

## Chromatic Variations and Aberrations in the Puerto Rican Tody, *Todus mexicanus* Lesson, 1838 (Aves: Coraciformes: Todidae)<sup>1</sup>

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**Abstract:** The description of the coloration of the Puerto Rican Tody, *Todus mexicanus* Lesson, 1938 (Todidae), varies in the literature. For example, the dorsal parts, including the wings, are described from light to dark green to emerald-green while the breast is reported to vary from whitish to gray. The objective of this work is to describe most of these chromatic variations, report plumage colors not previously included on the description of the species and two possible aberrations. More than 500 photos of Puerto Rican todies, mostly from eBirds, were studied to determine color variations. There are variations on the color of the dorsal, ventral and flank parts as well as in the eyes, bill, and legs of the tody. White tipping was observed on the feathers of the chin of 22 individuals. Blue was present on the bend of the wing of 13 individuals. Also, orange on the flanks of four other specimens is reported. Two mayor variations in color, individuals with yellow and black coloration, are reported. Some color variations may be related to the sex or age of individuals, or to mutations.

**Key Words:** Chromatic variations, aberrations, Puerto Rican Tody, *Todus mexicanus*, Todidae

### Introduction

Bird plumage coloration is mainly the result of the deposition of pigments in the feathers. In most birds, plumage coloration comes in three distinct forms: carotenoid-based (red, orange, and yellow), melanin-based (brown and black) and structurally based colors as blue (Fox and Vevers 1960 in van Grouw 2013, Davis 2007). Disturbance in the deposition of pigments in the feathers produce chromatic aberrations on birds (van Grouw 2006, 2013; Guay et al. 2012).

The description of the color variation of Puerto Rican Tody in literature is not uniform. The dorsal parts are described from light green (Danforth 1936, Biaggi 1970), to dark green (Rivera and Mojica 1981) to emerald-green (Oberle 2018).

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Eyes are described as white (Oberle 2018), grayish (Ridgway 1914), gray-white (Wetmore 1916), slate (Wetmore 1916), or blue (Oberle 2018). The bill is reported to be red (Kepler 1977, Raffaele 1983, Raffaele et al. 1998), orange red (Danforth 1936, Biaggi 1970) while others described the maxilla as blackish (Ridgway 1914, Rivera and Mojica 1981), and the mandible pale brown (Ridgway 1914) or orange (Mojica and Rivera 1981). Ventrally, the throat is described as red (Danforth 1936, Biaggi 1970, Kepler 1977), bright red (Wetmore 1916), dark red (Rivera and Mojica 1981), geranium red with white tipping (Ridgway 1914) and ruby (Raffaele 1983). The breast is reported as white (Ridgway 1914) to light gray (Danforth 1936, Biaggi 1970) and the belly from pale yellow (Ridgway 1914) to yellowish (Danforth 1936, Biaggi 1970). Flanks are described yellow (Raffaele 1983, Raffaele et al. 1998), pale yellow/yellowish (Rivera and Mojica 1981, Oberle 2018), and to sulphur-yellow (Ridgway 2014, Danforth 1936, Biaggi 1970). The color of the legs and feet is not described in most publications. Ridgway (2014) described these as brownish in dry skins. The juveniles of the species are poorly or not described in literature.

The objective of this work is to describe in more detail the species, provide evidence of color variations, report colors omitted in the species description and inform what seems to be two colors aberrations.

### **Methods**

This work is based in casual observations of Puerto Rican todies on the field and on examining photos of these published on eBird and in other sites of the internet such as Google. We examined 495 photos on eBird, and also nearly a hundred more available in different sites of the internet. Also, we used the collection of photos of co-authors Molina Opio and Colón-Archilla. In addition, we examined three skins of the *T. mexicanus* at the UPR-Humacao ornithological collection. Photos were cropped to show chromatic details, otherwise the photos were not manipulated in any other form. Although, we recognize that the type of camera, the position of the bird and light exposure may affect the color balancing in a photo (lighter or darker), we compared individuals in different habitats in which these were not exposed directly to sun light and the dorsal and ventral parts could be clearly observed. Color variations were considered when at least three birds exhibit it.

