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EDICIÓN ESPECIAL: AVES RAPACES DEL BOSQUE TEMPLADO AUSTRAL

FOR THE CHIMANGO'S LEGS!

¡Por las canillas del tiuque!

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RESUMEN.- Recientemente, Sarasola *et al*. (2011, J. Ornithol.152: 473–479) resolvieron la controversial diferenciación de sexo del tiuque (*Milvago chimango*) basada en la coloración de sus tarsos y su cera. Mediante el uso de espectrofotometría y análisis molecular, ellos determinaron que todos los individuos con tarsos y cera amarillos son machos adultos, y aquellos con tarsos y cera rosado-azulosos son hembras adultas, juveniles o sub-adultos. Por otra parte, estos autores afirman que la coloración de los tarsos y cera como un rasgo sexual del tiuque había sido pasada por alto hasta ahora. Sin embargo, Sarasola *et al*. (2011) omitieron cuatro referencias previas que hacen directa alusión al dicromatismo sexual del tiuque. Dos de estas referencias, indican incorrectamente que los machos adultos tienen las patas grisáceas, y las hembras adultas las tienen amarillas (Goodall *et al*. 1951, Las aves de Chile, Vol. II, Establ. Gráficos Platt, Buenos Aires, Argentina.; Pavez 2004, *en* Muñoz-Pedreros *et al*. [eds.], Aves Rapaces de Chile, CEA Editores, Valdivia). Otras dos referencias indican correctamente que los machos adultos tienen patas amarillas, y las hembras adultas e individuos juveniles las tienen gris azuloso (Reynolds 1934, Hornero 5: 339−353; Schlatter 2004, *en* Muñoz-Pedreros *et al*. [eds.], Aves Rapaces de Chile, CEA Editores, Valdivia). Los resultados de Sarasola *et al*. (2011) también han sido omitidos en artículos recientes relacionados con el sexo y la edad del tiuque. Aun cuando vivimos en la era de la accesibilidad y conectividad global, todavía parece haber un desconocimiento de literatura pertinente a nuestros estudios y una desconexión entre grupos de investigación afín.

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Accurate sex identification of animals in ecological and behavioral studies is important because it makes it possible know the role of females and males. At present, there are several methods for sex determination of birds including anatomical examination (laparatomy), molecular procedures (DNA markers), morphometric analysis, and identification of differences in plumage coloration (Flemming *et al*. 1996, Morrison *et al*., 1999, Balbontín *et al*. 2001, Palma *et al*. 2001, Sarasola & Negro 2004, Rodríguez *et al*. 2005).

Anatomical and molecular analysis are accurate methods, but are impractical in field studies. On the other hand, morphometric and plumage differences constitute easy, rapid and inexpensive methods for gender determination in the field (Rodríguez *et al*. 2005). However, when sexes are monomorphic in plumage and slightly dimorphic in size, such methods may be of limited utility. In fact, in many species there is considerable overlap between external body measurements of males and females that leads to important rates of misclassification (Mueller 1990, Morrison & Maltbie 1999). One such case is the Chimango Caracara (*Milvago chimango*), the most widespread and common raptor of southern South America.

The Chimango is a sexually monomorphic species in both body size and plumage coloration. Females tend to be only slightly larger than males (females: wing = 290−295 mm, tail = 199−208 mm, culmen = 23−24 mm; males = 280−290 mm, wing = 191−198 mm, culmen = 22−23 mm; Olrog 1948). In both sexes, general coloration of plumage is brown, more or less shaded ash-colored on

upper parts, and with whitish and cinnamon coloring on lower parts; the tail is greyish, with a conspicuous chestnut-brown sub-terminal band (Scott & Sharpe 1912, Hellmayr 1932, Housse 1934, Goodall *et al*. 1951).

Although some senior ornithologists proposed coloration patterns of legs and beak as a manner of differentiating the sexes in Chimangos, there has been much confusion about it. While some authors claim that tarsi and cere are yellowish in males, and bluish gray in females, others claim the opposite (see Table 1). Others maintain that leg coloration is not a sexual trait in the Chimango (Martínez & González 2005).

Recently, Sarasola *et al*. (2011) resolved the controversial sex differentiation by tarsi and cere coloration in the Chimango. By using sophisticated methods (e.g., spectrophotometry and molecular sexing), they definitively found that all individuals having yellow tarsi and cere were adult males, whereas those with paler tarsi and cere (bluish-pink) were either adult females, or juveniles and sub-adults of both sexes. In addition, the authors found that differences in color were not linked to plasma carotenoid levels and that color of tarsi was not influenced by season.

Because expression of tarsi and cere colors was affected by sex and age, but not by carotenoid levels, Sarasola *et al*. (2011) suggested that sexual rather than natural selection forces acted in the expression of yellow coloration in tarsi and cere of adult males. That is, color differentiation would be hormonally regulated.

