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COLOR ABERRATIONS IN SEVEN BIRD SPECIES IN COSTA RICA

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Abstract · Although there are 935 species of birds in Costa Rica, scientific reports of pigmentation abnormalities in this group are limited. Nevertheless, several cases have recently been documented, including Leucism, Ino mutation, Progressive Graying, Dilution, and two unusual color aberrations in a toucan and a motmot. Here, we describe seven cases of color aberrations observed over a period of five years in native birds of Costa Rica. An Eastern Wood-Pewee *Contopus virens* and a White-collared Manakin *Manacus candei* were Brown. A Scintillant Hummingbird *Selasphorus scintilla* and a Talamanca Hummingbird *Eugenes spectabilis*, also showed a Brown mutation, however, these two cases may be Ino. In addition, two cases of Progressive Graying were recorded in a Gray-necked Woodrail *Aramides cajaneus* and a Great-tailed Grackle *Quiscalus mexicanus*. An indeterminate case was also observed in the Turkey Vulture *Cathartes aura*. Identifying plumage abnormalities in wild birds is challenging and can lead to misidentifications. However, documentation of color variation and behavior in birds can help inform future research. We encourage the reporting of observations of abnormally colored birds to further our understanding of this phenomenon.

Resumen · Anormalidades cromáticas en siete especies de aves de Costa Rica
Aunque hay 935 especies de aves en Costa Rica, los informes científicos sobre anormalidades de pigmentación en este grupo son limitados. Sin embargo, se han documentado recientemente varios casos, incluidos leucismo, mutación Ino, encanecimiento progresivo, dilución y dos aberraciones de color inusuales en un tucán y un momoto. Aquí describimos siete casos de aberraciones de color observadas durante un período de cinco años en aves nativas de Costa Rica. Un pibí oriental *Contopus virens* y un saltarín cuelliblanco *Manacus candei* con mutación Brown. Un colibrí chispita *Selasphorus scintilla* y un colibrí de Talamanca *Eugenes spectabilis* también mostraron la mutación Brown, sin embargo, estos dos casos pueden ser Ino. Además, se registraron dos casos de encanecimiento progresivo en la pomponé *Aramides cajaneus* y el zanate *Quiscalus mexicanus*. También se observó un caso indeterminado en el zonchiche *Cathartes aura*. Identificar anormalidades en el plumaje de aves silvestres es un desafío y puede llevar a errores de identificación. Sin embargo, la documentación de variaciones de color y comportamiento en aves puede ayudar a informar investigaciones futuras. Alentamos la comunicación de observaciones de aves con coloración anormal para mejorar nuestra comprensión de este fenómeno.

Key words: *Albinism · Brown mutation · Ino · Leucism · Progressive graying*

INTRODUCTION

Color abnormalities in birds may have genetic origins or may result from environmental stresses during embryonic development, such as poor nutrition or disease (Bechtel 1978, Lamoreux et al. 2010, Hudon et al. 2013, Espinal et al. 2016). Some pigmentation abnormalities may be related to environmental factors, including deforestation, low habitat quality, pollution, and hybridization events (Møller & Mousseau 2001, Aximoff et al. 2020). Additional causes may be the result of physical injury, other environmental factors, or a poor diet (van Grouw 2013, 2018).

A topic of debate is the specific type of chromatic aberration documented in each case, particularly concerning abnormally white birds (van Grouw 2021). Among several factors, two aspects make it extremely challenging to determine the type of chromatic aberration that affects an individual. One significant challenge is the confusion and discrepancies surrounding the definition and categorization of various types of chromatic aberrations (van Grouw 2021). Another fundamental challenge is to identify the factor that causes the aberration in order to accurately classify and name it (van Grouw 2021). The primary reason for these difficulties may stem from a lack of familiarity with the different forms, coupled with the seemingly random usage of numerous terms to describe these color aberrations (van Grouw 2021).

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Most abnormalities in skin and integument coloration caused by an excess or absence of pigments are primarily attributed to genetic mutations (van Grouw 2013, 2018). Chromatic disorders resulting from melanin mutations can be categorized into four groups: (1) White Spotting, which involves abnormalities in the development of melanin cells; (2) Albinism, caused by defects in melanin synthesis; (3) Dilution, characterized by issues with melanin deposition in the feathers; and (4) Melanism, which arises from defects in the type of melanin produced (Lamoreux et al. 2010, van Grouw 2021). Albino, Ino and Brown are heritable color mutations within the broader category of Albinism, a group of mutations that affect melanin synthesis (van Grouw 2021). However, encountering an albino bird in the wild is unlikely, as albino individuals typically do not survive long after fledging due to poor eyesight (van Grouw 2021).

