

## WING-SHAPE AND ALARM CALL DIFFERENCES BETWEEN GURNEY'S BUZZARD (*Geranoaetus poecilochrous*) AND VARIABLE BUZZARD (*Geranoaetus polyosoma*) CORROBORATES THAT THEY ARE SEPARATE SPECIES

Diferencias entre la forma del ala y las vocalizaciones de alarma del aguilucho de la puna (*Geranoaetus poecilochrous*) y aguilucho variable (*Geranoaetus polyosoma*) corroboran que son especies separadas

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**RESUMEN.** - Para discriminar entre el aguilucho de la puna (*Geranoaetus poecilochrous*) y el aguilucho variable (*Geranoaetus polyosoma*) comparamos sus formas alares y los sonogramas de sus llamados de alarma. Obtuvimos medidas alares de 98 pieles de aguilucho de la puna y 349 de aguilucho variable de distintos museos y de aves vivas en cautividad (14 aguiluchos de la puna y 20 aguiluchos variables). El aguilucho de la puna tuvo proporcionalmente mayores valores de longitud alar y menores valores de fórmula alar comparado con el último. Además, el primero tuvo proporcionalmente mayor profundidad alar, menor longitud de la punta del ala, menor aspecto alar y la punta del ala más roma. El patrón de la longitud del ala fue geográficamente opuesto entre ambas especies. Los aguiluchos de la puna tienen alas más grandes en el norte y más pequeñas en el sur de su distribución. Lo opuesto ocurre en los aguiluchos variables. Los resultados del análisis comparativo de los sonogramas mostraron que los llamados de alarma del aguilucho de la puna son más prolongados y con un número menor de notas que los del aguilucho variable. Sobre la base de estas evidencias, recomendamos tratar a estas taxa como especies distintas.

**PALABRAS CLAVE:** tamaño del cuerpo, plumas primarias, sonogramas, patrón de distribución de variación, fórmula alar, contorno de la punta del ala.

**ABSTRACT.** - To discriminate between the Gurney's Buzzard (*Geranoaetus poecilochrous*) and the Variable Buzzard (*G. polyosoma*), we compared their wing shapes and the sonograms of their alarm calls. We obtained the measurements from 98 Gurney's Buzzard skins and 349 Variable Buzzard skins from different museums and live birds in captivity (14 Gurney's Buzzards and 20 Variable Buzzards). The Gurney's Buzzard had proportionally higher wing length values and lower wing formula values than the latter. In addition, the former had proportionally greater wing depth, shorter wing tip length, less wing aspect, and blunter wingtip. The pattern of wing length was geographically opposite between the two species. Gurney's Buzzards were larger winged in the north and smaller winged in the south of their range, while the opposite was true for Variable Buzzards. The results of the comparative analysis of sonograms showed that the alarm calls of the Gurney's Buzzard are longer, with fewer notes than those of the Variable Buzzard. Based on this evidence, we recommend treating these taxa as distinct species.

**KEY WORDS:** body size, primary feathers, sonograms, variation distribution pattern, wing formula, wing tip contour.

## INTRODUCTION

The Variable Buzzard (*Geranoaetus polyosoma*) and Gurney's Buzzard (*G. poecilochrous*) are closely related phylogenetically species inhabiting western South America, which were until recently in the genus *Buteo* (Amaral *et al.* 2010). These species share the following morphological traits: (a) similar body plumage and brown or grey-brown tails irregularly finely dark barred during the first two years of life (Stresemann 1925); (b) after the second complete molt, individuals acquire a white tail with fine transverse black lines and a broad black subterminal band; (c) definitive adult plumage is sexually dimorphic, males being grey above, females having a reddish dorsal patch on the mantle and scapular feathers (Stresemann 1925, Hellmayr & Conover 1949, Cabot & de Vries 2003, 2010b); (d) both species share two plumage morphs; *i.e.*, dark- and pale-phase birds (Stresemann 1925, Hellmayr & Conover 1949); and (e) a delayed appearance of mature plumage, with plumage patterns that change with age, sex, and morph (Cabot & de Vries 2010b).

These buzzards also share a similar plumage pattern when of the same age and sex, with little but evident differences among the pale-phase individuals and more noticeable differences among the dark-phase individuals (Stresemann 1925, Hellmayr & Conover 1949, Brown & Amadon 1968).

Some unproven assertions that have contributed to confusing the taxonomic status of both species are that (i) there was a possible hybridization in contact areas (Vaurie 1962); (ii) the Gurney's Buzzard is merely an altitudinal variation of the Variable Buzzard (Brown & Amadon 1968), and (iii) the two species are indistinguishable in the field (Brown & Amadon 1968, Márquez *et al.* 2005).

Stresemann (1925) and Vaurie (1962) evaluated morphological relationships between Gurney's Buzzard and Variable Buzzard. After thoroughly characterizing plumage for both sexes of the two species, Stresemann established two shared color morphs: pale- and dark-phase within each species. In addition, after measuring the wing lengths, Stresemann found that Gurney's Buzzards' fifth remige (p6) is approximately as long as or longer than the third (p8) and that the wing length is over 400 mm. On the contrary, Stresemann found that the Variable Buzzards' fifth remige is shorter than the third one. Without distinguishing ages or color morphs, Vaurie (1962) incompletely established the adult definitive plumages for each species and provided inaccurate wing measurements by incorrectly using Stresemann's criterion.