Sexual dichromatism guarantees a reliable method for gender identification in the Chimango. To a lesser extent, color differences in legs and cere are useful for determining age classes. Perhaps a combination of coloration patterns in the bare parts and plumage could permit more precise identification of juvenile Chimangos.

There are no doubt that the results of Sarasola *et al*. (2011) are robust, and that they will be very useful in future studies of natural history, ecology, and behavior. However, in their paper, these authors omitted some important references regarding the sexual dichromatism of the Chimango.

Sarasola *et al*. (2011) mention that: "Only Muñoz-Pedreros *et al*. (2004) have suggested that both yellow and grey colour patterns can occur in the tarsi of Chimango Caracaras, further stating that tarsus colouration is a sexual trait in which a yellow colouration differentiates females from the greyish-coloured males".

First, the correct citation is Pavez (2004), since it is this author who claims in the respective chapter in Muñoz-Pedreros *et al*. (2004) that the Chimango's legs are dull-yellow in females, and greyish in males. This incorrect citation is perhaps a remissible error because it is usual that many authors cite book editors rather than chapter authors.

Secondly, Sarasola *et al*. (2011) omitted at least three publications that clearly state that color of tarsi and cere is a sexual trait of the Chimango. Goodall *et al*. (1951) state: "It is interesting to note that Mr. Miguel Cerda and Dillman S. Bullock, from Angol, after examining many specimens have come to the conclusion that there is sexual dimorphism in the Chimango regarding the color of tarsi (legs). According to this study, the male has the bluish-gray tarsus, with the cere also being bluish. The female has yellow-colored cere and tarsi". Because Goodall and co-authors have long remained authorities on ornithology in our country, several national authors have followed their work. Of course, in the light of results of Sarasola *et al*. (2011), descriptions in Goodall *et al*. (1951) are incorrect.

The remaining two omissions are much more relevant. Long before Goodall *et al*. (1951) and Sarasola

	Adult Male		Adult Female		Juvenile/Subadult	
	Tarsus	Cere	Tarsus	Cere	Tarsus	Cere
Reynolds (1934)*	Yellowish	Yellowish	Bluish gray	Bluish gray	Bluish gray	Bluish gray
Goodall *et al*. (1951)	Bluish gray	Bluish gray	Yellowish	Yellowish	Not described	Not described
Couve & Vidal (2000)	Light gray	Orange yellow	Yellowish	Orange yellow	Not described	Not described
Narozki & Babarskas 2000	Withish	Not described	Withish	Not described	Light blue	Light blue
Pavez (2004)	Grayish	Not described	Dull yellow	Not described	Bluish	Not described
Schlatter *et al*. (2004)*	Yellowish	Yellowish	Grayish	Grayish/Pinkish brown	Bluish gray	Grayish/Pinkish brown
Martínez & González (2005)	Yelowish/Grayish	Not described	Yelowish/Grayish	Not described	Not described	Not described
Sarasola *et al*. (2011)*	Yellowish	Yellowish	Bluish pink	Bluish pink	Bluish pink	Bluish pink

Table 1. Color description of tarsi and cere of the Chimango Caracara (*Milvago chimango*) regarding sex and age throughout the literature. Asterisks indicate correct descriptions.

et al. (2011), Reynolds (1934) had already observed that sexes of chimangos are distinguishable by the color of bare parts. This author correctly claims that tarsi and cere are yellow in adult males, and bluish gray in adult females and chicks. Later, in the opening chapter of the book Aves Rapaces de Chile, Schlatter (2004) also correctly affirms: "... in our Chimango, the male has yellow cere and the female and juveniles from gray to pinkish brown." In a subsequent paragraph, the author adds: "The color of the legs can vary and is also an indicator of sex in falcons. Yellow in males (for example, yellow-legged chimangos), gray in females, and bluish-gray in juvenile birds (less than 2 years old)".

Although Reynolds (1934) and Schlatter (2004) do not explain how they came to such a conclusion, possibly the long time observing chimangos in the field allowed them to realize of color differences in tarsi and cere between adult males and females.

To know why all the above references were omitted in Sarasola *et al*. (2011), I directly asked the first author about it. J. H. Sarasola explained to me that they simply were unaware of the existence of those older works, and thereby, they unwittingly omitted them. Although the paper of Reynolds (1934) was published in the Hornero, a well-known and prestigious journal of Neotropical ornithology, they were unaware of the article because they did not believe there was information about sexual dimorphism of the Chimango in those earlier issues. On the other hand, because the work of Reynolds (1934) has been rarely cited, it has had very little visibility.

Even though Goodall *et al*.'s (1951) "Aves de Chile" is a classic ornithological work, J. H. Sarasola said to me that they really did not realize that this reference explicitly mentions that tarsi and cere coloration in the Chimango is sexually differenced.