Costa Rica is known for its remarkable bird diversity, making it a popular destination for birdwatchers and nature enthusiasts (Maldonado et al. 2018, Echeverri et al. 2022). Costa Rica provides a rich habitat for a wide array of bird species, including rainforests, dry forests, cloud forests, mangroves, and coastal regions (Dyer & Howell 2023). A total of 935 bird species have been recorded in Costa Rica, representing a significant portion of the bird diversity found in the entire Neotropical region (Garrigues et al. 2023). This includes both resident and migratory species that visit during the winter months (Dyer & Howell 2023). However, scientific reports of pigmentary abnormalities in birds are very limited in Costa Rica. Nevertheless, some cases have been recently documented, including Leucism in *Pelecanus occidentalis* (Vargas-Masís & Arguedas-Rodríguez 2014), *Turdus grayi* (Mora & López 2019), *Sporophila corvine* (Villegas 2021), and *Ramphocelus passerinii* (Mora et al. 2024a); Ino in *Coragyps atratus* (Mora & Rodríguez-Ruíz 2019) and *Turdus grayi* (Mora et al. 2024b); Progressive Graying in Groove-billed Ani *Crotophaga sulcirostris* (Mora & Campos 2020) and Blue-gray Tanager *Thraupis episcopus* (Villalobos Alvarado et al. 2024); Dilution in *Ramphastos ambiguus* (Mora & López 2020); an unusual aberrant colored *Ramphastos sulfuratus* (López & Mora 2021), and an aberrant white plumage in *Electron platyrhynchum* (Mora et al. 2023). Other known cases have not been reported in scientific publications (Mora & López 2019). In this paper, we describe seven instances of chromatic aberrations observed in birds native to Costa Rica.

METHODS

The observations were conducted on the Caribbean slope of Costa Rica, specifically in Turrialba (Turrialba city, Santa Teresita, and Santa Cruz), Guayacán de Siquirres, and San Gerardo de Dota on the Pacific slope. Turrialba city and its surroundings are located at an elevation of approximately 650 m in the Premontane Wet Forest, which is characterized by evergreen or semi-deciduous trees ranging from 25 to 40 m high, forming two or three strata with a dense understory and a ground layer of mosses and ferns (Hartshorn 1983). Annual precipitation in this forest ranges between 3500 and 5000 mm, with a barely noticeable dry period in March and April (Hartshorn 1983). Guayacán de Siquirres is located in the transition zone of Premontane Wet Forest, at a lower altitude than the Turrialba sites mentioned above.

Santa Cruz de Turrialba, situated at an elevation of 1550 m, and Santa Teresita de Turrialba, situated at 1700 m of elevation, occur in Lower Montane Wet Forest. This life zone experiences temperatures between 12 and 18°C and receives 2000–4000 mm of rain per year (Hartshorn 1983). It is characterized by broad-leaf forests with a dry season lasting one to two months, and clouds are typically present, creating a cloud forest environment (Hartshorn 1983).

San Gerardo de Dota is situated in the Lower Montane Rainforest, at an elevation of approximately 2400 m. The Lower Montane Rainforest has high humidity, with trees reaching heights of 20–30 m, although oaks can grow up to 50 m in height (Hartshorn 1983). The shrub stratum is covered with ferns and mosses, and there are abundant epiphytes, such as bromeliads and orchids. Annual rainfall ranges from 2800 to 3200 mm, with a short dry season lasting two to four months (Hartshorn 1983).

From 2019 to 2023, we had seven opportunistic encounters with abnormally colored birds. We found the birds while conducting birdwatching tours or on personal hikes to take photographs. At each encounter, we quickly took a picture before the bird flew away. Whenever possible, we observed the bird for several minutes, attempting to note any aberration details. Species identification was based on our field experience and the assistance of field guides (Stiles & Skutch 1989, Garrigues & Dean 2014, Vallely & Dyer 2018). We also sought to confirm the species identity from colleagues and experts in bird watching. We determined plumage aberrations based on existing literature (van Grouw 2013, 2018, 2021, Rodríguez-Ruíz et al. 2017). We cross-checked these determinations with Dr. Hein van Grouw, who provided guidance and corrected any errors in our identifications.