De Vries (1973) gave a wing length range for Gurney's Buzzard that was broader than in the Variable Buzzard, which did not overlap between individuals of the same sex. The first species had shorter wing projection, greater wing depth, and a blunter outline to the wingtip. De Vries highlighted other interspecific differences, including the tail length, bill/inner claw length, tarsus length, middle toe length vs tarsus length, and tarsus length vs average toe length. Cabot (1991) reported that both buzzard spe-

cies differed in wing lengths, wingspans, forearm lengths, and wing widths. He based measurements on the innermost and outermost secondaries. Cabot used these measurements to draw the corresponding flight silhouettes, which differed notably, as Fjeldså & Krabbe (1990) also showed.

Farquhar (1998), based on an analysis of wing parameters and plumages of museum skins and alarm calls, grouped both taxa into a single species under the name of Variable Buzzard. Cabot *et al.* (2020) rejected that proposal due to errors in the data collection, treatment, and analysis of the information of Farquhar.

The morphological differences between the two species in the field (*e.g.*, flight silhouette, plumage coloration) are so evident that several investigators have been able to differentiate them easily. Such advantage has allowed them to report valuable information on these species' ecology and natural history, including morphology, distribution, habitat, behavior, reproduction, migration, and feeding (*e.g.*, Stresemann 1925, Hellmayr & Conover 1949, Koepcke 1954, Dorst 1956, Macedo 1964, de Vries 1973, Solís & Black 1985, Cabot & Serrano 1986, Ortiz-Crespo 1986, Jaksic & Jiménez 1986, Jiménez & Jaksic 1990, Fjeldså 1987, Cabot 1988, 1991, Jaksic *et al.* 1991, Coello 1997, Cabot & de Vries 2003, de Vries *et al.* 2014, Ramírez *et al.* 2007, Araóz 2012). Even Cabot & de Vries (2009) described a new subspecies of Gurney's Buzzard.

Based on the abovementioned evidence, some bird guide's authors treat these taxa as separate species (*e.g.*, Hennessy *et al.* 2003, Ramírez *et al.* 2007, Martínez *et al.* 2010, de La Peña 2012, 2016). Despite that and molecular evidence (Lerner *et al.* 2008), several other authors persist in treat them as conspecifics (*e.g.*, Riesing *et al.* 2003, Rodríguez *et al.* 2006, López-Lanús *et al.* 2008, Amaral *et al.* 2009, del Hoyo *et al.* 2014).

Here, we provide additional morphological evidence that corroborates that Variable and Gurney's Buzzards are separate species. We found that wing morphometrics and alarm calls are reliable traits in diagnosing Variable and Gurney's Buzzards in the field.

## MATERIAL AND METHODS

To differentiate morphologically Gurney's Buzzards from Variable Buzzards, we measured the following variables: (i) wing length, (ii) wing formula, (iii) wing-tip projection, (iv) wing depth, (v) wing length minus wing tip, and (vi) wing-tip contour. The wing length was the maximum wing chord of the flattened-straightened wing. For the wing formula, we followed Baldwin *et al.* 1931 (*i.e.*, length of p8 minus p6). We defined the wing-tip projection as the distance from the tip of the innermost primary feather, p1, to the end of the longest primary feather, in this case, p7. The wing depth was an indicator of wing width, and it is also used to calculate the ratio of wing length to wingtip length. We outlined the wing-tip contour by measuring the distances from the end of the first prima-

ry feather, p1, to the end of the second primary feather, p2, and so on (*i.e.*, p1-p2, p1-p3) as far as p1-p10.

We took body measures from 98 museum skins of Gurney's Buzzards and 349 of Variable Buzzards. We discarded for our analysis the feathers that were still growing, worn, or broken. Wing length measures came from skins held in several museums (Cabot & de Vries 2003, 2004, 2009, 2010a), as well as the Ornithological Collection of the National Museums of Scotland, the Senckenberg Natural History Collections (Dresden), the Santiago Natural History Museum (Chile), and the collection of the Fundación Miguel Lillo (Tucumán, Argentina).

We also measured the wing width from the carpal joint to the tip of the outer secondary and the unfolded wing length from the tip of the lengthiest primary to the wing insertion in the thorax in 14 captive Gurney's Buzzards and 20 captive Variable Buzzards (Cabot & de Vries 2003). Both variables permitted us to calculate the wing aspect ratio (*i.e.*, maximum length of the open wing/maximum width).

We sexed museum specimens according to wing length and plumage features (Stresemann 1925, de Vries 1973, Cabot & de Vries 2003, Cabot & de Vries 2010a). Following Farquhar (1998), we plotted wing length against the wing formula to search for discrete groups that could define taxonomic boundaries. We graphed the wing-tip outlines by taking the wing depth as 100%. For an exploratory taxonomic classification based on wing-tip outlines, we entered the nine variables configuring the wing pattern (p1-p2, p1-p3, as far as p1-p10) into a principal component and discriminant analyses. Moreover, we analyzed the geographical variations in body sizes of Variable Buzzard based on its wing length.