### **Results**

We found ample variation in the colors of the Puerto Rican Tody. Dorsal parts including wings varied from light to dark green to emerald-green (n = 166). We found 90 light green and 76 dark green. Individuals of both types were observed either in places with light green (e.g., Guánica Forest) and dark green vegetation (e.g., Caribbean National Forest or El Yunque). The dorsal parts of the

wing of the sample studied match the general green color of the specimens. However, we found blue on the wrist or the bend of the wing of 14 individuals (13%), something omitted in previous description of the species ( $n = 107$ ). Also white in the border or edge of the wing (in some birds, this white border was more noticeable than in others, Figure 1), a peculiarity only informed by Ridgway (1914).

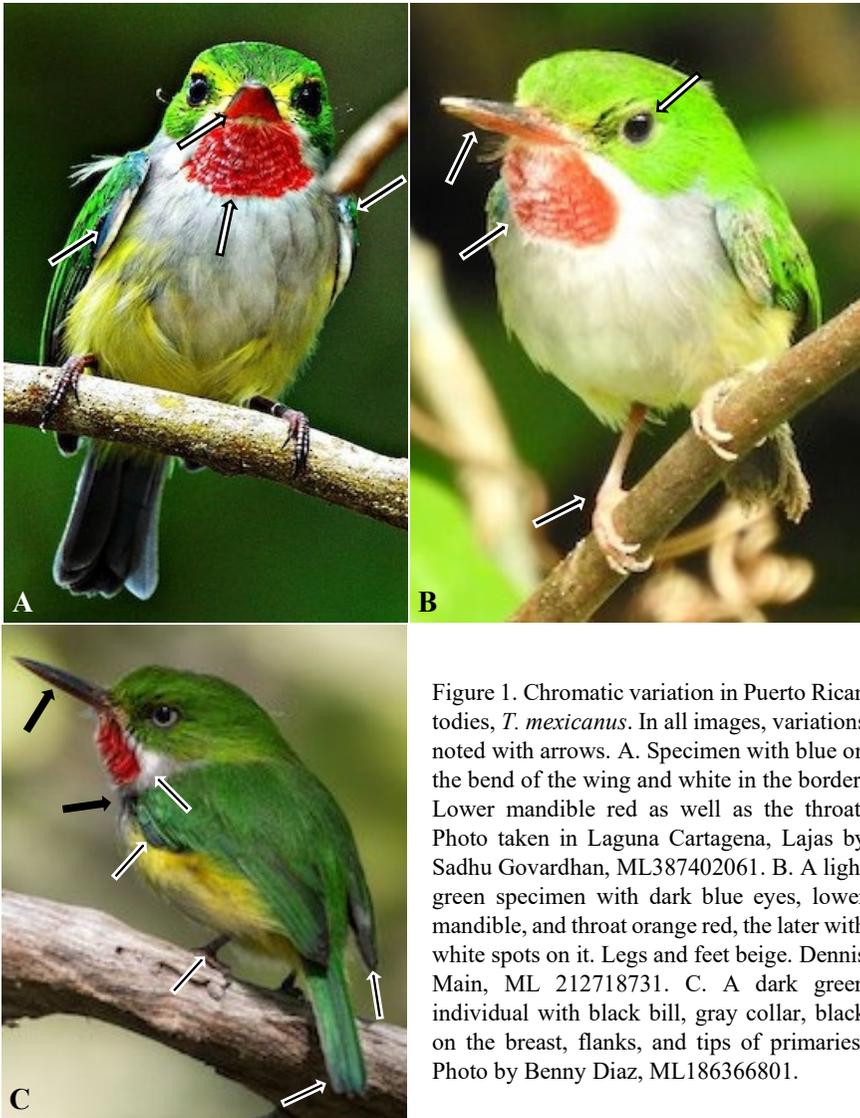


Figure 1. Chromatic variation in Puerto Rican todies, *T. mexicanus*. In all images, variations noted with arrows. A. Specimen with blue on the bend of the wing and white in the border. Lower mandible red as well as the throat. Photo taken in Laguna Cartagena, Lajas by Sadhu Govardhan, ML387402061. B. A light green specimen with dark blue eyes, lower mandible, and throat orange red, the later with white spots on it. Legs and feet beige. Dennis Main, ML 212718731. C. A dark green individual with black bill, gray collar, black on the breast, flanks, and tips of primaries. Photo by Benny Diaz, ML186366801.