RESULTS

Over five years, we encountered and photographed seven bird species exhibiting abnormal coloration in several localities in Costa Rica (Table 1). The species were: Turkey Vulture *Cathartes aura*, Gray-necked Wood-rail *Aramides cajaneus*, Talamanca Hummingbird *Eugenes spectabilis*, Scintillant Hummingbird *Selasphorus scintilla*, Eastern Wood-Pewee *Contopus virens*, White-collared Manakin *Manacus candei*, and Great-tailed Grackle *Quiscalus mexicanus* (Table 1).

Turkey Vulture *Cathartes aura.* We photographed a Turkey Vulture with a whitish coloration near Turrialba city on 02 July 2023 (Figure 1A). We observed this bird in the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE)

Table 1. Seven bird species in phylogenetic order, observed with some type of color aberration at different localities in Costa Rica from 2019 to 2023.

Species (Family)	Year	Locality	Affectation	Mutation	Color aberration
Cathartes aura (Cathartidae)	2023	Turrialba	Plumage sections	Melanin synthesis	Unknown
Aramides cajaneus (Aramidae)	2021	Turrialba	White plumage	Progressive loss of melanin-producing cells	Progressive Graying
Eugenes spectabilis (Trochilidae)	2020	Dota	Whitish plumage	Incompletely colored melanin	Brown/Ino
Selasphorus scintilla (Trochilidae)	2023	Turrialba	White plumage	Incompletely colored melanin	Brown/Ino
Contopus virens (Tyrannidae)	2022	Siquirres	Washed-out	Incompletely colored melanin	Brown
Manacus candei (Pipridae)	2023	Turrialba	Washed-out	Incompletely colored melanin	Brown
Quiscalus mexicanus (Icteridae)	2019	Turrialba	White spots	Progressive loss of melanin-producing cells	Progressive Graying

Figure 1. A) Aberrant individual of the Turkey Vulture, *Cathartes aura* (photo by Adrián Alvarado); B) individual with normal coloration (Photo by José M. Mora).

Figure 2. A) Gray-necked Wood-rail, *Aramides cajaneus*, with Progressive Graying (photo by Adrián Alvarado); B) an individual with normal coloration (photo by José M. Mora).

about 600 m of elevation in an open area. Some sections and feathers of this aberrant individual appear washed out, giving them a whitish appearance (Figure 1A) compared to a normal black feathered individual (Figure 1B). Without further information, it is challenging to determine definitively the exact cause of the aberration.

Gray-necked Wood-rail *Aramides cajaneus.* We photographed a white Gray-necked Wood-rail in Santa Teresita de Turrialba in 2021 (Figure 2A). This individual was almost entirely white (Figure 2A), except for colored eyes and beak, and the presence of red pigmentation around the eyes and legs that were similar to a normal individual (Figure 2B). Melanin was also present in the neck and beak. Near fully white plumage is indicative of Progressive Graying in an advanced stage of development.

Talamanca Hummingbird *Eugenes spectabilis.* We found a whitish Talamanca Hummingbird in San Gerardo de Dota on 8 April 2020 (Figure 3A). The aberrant individual stood out as a whitish bird with melanized eyes. The feathers of the aberrant individual certainly are not white (Figure 3A), ruling out the possibility of Leucism. The down layer also exhibits a significant amount of melanin, and the bill still retains melanin pigmentation, although it has reddish sections (Figure 3A). This whitish bird contrasts with a normal individual that has iridescent dark bronzy-green upperparts and chest, grayish belly, and dark bronze tail (Figure 3B). Additionally, the feet and bill of the aberrant individual appeared pinkish (Figure 3A), whereas both sexes of the Talamanca Hummingbird normally have a black bill and black feet (Stiles & Skutch 1989). This case could be either a Brown mutation or a dark form of Ino because it seems that eumelanin in the bill and feet has also been affected.

Scintillant Hummingbird *Selasphorus scintilla.* We observed a white Scintillant Hummingbird sipping flowers (Figure 4A) in Santa Cruz de Turrialba at an elevation of 1478 m on 16 May 2023. The Scintillant Hummingbird is a tiny, rufescent bird

with a white collar on the foreneck (Figure 4B). The plumage of the aberrant bird (Figure 4A) is significantly faded by the sunlight, making it challenging to identify accurately. This white aberrant individual (Figure 4A) retained some brown coloring on its tail. Therefore, this bird may be Brown, albeit significantly bleached. However, it should be noted that the bill appeared reddish, indicating that the aberration could be Ino.

