

DESCRIPTION OF A NEW SUBSPECIES OF THE EGYPTIAN VULTURE (ACCIPITRIDAE: *NEOPHRON PERCNOPTERUS*) FROM THE CANARY ISLANDS

JOSÉ ANTONIO DONÁZAR,¹ JUAN JOSÉ NEGRO, CÉSAR JAVIER PALACIOS
AND LAURA GANGOSO

Department of Applied Biology, Estación Biológica de Doñana, Consejo Superior de Investigaciones Científicas, Avda M^{ra} Luisa s/n 41013 Sevilla, Spain

JOSÉ ANTONIO GODOY

Laboratory of Molecular Ecology, Estación Biológica de Doñana, Consejo Superior de Investigaciones Científicas, Avda M^{ra} Luisa s/n 41013 Sevilla, Spain

OLGA CEBALLOS AND FERNANDO HIRALDO

Department of Applied Biology, Estación Biológica de Doñana, Consejo Superior de Investigaciones Científicas, Avda M^{ra} Luisa s/n 41013 Sevilla, Spain

NIEVES CAPOTE

Laboratory of Molecular Ecology, Estación Biológica de Doñana, Consejo Superior de Investigaciones Científicas, Avda M^{ra} Luisa s/n 41013 Sevilla, Spain

ABSTRACT.—On the basis of four study skins from museum collections and 37 live birds from the island of Fuerteventura, we describe a new subspecies of the Egyptian Vulture (*Neophron percnopterus majorensis*) from the Canary archipelago. Canarian Egyptian Vultures are significantly larger than Western European and North African individuals. In addition, some genetic differentiation may exist; analyses of the mitochondrial DNA control region revealed that there are haplotypes exclusive to the Canary Islands. The current population of Egyptian Vultures in the Canary Islands is 25–30 breeding pairs restricted to the islands of Fuerteventura and Lanzarote, and this subspecies is therefore endangered.

KEY WORDS: *Egyptian Vulture*; *Canary Islands*; *control region*; *mitochondrial DNA*; *Neophron percnopterus majorensis*; *subspecies*.

Descripción de una nueva subespecie de alimoche (*Neophron percnopterus majorensis*) nativa del archipiélago de Canarias

RESUMEN.—Describimos una nueva subespecie de alimoche (*Neophron percnopterus majorensis*) nativa del archipiélago de Canarias, sobre la base de 4 pieles de museo y 37 individuos capturados vivos. Los alimoches canarios son significativamente mayores que los del oeste de Europa y norte de África. Además, presentan diferenciación genética: un análisis de la Región Control del ADN mitocondrial mostró que existen haplotipos exclusivos de las Islas Canarias. La población actual de alimoches canarios es de 25–30 parejas restringidas a las islas de Fuerteventura y Lanzarote, y está, por tanto, gravemente amenazada.

[Traducción de los autores]

The genus *Neophron* has only a single species, the Egyptian Vulture (*Neophron percnopterus*), which lives in dry ecosystems of the Palearctic, Ethiopic, and Indo-Malayan biogeographic regions. Two subspecies have been recognized: *N. p. percnopterus* oc-

curring in most of the range of the species: Europe, Africa, Middle East, central Asia, and northwest India, and *N. p. ginginianus* in most of the Indian subcontinent (Brown and Amadon 1968, del Hoyo et al. 1994). Following Brown and Amadon (1968) the latter is slightly smaller, having yellow as opposed to dark-brown bill and comparatively weaker feet and claws.