In the case of the omission of the chapter of Schlatter (2004), J. H. Sarasola explained to me that they were based only on Pavez (2004), not knowing that other chapter in the same book also emphasizes coloration of tarsi and cere as a sexual trait of Chimango. Perhaps the title of the chapter of Pavez (2004) was more explicit than that of Schlatter (2004): "Description of Chilean raptors" vs. "Generalidades", respectively.

As you have noticed already, the descriptions in Schlatter (2004) and Pavez (2004) are conflicting. I recommend that future editions of the book "Aves Rapaces de Chile" ensure consistency between chapters with related aspects.

Importantly, Sarasola *et al*. (2011) obtained most of the prior information on sexual dimorphism from secondary sources, such as Brown & Amadon (1968), Blake (1977), Del Hoyo *et al*. (1994), Fergusson-Lees & Christie (2001), and Muñoz-Pedreros *et al*. (2004). All such references include a very general species account, rarely citing original sources directly in the text. Often, secondary references can create a "blind spot" that prevents other researchers from quickly and easily visualizing original articles (Figueroa 2014).

Citing Sarasola *et al*. (2011)

To date, results of Sarasola *et al*. (2011) have been referenced in three other papers (scholar.google.cl). Of these, only one is related to sex determination of the Chimango (Raimilla *et al*. 2015). However, there are two other subsequent papers directly related to sex and age identification of chimangos, which do not reference Sarasola *et al*. (2011). Biondi *et al*. (2013, 2014) mention "we used plumage colour (mainly tail feathers), tarsus colour and moult stage to determine age", citing White *et al*. (1994), and Ferguson-Lees & Christie (2001). However, the authors do not explain specifically how they determined age. Biondi *et al*. (2014) explain that they identified sexes of chimangos by molecular sexing, not mentioning some coloration difference in tarsi and cere between sexes. Even after three years, it is possible that Biondi *et al*. (2014) had not known the results of Sarasola *et al.* (2011). Even though we live in the age of global connectivity, there still appears to exist a disconnection among research groups focusing on related topics.

Caring for the citation network

Certainly, my revisions do not change the soundness of studies of Sarasola *et al*. (2011) and Biondi *et al* (2013, 2014). However, all of us should remember all participants in the scientific publication process need to ensure that the citation network of the scientific literature is as complete and accurate as possible. Even though some original references are more than several decade old, or they are rather naturalist descriptions without empirical analysis, we should give them recognition and credibility. Our responsibility is to ensure the integrity of knowledge.

Undoubtedly, the editorial process of scientific review is susceptible to errors (Smith 2006, Figueroa 2014, Székely *et al*. 2014,). For this reason, we should regard science and its byproducts as a collaborative and self-correcting enterprise where errors or omissions may be corrected by the same authors or pointed out by other researchers (Woodgett 2012, Székely *et al*. 2014).

Highlighting what we have gained

Regardless of omissions, the findings of Sarasola *et al*. (2011) are a significant contribution to the ornithological community, and have multiple applications in field studies. Now, we can improve and refine our research de-

signs to understand the different aspects of reproductive biology and behavioral ecology of the Chimango.

Sarasola *et al*. (2011) also have confirmed in the field that chimangos with yellow tarsi adopt a male posture during copulation indicating that such birds are adult males sexually mature, and that bluish is the typical color of tarsi for male and female nestlings, juveniles, and subadults (Sarasola *et al*. 2011).

While studying several breeding pairs of Chimango in Valdivia, southern Chile, I have observed that chimangos with yellowish tarsis always play a role typical of males. They intensively delivered food to females -birds always with gray-bluish tarsi- during courtship and incubation periods, and to nestlings and fledglings during the chick-rearing period. In addition, chimangos with yellowish tarsi transported most of the material for nest building, while chimangos with bluish gray tarsi remained most of the time perching near the nesting site.

Only on one occasion did I observe both pair members having bluish gray tarsi. In that case, I think the male was a subadult bird. Perhaps this was also what Martínez & González (2005) really observed. These authors affirm that "There are individuals with yellowish legs and grayish legs, something which would not be related to sex ([we] have observed copulations in pairs in which both sexes had grayish legs)".

Up to now, it is uncertain just when male chimangos acquire yellowish color of their tarsi and cere (Sarasola *et al*. 2011). According to the description of Schlatter (2004), perhaps tarsi of male chimangos could become yellowish when they are more than 2 years old. Possibly, some male chimangos are mature enough sexually to reproduce at an age of two years, when they still retain the bluish gray coloration in tarsi and cere. Further studies are needed to determine when the male chimangos exactly change color of their bare parts from bluish gray to yellowish, and if this type of visual signalling is significant for territoriality, pair forming, or sexual selection.

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