Eastern Wood-Pewee *Contopus virens.* We observed an Eastern Wood-Pewee in Guayacán de Siquirres in 2022 with a faded or washed-out coloration (Figure 5A). Normally, the Eastern Wood-Pewee has grayish-olive upperparts, with darker and dusky tones on the crown, dusky wings, and tail, and a white belly tinged with yellow (Figure 5B). In the aberrant individual, these colors appeared significantly faded rather than white (Figure 5A), suggesting that the mutation is most likely Brown.

White-collared Manakin *Manacus candei.* On 24 May 2023, at 10:33 h, we observed a color-aberrant White-collared Manakin (Figure 6A) perched on a branch in the forest of the Guayacán Reserve, Turrialba. The aberrant individual, a female, appeared washed out, suggesting that the mutation is likely

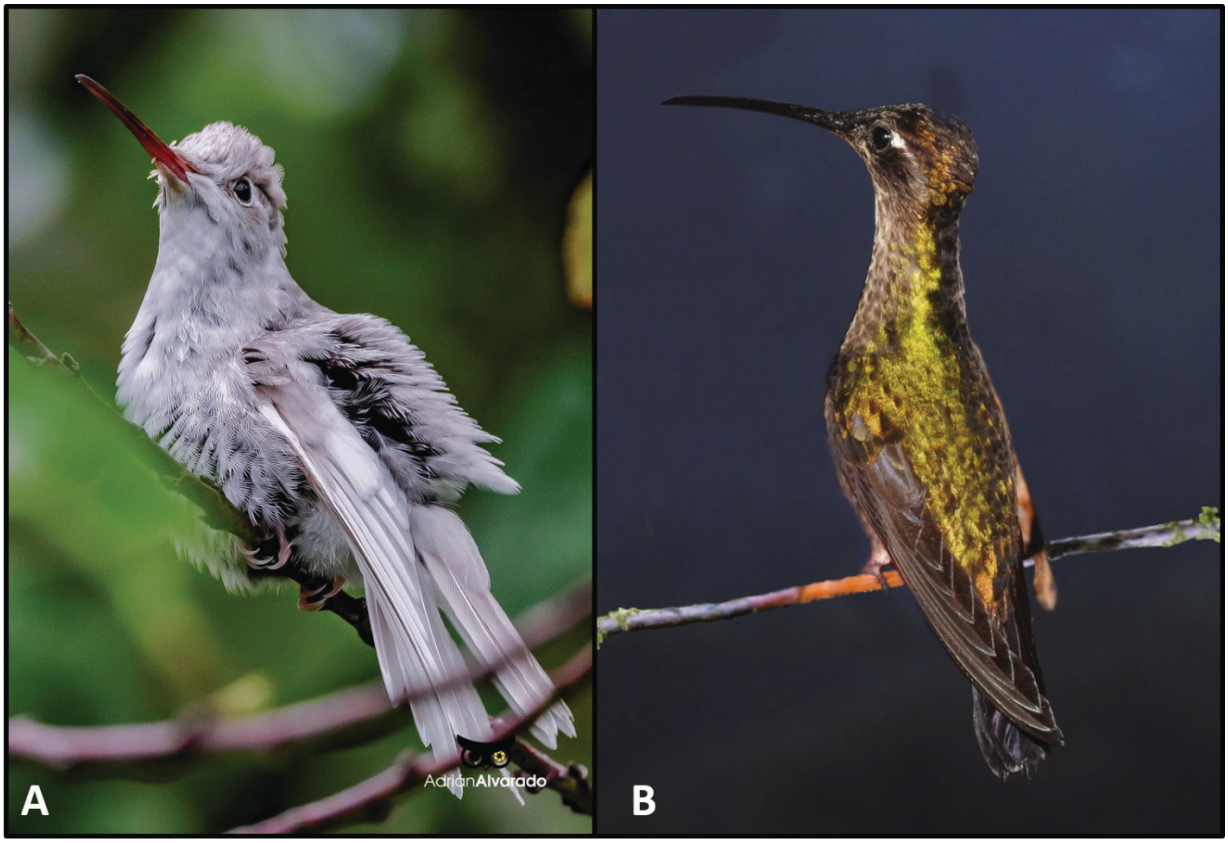

Figure 3. A) Talamanca Hummingbird, *Eugenes spectabilis*, showing either a Brown mutation or a form of dark Ino. (photo by Adrián Alvarado); B) female with normal coloration (photo by José M. Mora).