To detect differences that can serve as taxonomic boundaries between both taxa, we compared the patterns of geographical variation in body size, based on wing measurements, for each taxon. We also compared wing measurements within each species to identify patterns of intraspecific geographical variation in body size.

Complementarily, we compared the patterns of alarm calls of both species from Farquhar's (1998) sonograms. Such sonograms come from four female buzzards with different morphological characters and geographic origins. The recordings of the voices of these females come from Paloguillo, near Antisana Volcano (3700 m a.s.l.), Ancón and Santa Elena (65 m a.s.l) in Ecuador, and Santiago (2800 m a.s.l.) in Chile. The female from Paloguillo had long and broad wings, the females from Ancón and Santa Elena had narrow and short wings, and the female from Santiago had long and narrow wings.

Based on our criteria, we re-assigned each female recorded by Farquhar to either the Gurney Buzzard or Variable Buzzard. We identified the female from Paloguillo as a Gurney's Buzzard. We are familiarized with this morph as we have intensively studied the breeding and feeding activities in the Paloguillo paramo (de Vries *et al.* 2014). We identified females from Ancón and Santa Elena

as Peruvian Variable Buzzards (*G. polyosoma peruvien-sis*). This subspecies is endemic to the dry desert, the coast of SW Ecuador, and NW Peru (Swann 1922, Fjeldsá & Krabbe 1990, Buitrón *et al.* 2010). According to the altitude and habitat, the female from Santiago corresponds to the nominate subspecies of Variable Buzzard (*G. polyosoma polyosoma*). Variable Buzzards are common, and they widely reproduce in the montane areas covered with sclerophyllous forest shrubs alternated with open fields (Alvarado *et al.* 2015).

## RESULTS

### Morphometrics

Wing length values of the Gurney's Buzzard exceeded those of the Variable Buzzard and did not overlap between species in either sex (Table 1). Both species also had different wing formulas ( $t\text{-test}_{131} = 16.6$ ,  $P < 0.0001$ ). The average distance between the tips of p6 and p8 was  $< 1.5$  mm in both sexes of the Gurney's Buzzard (Table 2), but was higher in the Variable Buzzard, approaching 14 mm in both sexes. The wing formula values for the Variable Buzzard were positive, while for the Gurney's Buzzard, they were positive or negative. By contrasting the wing formula against wing length, we observed two well-segregated groups of points for each sex (Fig. 1), corresponding to two morphs with non-overlapping wing lengths and different wing formulas.

The absolute values of average wing projection were similar sex to sex between the Gurney's Buzzard and Variable Buzzard (Table 3). In both species, females had higher wing-tip projection than their male counterparts (Gurney's Buzzard:  $t\text{-test}_{21} = 2.57$ ,  $P < 0.017$ ; Variable Buzzard:  $t\text{-test}_{77} = -5.56$ ,  $P < 0.001$ ).

Compared to the Gurney's Buzzard, the Variable Buzzard had proportionally longer primaries regarding its wing length and wing width (Fig. 2). In Gurney's Buzzard, the wing-tip distance was less than half that of the wing depth (47.7%), while in Variable Buzzard, the wing-tip was longer than half of the wing depth (57.4%). The differences in the wing-tip/wing length ratio were evident between sexes for both species (males:  $t\text{-test}_{44} = -7.31$ ;  $P < 0.001$ ; females:  $t\text{-test}_{36} = 10.21$ ,  $P < 0.001$ ).

Within species, males had longer and broader wings than females. In the Variable Buzzard, the relationship wing-tip distance vs wing length was  $37.08 \pm 1.99\%$  for males and  $33.34 \pm 1.79\%$  for females (mean  $\pm$  SD;  $t\text{-test}_{61} = 7.78$ ,  $P < 0.0001$ ). In Gurney's Buzzard, that relationship was  $32.08 \pm 0.88\%$  for males and  $30.89 \pm 1.44\%$  for females ( $t\text{-test}_{67} = 4.09$ ,  $P = 0.0001$ ). It was evident that males from both species have a blunter wingtip contour regarding wing length.

The wing aspect ratio was lower in the Gurney's Buzzard than in the Variable Hawk ( $t\text{-test}_{31} = 5.01$ ,  $P < 0.001$ ; Table 4). The Gurney's Buzzard had a blunter wing-tip outline than the Variable Buzzard (Fig. 3), and the p5 was longer than p9. In the latter, the primary feathers p6, p7, p8, and p9 projected beyond the others, and

**Table 1.** Mean and ranges (in mm) for wing length of Gurney`s Buzzards (*Geranoaetus poecilochrous*) and Variable Buzzards (*Geranoaetus polyosoma*) according to various authors. nr = non-reported. When available, measurements include standard deviations around of the mean ( $\pm$  SD).