¹ E-mail address: donazar@ebd.csic.es

The Canary Islands are an archipelago of volcanic origin formed in the past 20 million years close to the western African coast (100 km for Fuerteventura, the nearest island). The islands have a subtropical climate; fauna and flora are related to other Macaronesian archipelagos (Madeira, Azores) and to the Mediterranean region. Twenty-seven percent of the vascular plants and 50% of the invertebrates are endemic (Juan et al. 2000). In addition, seven avian species are considered to be endemic of the archipelago (Blanco and González 1992). Endemic subspecies have already been described for three birds of prey living in the islands: Common Buzzard (*Buteo buteo insularum*, Focke 1903), Eurasian Sparrowhawk (*Accipiter nisus granti*, Sharpe 1890), and Eurasian Kestrel (*Falco tinnunculus canariensis*, in the West islands, Koenig 1890; and *F. t. dacotiae* in the East islands, Hartert 1913). Three other raptor species exist in the archipelago without known distinct subspecific status: Egyptian Vulture, Osprey (*Pandion haliaetus*), and Barbary Falcon (*Falco pelegrinoides*) (del Hoyo et al. 1994).

In Macaronesia (Palearctic subregion including the Atlantic Islands), the Egyptian Vulture inhabits the Canary and Cape Verde archipelagos (Bannerman 1963, Bannerman and Bannerman 1965, 1968). In the Canary Islands this bird was common historically; the species formerly occurred in the islands of La Gomera, Tenerife, Gran Canaria, Fuerteventura and Lanzarote (Martín 1987). At present, the Egyptian Vulture persists only in the two easternmost islands (Fuerteventura and Lanzarote) with a total population estimated at 25–30 pairs in the year 2000 (pers. observ.).

We have observed strong differences in the morphology (see below) of this population in relation to that of Western Europe and North Africa. In addition, analyses of the mitochondrial DNA control region revealed that haplotypes exist exclusive to the Canary Islands. This result suggests that the population has been isolated from others for a very long time. Consequently, we propose the recognition of this population at the subspecific level. In this paper, we describe the Canarian Egyptian Vultures as *Neophron percnopterus majorensis* subsp. nov.

DESCRIPTION

Holotype. This specimen is an immature (second plumage) male collected on 22 October 1913 in Tostón (northwestern coast of Fuerteventura) by D. Bannerman. It is located in the British Museum

of Natural History (BMNH) collection (Tring Catalogue No. 199).

Geographical Distribution. The subspecies is currently endemic to the islands of Fuerteventura and Lanzarote (eastern Canary Islands). It almost certainly occurred in the remaining islands of the archipelago until extirpated in the 20th century. There are three specimens in the British Museum of Natural History (Tring) which were collected at Gran Canaria (BMNH No. 121) and Tenerife (BMNH No. 231 and BMNH No. 232, respectively) at the beginning of the 20th century.

Description. Plumage patterns of color of *Neophron percnopterus majorensis* resembles the nominate subspecies *N. p. percnopterus* (Brown and Amadon 1968, Cramp and Simmons 1980). Adult individuals of the Canarian subspecies typically show white plumage impregnated by rufous coloration, especially in the crown, nape, median wing coverts, breast, and tail. This coloration is variable among individuals and seems to be acquired from iron oxides derived from the local soils, which are rich in iron compounds; evidently, this is an ecological attribute associated with this population and not a taxonomic characteristic. Canarian Egyptian Vultures are sedentary and thus differ behaviorally from Western European populations, which are long-distance migrants (Cramp and Simmons 1980).

Measurements. We captured and measured 37 wild individuals in 1999–2000 (all birds released after capture), and compared these data from individuals from continental Spain (Table 1). Measurements (mm) of the holotype (BMNH-Tring 199) are: flattened wing chord 516.3 mm; tarsus 88.2 mm; tail 240.6 mm; bill length with cere 63.5 mm; bill length to the distal edge of cere 31.8 mm.