Iris colors range from gray, to stale, to dark blue, to almost black. The eyes of juveniles are charcoal gray (González, personal communication) to black (Figure 2). The maxilla varies from orange to dark brown or black and the lower mandible from orange to red to black (Figure 1). However, we found four adults with most of the bill black and two individuals with the bill completely black. The bill of the juveniles is black and smaller than in adults. The throat ranges from orange to bright red in adults. About 4.4% of the individuals ( $n = 495$ ) showed white spots on the throat (Figure 1A and B). The throat of juveniles is yellowish. Four individuals showed a gray collar, below the malar region, moving into the neck (Figure 1C).

The breast varies from white to dark gray. In some adults the white on the breast showed gray to black streaks (Figure 3A). In the juveniles studied, the breast was light gray. The belly also diverges from pale to bright yellow; and four individuals had orange on it. Flanks varied from pale to bright yellow and four individuals had orange (Figure 2B). In juveniles the belly and the flanks are light yellow. Some individuals show gray on the neck in some forming a sort of collar (González Díaz personal communication, Figure 2). Dorsal parts of the tail are green with the distal part blue, and a pair of todies show white tipping at the end, details not previously reported. Ventral part of rectrices varied from gray to dark brown to black in four specimens. Undertail covers varied from light to bright yellow and four individuals had orange on it (Figure 2). Legs and toes also vary from beige/pinkish to dark gray to black (Figure 1). Of a sample of 107 individuals, 59 show beige/pinkish legs and feet, 28 gray, 6 black and 7 beige legs and gray feet. In juveniles undertail covers are light yellow and legs and toes gray.

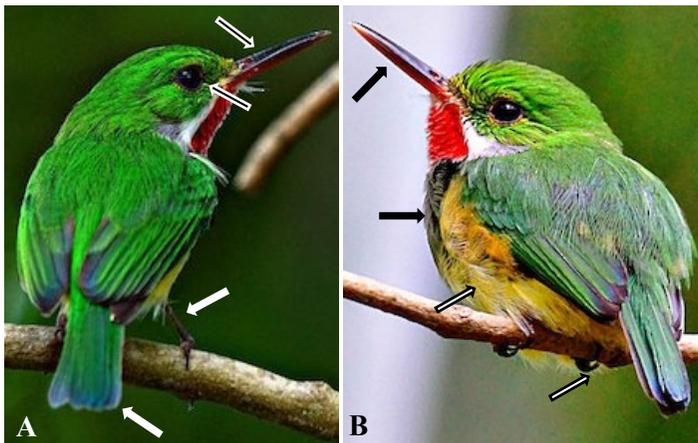


Figure 2. A. Puerto Rican Tody with bill almost completely black. Also, black eyes and black on the border of the throat. Legs black and distal part of the tail blue. Photo taken in Lajas by Sadhu Govardhan, ML385320441. B. Tody with a dark brown bill with an orange tip, black on the breast, orange on the flanks and undertail coverts, as well as blue on the distal part of the tail. Photo taken in Mayagüez by Sadhu Govardhan, ML 25285551.

On 28 September 2005, Sadhu Govardhan, photographed a Tody, in which the bird had yellow feathers on the front (lores) and over the eyes (Figure 3A). This specimen had also extensive blue in the dorsal part of the outer rectrices. The photo was taken in the Guánica Forest, considered the best-preserved xerophytic forest in the world. It is located in southwestern Puerto Rico ( $18^{\circ}12' 34.56''$  N,  $65^{\circ}12' 34.56''$  W), and have been described in many publications (Faaborg 1982, Pérez-Rivera 1994, Faaborg et al. 2013, Wiewel et al. 2013).

On 11 February 2007, co-author Colón-Archilla, took a photo of another Puerto Rican Tody with abnormal yellow coloration in the front, sides of the face and on the primaries (Figure 3B). The specimen had dark blue eyes; thus, we assume it was a female (Wetmore 1916, Kepler 1977, González Díaz and Collazo-Torres 2015). The photo was taken at the El Yunque or Caribbean National Forest ( $18^{\circ}17'42''$  N,  $65^{\circ}48'0.12''$  W). This is a subtropical rain forest also well described in many publications (Wetmore 1916, Kepler 1977, Birdsey and Weaver 1982, Brandeis 2003).