Author(s)	Gurney`s Buzzard ( <i>Geranoaetus poecilochrous</i> )						Variable Buzzard ( <i>Geranoaetus polyosoma</i> )					
	Male			Female			Male			Female		
	Mean	Range	n	Mean	Range	n	Mean	Range	n	Mean	Range	n
Stresemann (1925)	413	405-421	2	461.3	444-475	9	368	373-362	6	400.8	380-430	nr
Chapman (1926)	425	418-435	3	467	-	1	-	-	nr	-	-	nr
Goodall <i>et al.</i> (1951)	-	420-450	nr	-	460-490	nr	367.2	355-385	nr	399.8	388-418	nr
Behn <i>et al.</i> (1957)	436	-	1	477	-	1	367	-	nr	400	-	nr
Dorst (1956)	425	-	1	460	-	4	-	-	nr	-	-	nr
Hellmayr & Conover (1949)	-	420-450	nr	-	460-490	nr	-	355-400	nr	-	400-440	nr
Johnson (1965)	-	420-450	nr	-	460-490	nr	367.2 $\pm$ 2.56	-	nr	399.8 $\pm$ 2.80	-	nr
De Vries (1973)	421	408-435	6	457.6	452-465	5	371.8	352-390	24	415.1	400-447	18
Cabot (1991)	421	402-444	8	461	446-474	8	370	350-392	18	391	391-392	2
Cabot & de Vries (2003)	425	402-444	17	464.3	450-490	23	370.2	342-386	36	406	387-446	41
Cabot & de Vries (2009) <sup>a</sup>	434 $\pm$ 10.2	-	20	469.1 $\pm$ 10.3	-	15	-	-	-	-	-	-
Cabot & de Vries (2009) <sup>b</sup>	424 $\pm$ 10.2	-	17	464.3 $\pm$ 8.6	-	19	-	-	-	-	-	-

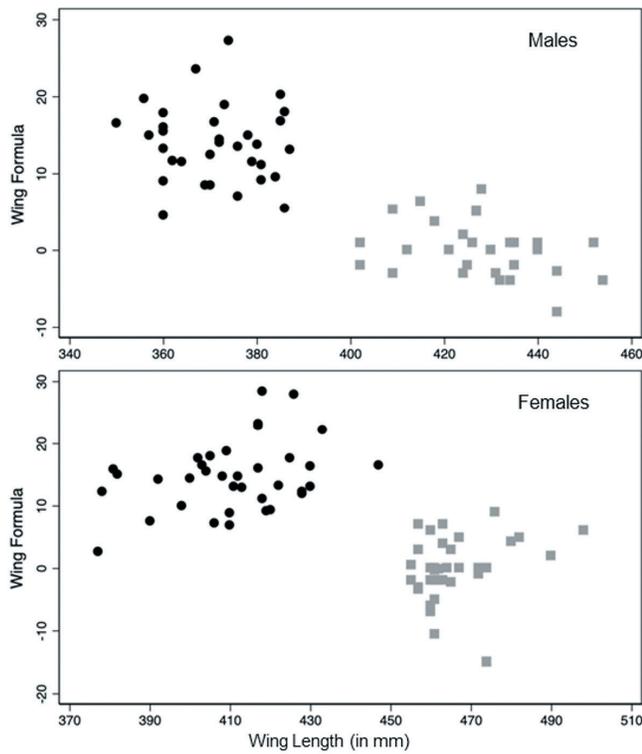
<sup>a</sup>*Geranoaetus poecilochrous poecilochrous*, <sup>b</sup>*G. poecilochrous fjeldsai*.

**Table 2.** Mean size of the wing formula for male and female Gurney`s Buzzards (*Geranoaetus poecilochrous*) and Variable Buzzards (*G. polyosoma*). Values include standard deviations ( $\pm$  SD) and confidence intervals (CI) around the mean. Measurements came from museum skins.

Species	sex	Wing formula (p8 minus p6)		
		Mean $\pm$ SD (in mm)	CI (95%)	n
Gurney`s Buzzard	♂	0.136 $\pm$ 3.68	(-1.29, 1.53)	28
Gurney`s Buzzard	♀	-0.049 $\pm$ 5.01	(-1.77, 1.67)	35
Variable Buzzard	♂	14.46 $\pm$ 5.61	(12.59, 16.33)	37
Variable Buzzard	♀	13.92 $\pm$ 4.98	(12.15, 15.68)	33

**Table 3.** Wing-tip lengths for male and female Gurney's Buzzards (*Geranoaetus poecilochrous*) and Variable Buzzards (*G. polyosoma*). Values include standard deviations ( $\pm$  SD) and confidence intervals (CI) around of the mean. Measurements came from museum skins.