Morphological Comparisons. *N. p. majorensis* differs from the nominate subspecies on the basis of larger body measurements. Comparisons with live Iberian individuals (Table 1) revealed significant differences for every trait when the effects of age and sex were controlled. Differences were particularly large for body mass, with the island birds being 18% heavier than Iberian vultures. Tail feathers and wing chord were about 4–8% longer in Canarian vultures. Smaller (ca. 2%), but still significant differences were detected in the length of the tarsus, primary-feather, bill, and bill with cere. Gigantism is well known to occur on islands (Petren and Case 1997, Grant 1998), which has been

Table 1. Biometry of live-trapped Canarian vs. European (Iberian) Egyptian Vultures. For each measurement (see methods) mean, range, standard deviation (SD), and sample size (*N*) are given; % = percent of increase in measurements of Canarian vs. Iberian individuals. Statistical comparisons were performed through three-way Analysis of Variance including effects of age (preadult, adult), sex, and locality. Significance of each factor is shown (*P*).

	CANARY ISLANDS					IBERIAN PENINSULA					OTHER EFFECTS (<i>P</i>)	
	MEAN	RANGE	SD	<i>N</i>	MEAN	RANGE	SD	<i>N</i>	%	LOCALITY (<i>P</i>)		
Mass (g)	2413.8	1900–2850	292.5	34	1963.2	1550–2300	152.8	79	18.4	<0.0001	Age:	0.0167
Tarsus (mm)	85.9	73.5–93.0	3.6	37	83.9	76.9–98.5	3.8	81	2.3	0.0001	—	—
Wing chord (mm)	519.7	485–554	20.6	36	499.3	470–535	12.4	73	3.9	<0.0001	Age:	0.0041
Primary (mm)	385.0	346–410	15.9	32	378.2	342–412	13.8	64	1.7	0.0003	Age:	0.0015
Tail (mm)	264.8	240–285	32.0	32	242.7	212–274	13.8	43	8.4	<0.0001	Sex:	0.0055
Bill length (mm)	32.4	29.1–36.5	1.5	35	31.8	29.4–34.5	1.2	69	1.9	0.0153	Sex:	0.0003
Bill cere (mm)	62.8	57.1–68.5	3.0	35	61.7	55.0–70.3	2.9	70	2.5	0.0057	Sex:	<0.0001

attributed to the absence of dominant species (Thaler 1973).

We lack measurements of birds from neighboring "Sahara," where the small resident population seems to have been extirpated (see below). We have examined one live bird from the former Spanish Sahara (now Morocco), captured in 1975, which is currently at the Zoo of Jerez (Spain). This bird's measurements (mm) were: wing chord = 505, tail = 256, tarsus = 75.9, primary = 376, bill length = 31.1, bill cere = 59.4, and mass = 1820 g. These measurements are similar to those of continental birds from the Iberian Peninsula (Table 1).

Measurements from existing museum specimens are not reliable for the description of the Canarian subspecies as there is only a single skin from Fuerteventura and the taxonomic status of the extirpated Egyptian Vultures from other Canary Islands is unknown. In addition, problems relative to the condition of skins, small sample size, and the existence of variability linked to age and sex precluded statistical analyses. Nonetheless, we took measures of flattened wing chord (the measure that can be taken with least error in our experience) from specimens deposited at the BMNH (Tring) (Table 2). The four Canarian Egyptian Vulture skins showed the highest values for wing-chord for the entire range. Their values were well above those of individuals from neighboring populations in the western Mediterranean, continental Africa, and Cape Verde Islands. This suggests that birds from the Canary Islands constituted a single subspecies, which is today restricted to Fuerteventura and Lanzarote. There are no additional skins deposited in other museums, which precludes further comparisons. It seems interesting that Cape Verde Egyptian Vultures are smaller than Canarian birds. Hazevoet (1995) reported that these birds are similar in plumage to individuals from African populations; he considered them as belonging to the nominal subspecies.

ETIMOLOGY

Scientific Name. The name of the proposed new subspecies is derived from "Majorata," the ancient name of Fuerteventura Island. It was so called by the Spanish conquerors, since the main native guanche tribe of the island was known as the "Majos." At present, the inhabitants of the island are still called "majoreros."