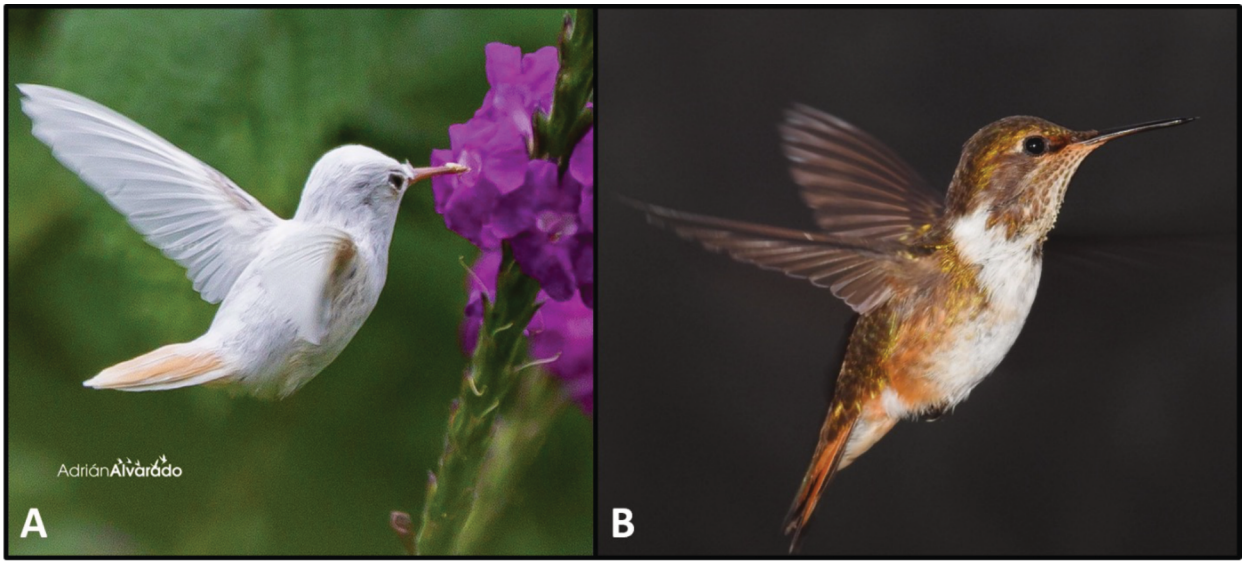

Figure 4. A) Individual of the Scintillant Hummingbird, *Selasphorus scintilla*, displaying an apparent Brown mutation or Ino (photo by Adrián Alvarado); B) individual with normal coloration (photo by José M. Mora).

