be more carefully analyzed in future investigations on the taxonomy of *Tamandua*. In addition, we reiterate the need for further investigations into the phenotypic expression, geographic distribution, and the origins of chromatic variations in *Tamandua* and related taxa.

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