English Name. According to the species geo-

Table 2. Flattened wing chord measurements (mm) of Egyptian Vulture (*Neophron percnopterus*) skins kept in the British Museum of Natural History (Tring).

REGION	SUBSPECIES	MEDIAN	RANGE	N
Canary Islands	<i>N. p. majorensis</i>	505.7	490.0–516.3	4
Cape Verde Islands	<i>N. p. percnopterus</i>	489.6	456.0–515.6	6
Western Mediterranean ^a	<i>N. p. percnopterus</i>	490.0	472.0–510.0	14
East Africa ^b	<i>N. p. percnopterus</i>	480.4	450.0–518.0	13
Middle East ^c	<i>N. p. percnopterus</i>	501.3	485.5–505.0	4
South Arabia ^d	<i>N. p. percnopterus</i>	475.7	351.1–491.3	4
Indian subcontinent	<i>N. p. percnopterus</i>	493.5	471.0–510.0	14
Indian subcontinent	<i>N. p. ginginianus</i>	460.6	441.5–495.3	23

^a Spain, France, Algeria, Morocco.

^b Abyssinia, Somalia, Kenya.

^c Egypt, Palestine, Turkey.

^d Oman, Socotra, Arabia.

graphical distribution of this subspecies we propose the name *Canarian Egyptian Vulture*.

GENETIC DIFFERENTIATION

Methods. We used sequence data of the control region of mitochondrial DNA from 11 Egyptian Vultures of different provinces (two from Fuerteventura, two from the Balearics, four from continental Spain, one from western Sahara [Morocco] and two from India [*N. p. ginginianus*] (Table 3). Analyses of mtDNA have been particularly common for studies of subspecies and closely related species because of the relatively rapid rate of evolution and ease of analysis relative to nuclear (chromosomal) DNA (Wilson et al. 1985, Avise et al. 1987).

Total DNA was extracted from blood samples following Gemmell and Akiyama (1996) with some modifications. Preliminary work in our laboratory indicated that the order of genes in the mitochondrial molecule of Egyptian vultures is consistent with the new avian gene order recently described by Mindell et al. (1998). We thus targeted for amplification by PCR a potentially hypervariable fragment located between the conserved sequence block called Fbox and the flanking Thr-tRNA (for primer sequences and PCR conditions please contact authors). Sequencing reactions were run in an ABI-377 automatic sequencing system (Applied Biosystems) in an external laboratory. Sequences were manually edited and aligned. Genetic distance calculations and phylogenetic analyses were performed with the program PAUP-Version 4.0b4a (Swofford 2000). Previous analysis of families of captive birds showed a strict maternal in-

heritance of the analyzed sequences, indicating that these were of mitochondrial origin and not from nuclear insertions.

Results. A fragment of 459 base pairs of control region was used in the sequence analyses. Sequences for the 11 individuals were all different, i.e., each individual presented a unique haplotype (Fig. 1). A total of 53 polymorphic sites were observed (11.5% of the 459 bp sequenced). Absolute numbers of pair-wise differences ranged from 2 (0.44%) between samples from Canary Island and 35 (7.63%) between Iberian and Indian samples. Net mean Kimura's 2 parameter distances between Indian and other groups ranged from 0.066 to 0.077, while the range of distances between non-Indian groups was 0.005 (Iberian and Balearic) to 0.020 (Canarian and Saharian). Consequently, phylogenetic analyses of these sequences with using different algorithms approaches (maximum parsimony, minimum evolution, and maximum likelihood) consistently grouped the two Indian sequences in a clade widely separated from the rest of Iberian, Balearic, Canarian or Saharian sequences, with bootstrap values close to 100% (Fig. 1). The two Canarian sequences also consistently grouped together as a subclade within non-Indian sequences, with bootstrap values up to 92%. A clade of Balearic sequences was obtained with some algorithms, with values of up to not higher than 62%. Finally, the only Saharian sequence included was more closely related to Iberian or Balearic than to Canarian sequences. The sequences are deposited at the EMBL databank under accession numbers AJ305147 to AJ305150 (*N. p. majorensis*), AJ305151