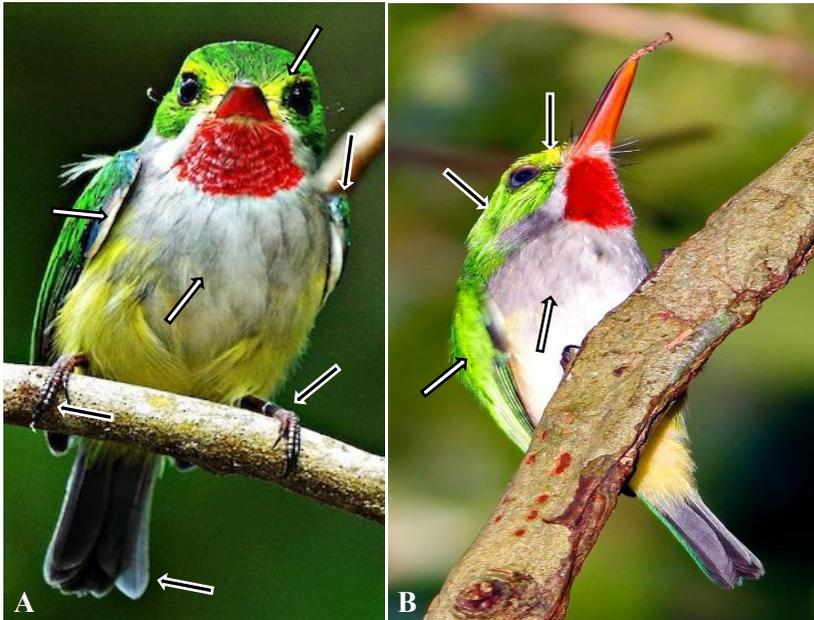


Figure 3. A. Puerto Rican Tody showing some yellow feathers in the lores and over the eyes, blue in the bend of the wing, and white in the border of it. Note the white breast with gray streaks, beige legs, and gray toes. External feathers of the tail light blue. Photo taken in Laguna Cartagena, Lajas. Sadhu Govardhan, ML387402061. B. A Puerto Rican tody showing yellow feathers in the front, the face, and on the primaries as well as a gray breast. Observed at the Caribbean National Forest. Photo by Alfredo Colón-Archilla.

On 10 January 2020, about 01600 h, Pérez-Rivera observed a tody that had all the usual green parts of the species, from the forehead to the wings and dorsal parts, replaced with yellow. All under parts were of the usual color including the red lower mandible. The bird had black legs and dark eyes; thus, we have assumed it was a male (Wetmore 1916, Kepler 1977, González Díaz and Collazo 2015). The Tody was observed in Urbanización Monte Verde, Cayey which is very close to the Menonitas Hospital of the town (18°06'44" N, 66°10'57" W), in the remaining of a shrubby area with a few scattered trees mostly of Siri, *Albizia lebeck* (Linnaeus) Bentham (Fabaceae) and planted bananas, *Musa* × *paradisiaca* Linnaeus, which two weeks before survived a fire in the area. Cayey is a mountain municipality in central Puerto Rico, located on the Central Mountain range at approximately 1450 m of elevation. We failed to get a photo of the bird although visited the area in four other occasions.

On eBird we found several photos of todies with abnormal dark color. One of the specimens, had black on its face, shin, breast and flanks (Figure 4A). A second one had black on the face, dark gray on the breast and grayish on the flanks. In the work of Gonzalez Diaz and Collazo Torres (2015, p.119), there is a bird with the breast almost totally black, and black spots on the wings including its tip. There is another picture in eBird recently posted (ML412602421), in which the breast as also totally black. Another individual had black feathers on the throat, dark gray along the breast and lighter gray on the belly (Figure 4B).

### Discussion

There are differences among the description of the Puerto Rican Tody in literature (Ridgway 1914, Wetmore 1916, Danforth 1936, Biaggi 1970, Kepler 1977, Rivera and Mojica 1981, Raffaele 1983, Raffaele et al. 1998, Oberle 2018). As the species is variable, the description offered by the different authors may have been related to a small sample or the particular specimens or photos used to describe the species. Difference in colors, of dorsal and ventral parts as well as bill, legs and toes may be related to the sex or the age of individual (van Balen et al. 2013).