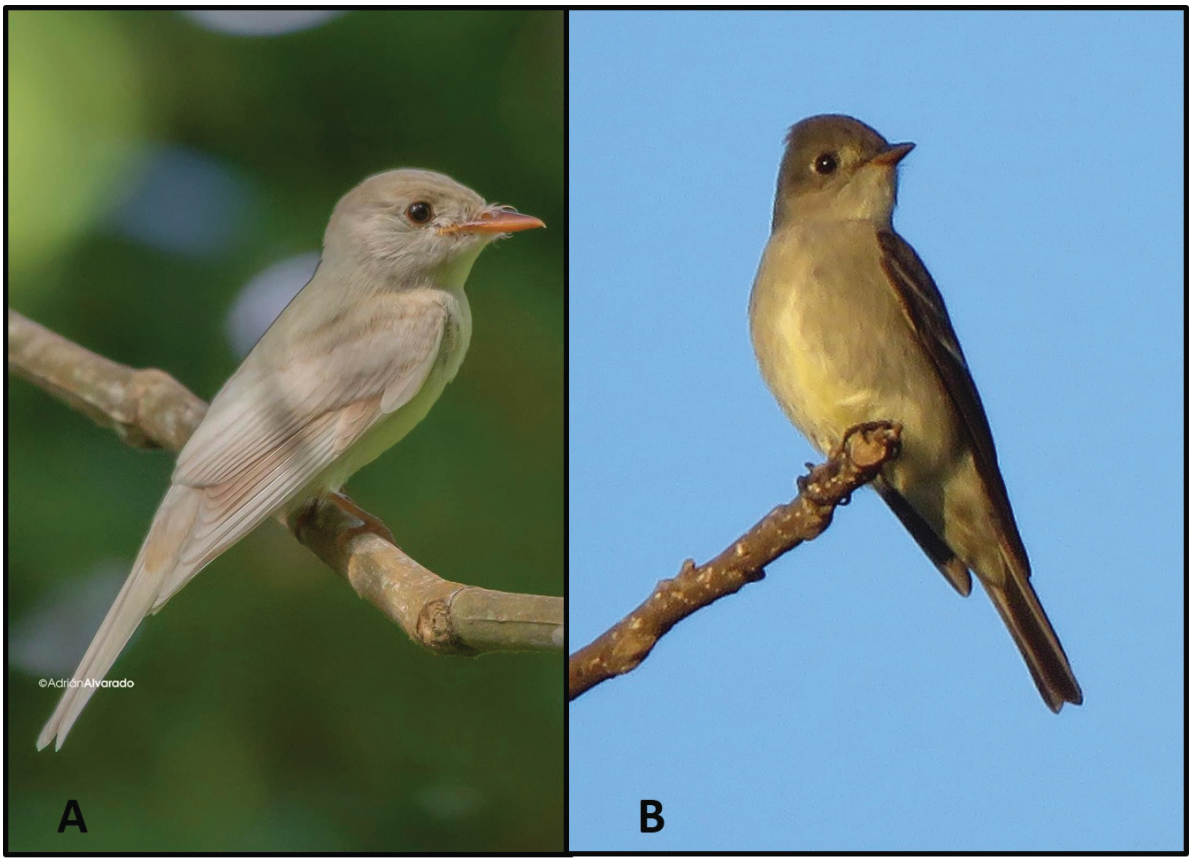

Figure 5. A) Brown individual of the Eastern Wood-Pewee, *Contopus virens* (photo by Adrián Alvarado); B) individual with normal coloration (photo by Miguel A. Rodríguez R.).

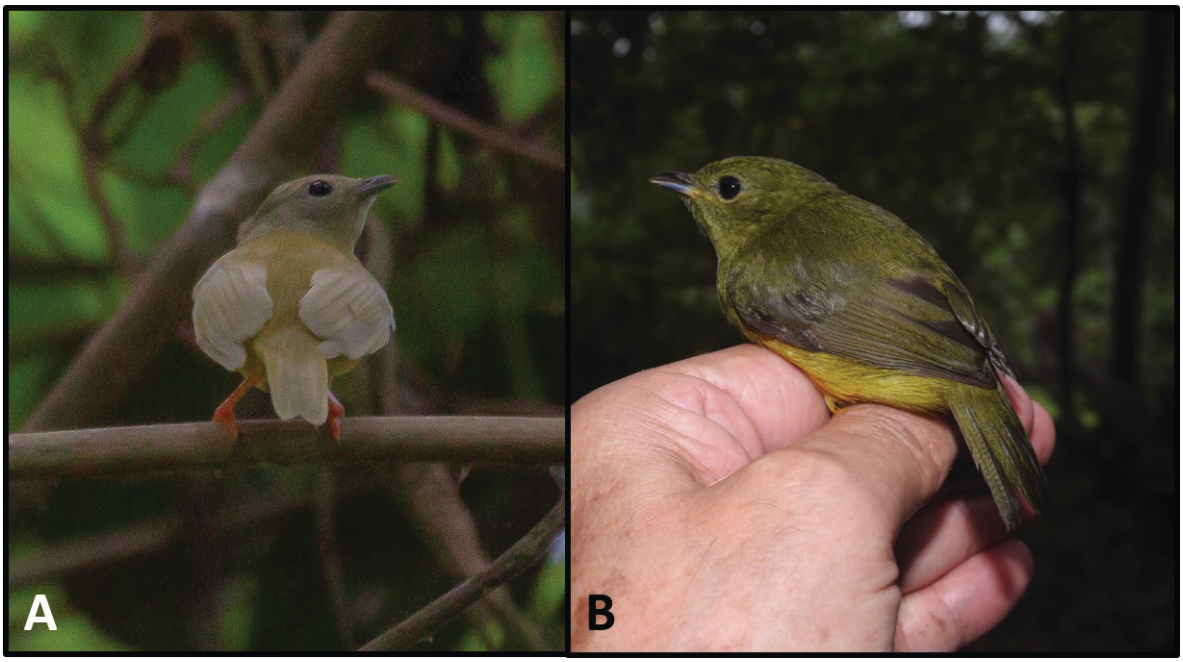

Figure 6. A) female White-collared Manakin, *Manacus candei*, with Brown mutation (photo by Adrián Alvarado); B) female individual with normal coloration (photo by José M. Mora).