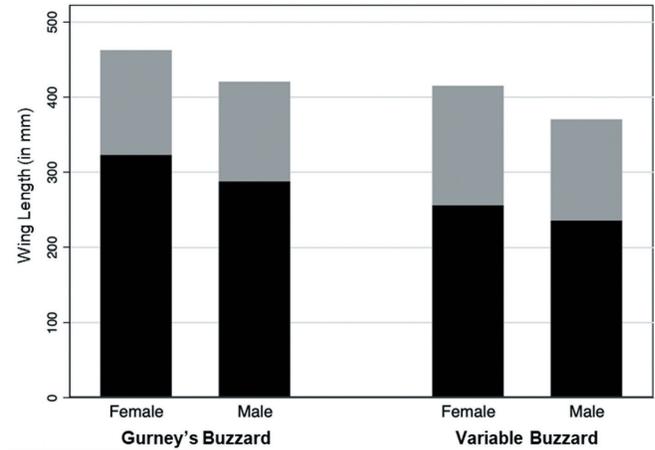
Species	sex	Mean $\pm$ SD (in mm)	CI (95%)	n
Gurney`s Buzzard	♂	136.22 $\pm$ 1.7	(135.65, 136.79)	36
Gurney`s Buzzard	♀	142.01 $\pm$ 7.19	(139.79, 144.22)	43
Variable Buzzard	♂	138.89 $\pm$ 5.20	(134.89, 142.89)	9
Variable Buzzard	♀	141.34 $\pm$ 7.99	(136.73, 145.95)	14



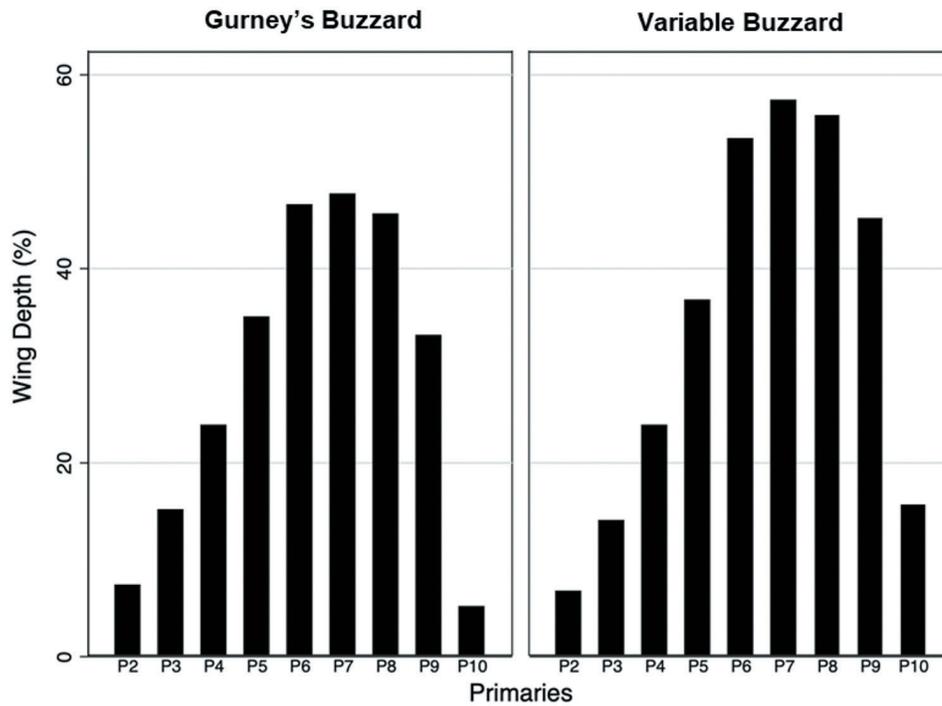
**Figure 1.** Wing formula with respect to wing length in male and female Gurney's Buzzards (*Geranoaetus poecilochrous*; gray squares) and Variable Buzzards (*G. polyosoma*; black dots).

conversely, p9 was longer than p5.

The principal component analysis showed that the wing-tip contour patterns differ between Gurney's Buzzard and Variable Buzzard. The first three cumulative proportions (0.54, 0.28, and 0.07) constructed with the variables p1-p10, p1-p6, and p1-p3 explained 89.8% of the total variance. The data points in the new space formed by these three principal components (Fig. 4) again revealed that the shape of the wing outline differs between the two species.



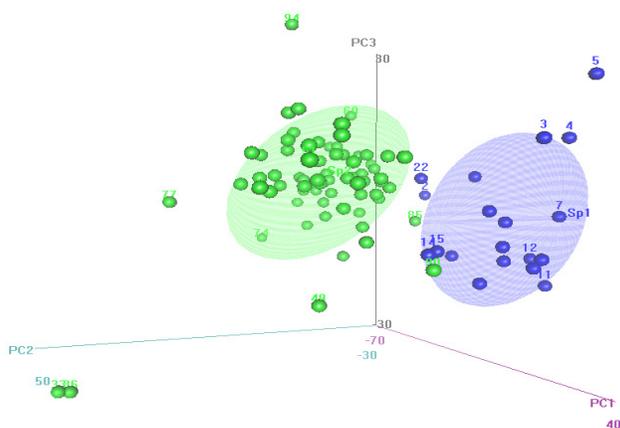
**Figure 2.** Wing-tip (in gray bars) and wing depth (in black bars) in relation to wing length in male and female Gurney's Buzzards (*Geranoaetus poecilochrous*) and Variable Buzzards (*G. polyosoma*).