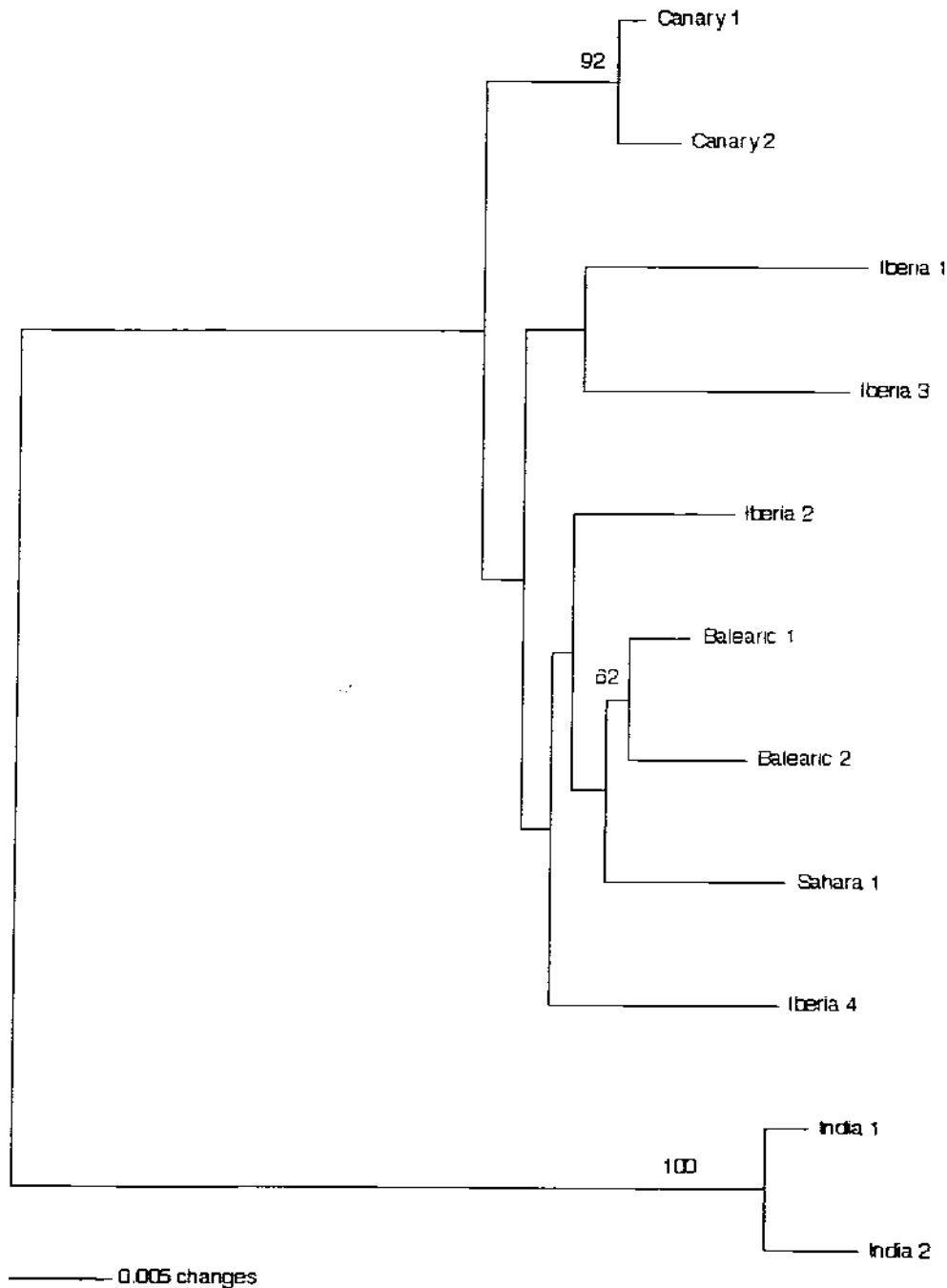


Figure 1. Phylogenetic relationships among the Egyptian Vulture Control Region sequences identified in this study. Minimum evolution tree, constructed with the program PAUP using Kimura's 2 parameter distances and the neighbor-joining algorithm followed by a branch-swapping procedure. Values above branches represent support from 100 bootstrap replications (only values above 50% are shown).

to AJ305162 (*N. p. percnopterus*), and AJ305163 to AJ305166 (*N. p. ginglyaninus*).

DIAGNOSIS

The new subspecies can be distinguished from individuals belonging to the nominal subspecies

percnopterus on the basis of its larger size (Table 1, 2); the difference is strong with respect to Iberian Egyptian Vultures, which constitute the main western Palearctic population. These latter birds migrate along the African coast (Cramp and Simmons 1980) and, thus, have some chance of

straggling to the Canary Islands. Morphological differences between *majorensis* and *percnopterus* of western European and African populations (including Cape Verde Islands) are as marked as those existing between the subspecies *ginginianus* and *percnopterus* in central Asia (Table 2).

A wider population genetic screening of the species will be needed to assess levels of genetic variability and estimations of gene flow among subpopulations. Meanwhile, the analysis of Control Region sequences in a limited number of Egyptian Vultures shows limited low genetic diversity within the Canary Islands populations versus the larger Iberian populations. On the other hand, the Canarian population shows unique mitochondrial haplotypes that group monophyletically within *N. p. percnopterus* non-Indian sequences. Both results are consistent with colonization and further expansion in the islands by individuals from the mainland and suggest limited gene flow between Canarian and other populations. A differentiated evolution of the Canarian population of Egyptian Vultures would have been favored by the isolation resulting from the 100 km-wide sea corridor existing between the eastern coast of Fuerteventura and that of the African continent. Possibility of individual interchange with other breeding