Conspicuous plumage color in birds (e.g., red and yellow) seems to be highly variable (Delhey and Peters 2008, Delhey et al. 2017). High variability in the color of todies may be important since these differences, between individuals, may convey information about the quality of the signalers (Reid and Weatherhead 1990, Hill 2007 (referenced in Toomey and Ronald 2021), Alonso-Álvarez et al. 2012, Delhey et al. 2017).

We did not find any previous record of color aberrations in the family Todidae. Thus, these seems to be first record for the family. The white spotting on the throat reported in more than 4% of the photos studied, may be a normal variation in the species, being overlooked by most ornithologist except Ridgway (1914). There

are some with large portions of the throat with white (Figure 1A), thus there is a possibility that these may be a case of juveniles molting, or partial leucism which is caused by the partial or total lack of eumelanin and pheomelanin in the bird feathers (van Grouw 2006, Correa et al. 2011).

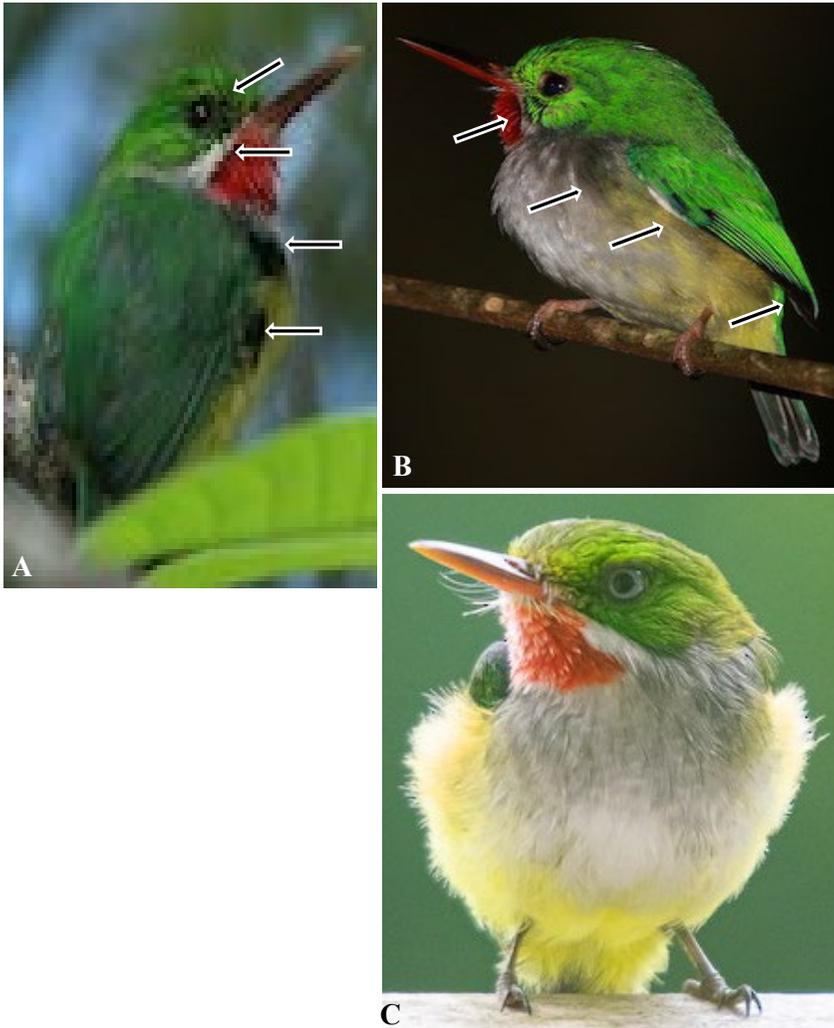


Figure 4. A. Tody with black on the face, shin, breast, and flanks. Photo taken at the Maricao Forest by Jodhan Fine, ML357672641. B. Tody with black on the face and wings and dark gray in the underparts including the flanks. Photo taken at the Maricao Forest by Guy Poisson, ML38031271. C. Bird with fluffy feathers which do not show any sign of black. Photo taken in Vega Alta by Ricardo Sánchez, ML226672761.