**Figure 3.** Shape of wing-tip contour with respect to wing depth (100%) in the Gurney's Buzzards (*Geranoaetus poecilochrous*) and Variable Buzzards (*G. polyosoma*). Measurements came from museum skins.

**Table 4.** Wing aspect ratio for male and female Gurney’s Buzzards (*Geranoaetus poecilochrous*) and Variable Buzzards (*G. polyosoma*). Wing-tip lengths for male and female Gurney’s Buzzards (*Geranoaetus poecilochrous*) and Variable Buzzards (*G. polyosoma*). Values include standard deviations ( $\pm$  SD) and confidence intervals (CI) around of the mean. Measurements came from captive individuals.

Species	sex	Wing aspect ratio		
		Mean $\pm$ SD (in mm)	CI (95%)	n
Gurney`S Buzzard	♂	2.30 $\pm$ 0.03	(2.26, 2.34)	5
Gurney`S Buzzard	♀	2.11 $\pm$ 0.04	(2.08, 2.14)	9
Variable Buzzard	♂	2.40 $\pm$ 0.09	(2.34, 2.46)	11
Variable Buzzard	♀	2.41 $\pm$ 0.11	(2.32, 2.49)	9



**Figure 4.** Wing-tip outlines segregation for Gurney’s Buzzards (*Geranoaetus poecilochrous*, in blue) and Variable Buzzards (*G. polyosoma*, in green) based on the distances between the tip of the first primary (p1) and the tips of the other primaries.

Different wingtip contour patterns were also evident in a discriminant analysis based on the same variables, classifying 100% (n = 19) of Gurney’s Buzzards and 97.3% (n = 73 of 75) of Variable Buzzards. A discriminant analysis by steps allows for reducing the dimension; that is, it selects those most explanatory variables that summarize the relationships. The distances p1-p10, p1-p6, p1-p3, and p1-p7 stand out as the most statistically significant ( $P < 0.0001$ ). The discriminant model allows the classification of both species concerning said selected variables. That indicates that such variables are highly differentiable for both species.

**Geographical variation in the body size of the Variable Buzzard**

According to our analysis, Variable Buzzards of smaller body size -in terms of wing length- occur along the southern coast of Ecuador and in northwest Peru, while those of individuals of larger body size are in Tierra del Fuego and the Strait of Magellan in the south of the continent (Table 5). Individuals from the Bolivian and Ecuadorian Andes, central Chile, and the Falkland Islands are intermediate in body size. Of these latter, it is worth highlighting a juvenile pale-phase female (Brit. Mus.1924.5.8.20.; col. J.E. Hamilton, 21 Nov. 1917) with a wing length of 447 mm, which suggest that some variation in wing length between

**Table 5.** Wing lengths (in mm) for male and female Variable Hawks (*Geranoaetus polyosoma*) in different localities of its distribution range. Measurements taken by the author from museum specimens.

Locality	Male			Female		
	Mean	Range	n	Mean	Range	n
Andes in Ecuador and Colombia	373.2	360-384	9	399.8	390-412	14
Coast of Ecuador and Peru	360.4	342-370	13	388.4	377-409	23
High Andes in Bolivia	369.8	360-386	14	395.5	392-408	4
Lowlands of central Chile	375.1	362-387	13	398.3	389-416	14
Tierra de Fuego and Strait of Magellan	384.2	373-399	12	427.5	418-433	6
Falklands Islands	374.1	360-387	26	412.0	391-447	40

islands may exist.