Brown (Figure 6A). Normally colored females have olive green upper parts, head and breast, yellowish-olive sides and flanks, and a bright yellow belly tinged with olive (Figure 6B), all of which appeared faded in the aberrant individual (Figure 6A).

Great-tailed Grackle *Quiscalus mexicanus.* In 2019, we found a Great-tailed Grackle with abnormal coloration in Turrialba city (Figure 7A). This female grackle exhibited white spots scattered across its plumage (Figure 7A), indicative of early signs of Progressive Graying. Normally, individuals of this species are dull dark brown above, with blackish wings and tail, and grayish-brown below (Stiles & Skutch 1989), without any white spots on the body (Figure 7B).

DISCUSSION

Of the seven records of birds with chromatic aberrations that we present in this study, two were classified as Progressive Graying, four as Brown or Brown/Ino, and none as Leucism. Our case of a white Gray-necked Wood-rail is not Leucism because the affected plumage would have been without melanin. If a bird is fully white as a result of Leucism, then its feet and beak are also without melanin pigment (van Grouw 2021). Leucism affects only the migration of melanocytes originating from the neural crest, with no influence on eye pigmentation with an optic cup origin, and even though iris color may be affected, melanin is present in the rest of the eye, so the pupils are black (van Grouw 2021). The beak and feet lack melanin, as their melanocytes originate from the neural crest (Van Grouw 2021). Mutations affecting melanin production do not impact carotenoid pigments, which account for the red eye ring, leg coloration, and orange/yellow hues in the beak in the Gray-necked Wood-rail. Therefore, even in cases of other melanin mutations, such as Albino, Brown, or Dilution, the red, orange, and yellow colors would remain unaffected (van Grouw 2021).

We considered that the Gray-necked Wood-rail and Long-tailed Grackle both presented Progressive Graying, which is the progressive disappearance of melanin cells. While Leucism is a congenital condition, Progressive Graying is a phenomenon that can start at any moment after the juvenile plumage is fully grown (van Grouw 2021). As the condition progresses, the bird gradually acquires an increasing number of white feathers in each molt. Initially, these white feathers are typically scattered randomly across the bird's plumage, and in some instances, the entire plumage may become almost white (van Grouw 2021). Therefore, we consider that the female Long-tailed Grackle was an example of early stage Progressive Graying, where the aberrant coloration consisted of white spots over the entire body, and the Gray-necked Wood-rail represented an advanced condition. Progressive Graying as a group of aberrations is certainly the commonest cause of white feathers in wild birds (van Grouw 2013, 2018), although Brown is the most common and misidentified heritable aberration in birds (van Grouw 2013, 2021).

Two species of the seven cases presented here exhibited the Brown mutation: the Eastern Wood-Pewee and the White-collared Manakin. Brown alters the production or distribution of melanin in feathers, resulting in a distinct brown color (van Grouw 2021). Individuals with the Brown mutation exhibit variations in their original coloration, leading to different effects depending on the specific species or individual bird. Some birds with the Brown mutation may show a lighter, more diluted brown coloration, whereas others, either belonging to different species or within the same species, might exhibit a darker or richer brown hue than usual (van Grouw 2021). This variation can be attributed to factors such as the presence or absence of phaeomelanin. Brown primarily affects eumelanin, which is responsible for dark brown to black pigmentation, without impacting phaeomelanin, which produces reddish-brown to buff-brown hues in the feathers (van Grouw 2021). The change to a light brown color was more clearly defined in our Eastern Wood-Pewee. It is important to consider that Brown plumage is highly sensitive to light and can fade quickly when exposed to sunlight. In just a few months, freshly grown but abnormal Brown feathers can turn nearly white, posing challenges for accurate identification (van Grouw 2021).

In the case of the White-collared Manakin, the color mutation is not Dilution because this aberration changes the original black to bluish or silvery-gray (van Grouw 2021). If it were Dilution, the blackish parts of the plumage would appear bluish or silvery-gray. While there are various Dilution mutations that affect color dilution differently, they are relatively rare compared to those categorized under Albinism, including Brown mutations (van Grouw 2021).

The chromatic aberration of the Scintillant Hummingbird and the Talamanca Hummingbird could also be Brown. However, the Talamanca Hummingbird is most likely a dark form of Ino because the feet and bill of the aberrant individual appeared pinkish, indicating that eumelanin in the bill and feet has also been affected. Both Brown and Ino are mutations under Albinism, both of which affect melanin synthesis (van Grouw 2021). Ino is inherited in a recessive manner and is sex-linked (van Grouw 2021). In Ino individuals, the eyes display a reddish coloration resulting from the reduction of melanin. However, it is important to note that the visual acuity of an Ino, even in its palest variations, is significantly superior to that of an Albino (van Grouw 2021). Therefore, any adult wild bird exhibiting "white" plumage and reddish eyes is likely to be an Ino rather than an Albino (van Grouw 2021).