The dominant color in the Puerto Rican Tody is green. Melanin provides the dark background necessary for the perception of both blue and green resulting from light scattering in such a way that the combination of blue refraction and yellow pigment thus creates the green color (Fox and Vevers 1960). If there is a mutation in which the melanin is removed it also removes the blue and the yellow is exposed. This is the case of some caged birds, such as psittacine, in which the green color is substituted by yellow (Rubin 1997). This type of mutation is called a lutino, it is a recessive trait and is sex-linked (Rubin 1997, Birkhead 2004). Van Grouw (2021) refers to the reduction of melanin and remaining melanin changing in color as an ino mutation.

The change of green to yellow color reported in this work, also matches the definition of carotenism (Guay et al. 2012, Gómez et al. 2013, Rodríguez et al. 2017) and its division into xanthochroism (Van Tyne and Berger 1959, Harrison 1966, Richardson 1981, Poulis 2011, Mayntz 2018, Rodríguez et al. 2017). Rodríguez et al. (2017) gives the amplest definition to the concept indicating that it is the partial or total absence of melanin replaced by carotenoids such as red, orange, or yellow. This type of color aberration seems rarely reported in about a dozen of species including *Setophaga tigrina* (Schnell and Cadwell 1966), *Petroica multicolor* and *P. phoenicea* (Wall 1967), *Coccothraustes vespertinus* (Saunders 1958, Helleiner 1979), *Haemorhous purpureus* (Isted 1985), *Haemorhous mexicanus* (González Arrieta and Zuria 2015, Barragan-Farias et al. 2019), *Coereba flaveola* (Hudon et al. 1996), *Lichmera indistincta* (Bielewicz et al. 2010), *Pyrocephalus rubinus* (Marín 2011, Gómez et al. 2013), *Cardinalis cardinalis* (McGraw et al. 2003, Winstead 2017), and *Paroaria coronata* (Etchegaray et al. 2016).

Potential factors in the expression of xanthochroism include: 1) changes in carotenoid distribution; 2) increase or decrease in carotenoid pigments affecting color intensity; 3) changes in the type of carotenoid pigment; 4) or mutations (Harrison 1985, Hill 1992, Hudon et al. 1996, McGraw et al. 2003, Davis 2007, Gómez et al. 2013, Konter 2015, Lopes et al. 2016, Barragan-Farias et al. 2019).

Individuals with black on the face, throat and breast or dark grey color on the underparts may be cases of partial melanism, which is quite common on birds (Davis 2007, Petry et al. 2017). This may be caused by an aberrant production and distribution, in the feather cells, of normal melanin (van Grouw 2006, 2021). One of the reviewers of this paper suggested that fluffed feathers may reveal black at the base of the feathers. This may be the case of the throat in which the base of the feathers may be black (Figure 2). However, we have seen a large number of todies with fluffed feathers, preening, and showing black on the rest of the plumage has not been noticed (Figure 4).

Many of our observations reported in this work, seem to have been overlooked (e.g., by bird watchers or amateur ornithologists) or observed and not published (González Díaz has observed most of these, per. com.). Gonçalves Junior et al. (2008) suggest that the number of published records of these plumage oddities

underestimates the frequency of occurrence of these. Another possibility of the few cases report may be that aberrant individuals (e.g., yellow or red) may be short lived (Harrison 1985). In the same way that these birds are conspicuous to the professional ornithologist, may also be to predators (Pomerode 1991, Ellegren et al. 1997, Collins 2003). We tried to locate the “yellow Puerto Rican Tody”, observed at Cayey, on several occasions and we fail do it. Probably the conspicuous bird, was depredated by one of the members of a pair of Kestrels (*Falco sparverius*) established in the locality. We have observed Kestrels preying upon scaped budgerigars (*Melopsittacus undulatus*) and lovebirds (*Agapornis* spp.).

Todies are usually observed in pairs (Kepler 1977, González-Díaz and Collazo-Torres 2015, Pérez-Rivera, personal observation), and the observations reported in this work were from single individuals. Probably, such aberrant individuals may suffer rejection or harassment from conspecifics (Nero 1954, Harris 1983, Withgott and McMahon 1993).

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