### Alarms calls

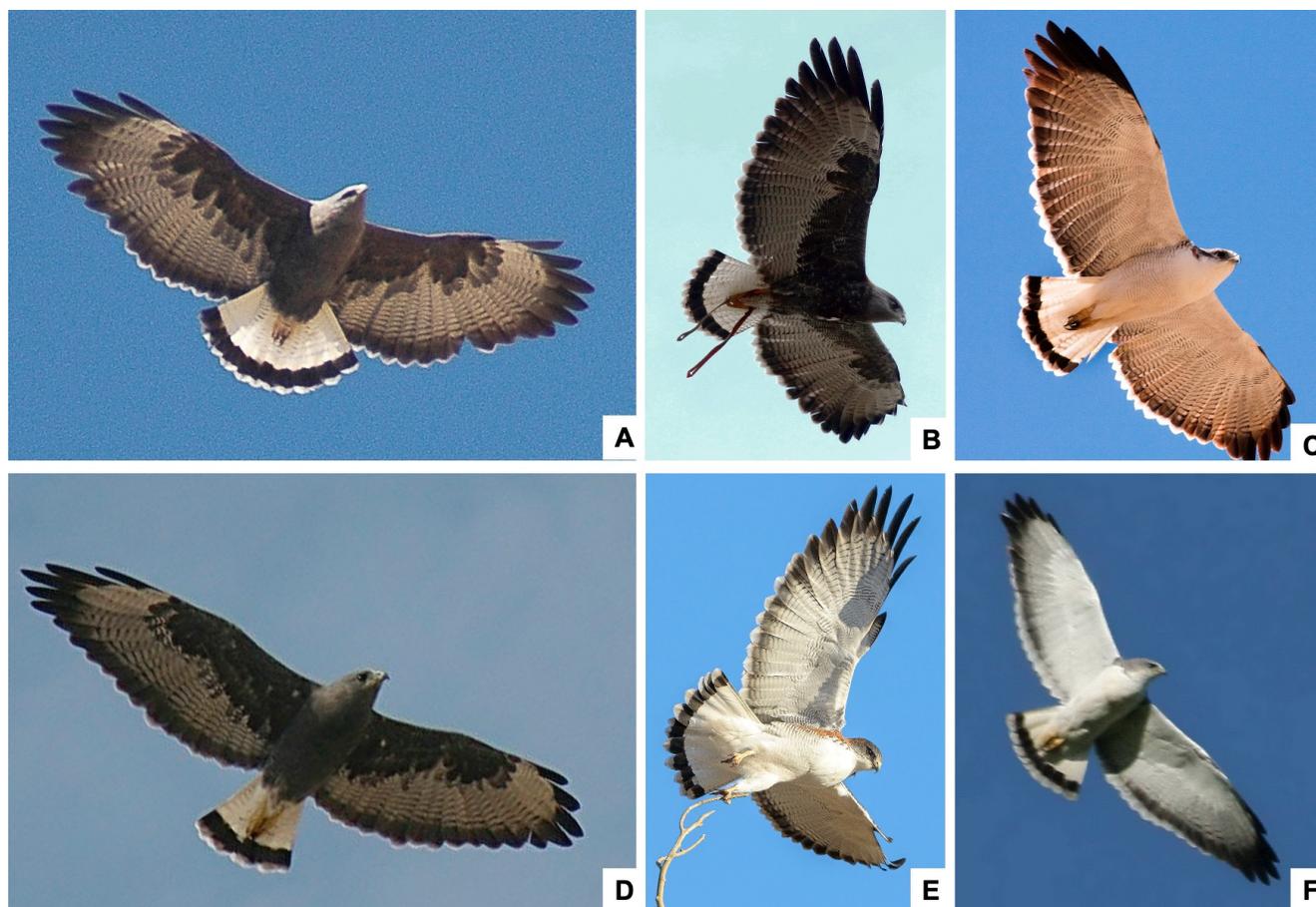
We detected evident differences between Farquhar's (1998) sonograms of alarm calls for adult "Red-backed Hawk" females (Table 6). The alarm calls of Peruvian

Variable Buzzards appeared closer to those of Gurney's Buzzards than to those of Variable Buzzards from central Chile. The duration of calls, the total number of vocalizations, and the period of the initial note are similar between Gurney's Buzzard from the high Andes in Ecuador and Peruvian Variable Buzzard from the coast of Ecuador.

**Table 6.** Characteristics of the alarm calls of female Gurney's Buzzards (*Geranoaetus poecilochrous*) and Variable Buzzards (*G. polyosoma*) according to Farquhar's (1998) sonograms taken in different localities.

	Gurney's Buzzard Cerro Paloguillo, Ecuador	Variable Buzzard <sup>a</sup> SW Ecuador	Variable Buzzard Central Chile
Length alarm call (in seconds)	3.2	3.4	4.1
Nº vocalizations	13	16 (15-17)	20
Length of 1 <sup>st</sup> voc.	0.35	0.37 (0.34-0.40)	0.77
Nº vocs./1 <sup>st</sup> second	3.5	4	1
Nºvocs./2 <sup>nd</sup> second	5	5	7

<sup>a</sup>*Geranoaetus polyosoma peruvienis*



**Figure 5.** Above, some Gurney's Buzzard (*Geranoaetus poecilochrous*) morphs. **A.** A dark female from Challapacocha, Peru (photography: Douglas Hardy). **B.** A dark Peruvian female in captivity (photography: José Cabot). **C.** A pale adult female from La Paz Valley, Bolivia (photography: Mauricio Pacheco). Below, some Variable Buzzard (*Geranoaetus polyosoma*) morphs. **D.** An adult dark male from southwest coast of Ecuador (photography: Ben Haase). **E.** An adult pale female from Tucuman, Argentina (photography: Walter Baliero). **F.** A pale adult male from Farellones, Chile (photography: Roberto Cañete).

Variable Buzzards from central Chile have the longest alarm call, a more persistent initial note, and produce only one vocalization in the first second. In contrast, Gurney's Buzzards and Peruvian Variable Buzzards emit four and five vocalizations in the first second, respectively. In the next second, Variable Buzzards from central Chile emit seven vocalizations, while Gurney's and Variable Buzzards from southwest Ecuador only emit four and five notes, respectively.