The appearance of the aberrant Turkey Vulture, particularly the apparent symmetrical distribution of white feathers, might initially suggest the possibility of Leucism (Rodríguez-Ruíz et al.

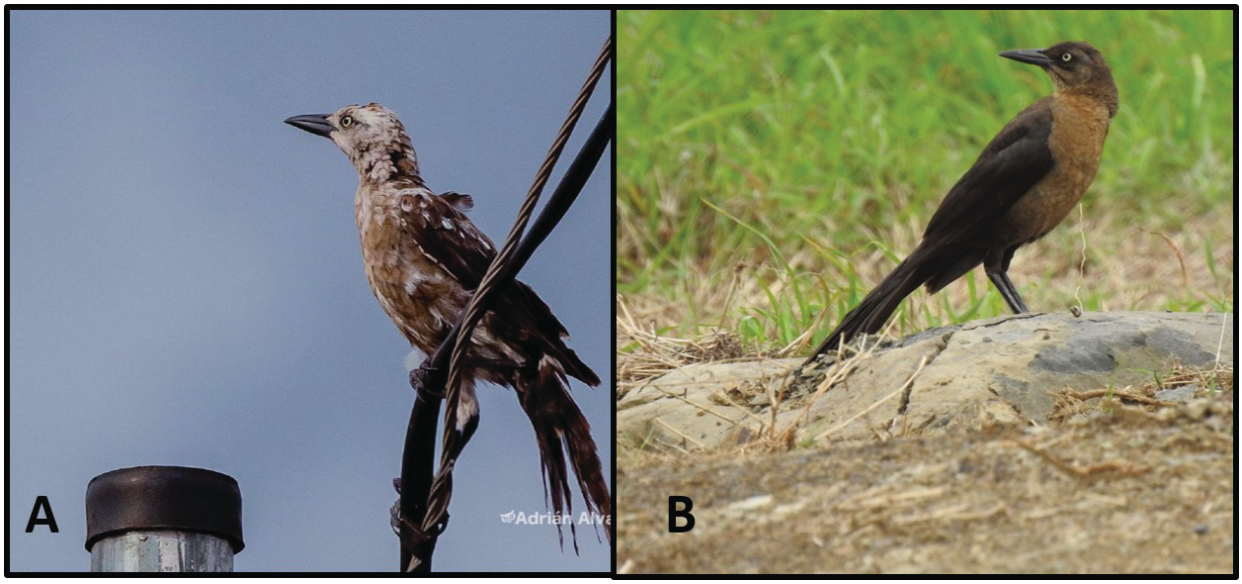

Figure 7. A) Female Great-tailed Grackle, *Quiscalus mexicanus,* with Progressive Greying (photo by Adrián Alvarado); B) Female individual of normal coloration (photo by José M. Mora).

2017, van Grouw 2021). However, it should be noted that the feathers were not truly white but rather a dirty or light brown color. While some feathers appeared pale and significantly bleached, others on different parts of the body seemed to be minimally affected. This could suggest the presence of a mutation affecting melanin synthesis, resulting in the observed color aberration. For an unknown reason, melanin synthesis in this bird halted, leading to the gradual replacement of its entire plumage with a brownish appearance. Since the feathers were not entirely white, Leucism can be ruled out, and because the bill and feet retain their natural colors, Ino is also unlikely. Alternatively, it is possible that this is a temporary abnormality that is not heritable, and that the plumage may return to normal after the next molt. Therefore, it remains uncertain whether this aberrant plumage is the result of a melanin-synthesis-affecting mutation or temporary anomaly.

Identifying plumage aberrations in wild birds is challenging because they can only be recognized based on their physical appearance, which may lead to misidentifications (van Grouw 2021). Despite our efforts to accurately determine color mutations in the seven bird species discussed in this study, we acknowledge that errors and inconsistencies may have occurred. Documenting chromatic mutations in birds in their natural habitat and describing the behavior of mutants and variations in plumage patterns can provide valuable information for future research (Silva-Alves et al. 2021). We encourage researchers, tour guides, and other professionals to report observations of abnormally colored birds to contribute to our understanding of this phenomenon and its underlying causes.

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