## DISCUSSION

Our results reveal that Gurney's and Variable Buzzard markedly differ in body size. The first species is larger than the latter, with non-overlapping wing length ranges between individuals of the same sex. That is consistent with the results obtained by other authors (Table 1). There are no intermediate forms or clinal gradients between both species. Gurney's Buzzards have a wider-wing and lower wing formula and aspect ratio. Moreover, Gurney's Buzzards have a wing-tip contour blunter than Variable Buzzards (see Fig. 5). These results are consistent with those obtained by de Vries (1973), who found similar morphometric patterns. Moreover, there are differences in the size of the bill, tarsus, toes, and claws, whose dimensions are more prominent on average in Gurney's Buzzards (de Vries 1973).

Cabot (1991) noted that Gurney's Buzzards have longer secondary feathers than Variable Buzzards and that there was no interspecific overlap. When comparing sexes, Cabot (1991) found that Gurney's Buzzards have a greater wingspan and total length (from bill tip to distal tail extreme), wing and forearm lengths and that their flight silhouettes (constructed from body measurements) differ between the species. Gurney's Buzzards have relatively broad wings with a more rounded tail that protrudes less. On the contrary, Variable Buzzards have narrower wings and a comparatively longer tail (Fig. 5). Several authors have noted these differences, including that flight silhouettes are different (Dorst 1956, Fjeldså & Krabbe 1990, Walker 2002). After Farquhar (1998), the results of several studies reinforced the idea that Gurney's Buzzard and Variable Buzzard have different body sizes and proportions and that there is no evidence of any transitional forms (Cabot & de Vries 2003, 2009, 2010 a, b). Cabot & de Vries (2003) found that these morphometric differences persist when both species coexist in the same altitudinal range.

Patterns of geographic trends in body size also differ between both species. The body-larger individuals of Variable Buzzards occur in the extreme meridional of their range in the tip of South America (Vaurie 1962, Jimenez 1995, Cabot & de Vries 2003, our results). Conversely, the larger-sized individuals of Gurney's Buzzard occupy the northern part of their geographical range in Colombia and Ecuador (Cabot & de Vries 2009).

We are aware that the number of alarm calls analyzed is very low. Even so, the alarm calls are not reli-

able traits for separating species. Buzzards use alarm calls to dissuade potential intruders, which do not necessarily have to be conspecific. Therefore, the intraspecific selection processes on which the calls depend do not have to be as strong as those whose calls are directed exclusively to their conspecifics. Nonetheless, it is surprising that the alarm calls of the coastal buzzards in Ecuador and northern Peru are more like those emitted by Gurney's Buzzard than they are to those of the Variable Buzzard.

Phylogenetic analyses are necessary to clarify the separation among the three taxa abovementioned. Ecuadorian and Peruvian coastal buzzards were included originally within a subspecies of the Variable Buzzard (*G. polyosoma peruviansis*) by Swann (1922) based on their morphometrics and plumage characteristics. Later, Stresemann & Amadon (1979) rejected that subspecific status based on a cursory analysis of a few specimens. The "Peruvian" Variable Buzzards, restricted to the desertic coastal habitats of Ecuador and Peru, require a taxonomic study based on the morphological peculiarities such as its small size, graceful and slender silhouette, and different plumages to the nominate subspecies individuals. Some authors who can differentiate it in the field continue to recognize it as a valid subspecies (Fjeldså & Krabbe 1990), Buitrón *et al.* 2010, de Vries *et al.* 2014).

Our results show that Gurney's and Variable Buzzards are two biological forms differentiated by morphology and alarm calls. The information collected in an extensive review of bibliography reveals that both species differ in morphology, social and reproductive behavior, ecological requirements, altitudinal and habitat preferences, distribution patterns, and natural histories. All this support that they are two taxa reproductively isolated and capable of coexisting in the same areas.

Some authorities consider Gurney's Buzzard a subspecies of the Variable Hawk (*e.g.*, Riesing *et al.* 2003, Bierregaard *et al.* 2020), but this is an aberration from a taxonomic point of view. According to O'Neill (1982), a subspecies is "an aggregate of local populations of a species that inhabit a geographic subdivision of the species range, which differs from other populations of the same species". However, it is not tenable that the subspecificity of Gurney's Buzzard is sustained by that premise. To assign a subspecific status without sound evidence is nonsense. The number of specimens examined, their descriptions, diagnosis, morphological limits, localities of origin, and museums where the type specimens remain for recognition of the subspecific status of this taxon are not known.

## CONCLUSION

We conclude that the arguments on which the proposed con-specificity of Gurney's Buzzard and Variable Buzzard (Farquhar 1998) are based, are untenable. Our results and abundant documentation, not considered by Farquhar, indicate that these taxa differ clearly in body size. More evident differences between both species are that: (i)

they inversely vary their body size with latitude; (ii) their plumage patterns are different at interspecific levels, (iii) they do not change randomly but depend on age, sex, and color morph, and have different ecological requirements, social and reproductive behavior, movements, distribution patterns, and natural histories (Cabot & de Vries 2003, 2010a); and (iv) there is no evidence of interbreeding or individuals with intermediate morphology. Thus, there is no justification for considering Gurney's and Variable Buzzard conspecific based on morphological features and alarm calls. In agreement with Cabot & de Vries (2003) and the classical biological concept of species (Mayr 1942), we propose that they continue to be considered separate species as Gurney (1879) postulated originally.

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