populations appears to be low. The current population in the western Sahara seems to be virtually extinct (J. Donazar unpubl. data), and therefore the main possibility of genetic exchange would seem to come from Iberian birds migrating along the African coast and straggling to the islands. We cannot rule out the possibility that some Iberian individuals reach the island and eventually interbreed with local individuals. However, there is strong evidence that Fuerteventura's Egyptian Vultures constitute an ecologically-isolated population with well-differentiated morphological and genetic characteristics.

Summarizing, we propose that the naming of this new subspecies is justified. Description of new subspecies, and even of avian species, has been recently done on the basis of only biometric approaches and taking in account only a few specimens (e.g., Smith et al. 1991, Forero and Tella 1997, Safford et al. 1995, Preleuthner and Gamauf 1998, Yosef et al. 2000). In some cases the distance between these new taxa and those closely related were lower than that found in our study. We cannot discard that further genetic analyses might permit the discovery of additional haplotypes which may

show them closer to continental birds. This would not invalidate, however, the existence of a differentiated Canarian lineage as it is shown in this paper.

CONSERVATION

As was stated above, the entire Canarian Egyptian Vulture population is restricted to Fuerteventura and Lanzarote, where no more than 30 territories remain occupied. Total population has been estimated at around 130 birds (pers. observ.). Breeding success has been extremely low in recent years (ca. 0.5 fledglings/pair in 1998–2000). Current threats to this population include mortality from power lines due to collision and electrocution (12 cases during the study period; see also Lorenzo 1995), poisoning (4 cases), and lead intoxication by ingestion of lead bullets (pers. observ.). Theft of eggs and young at the nest, and other human activities may account for some cases of nest desertion during the breeding period (Palacios 2000). Conservation measures should be directed preferentially to prevent casualties related to power lines, lead intoxication, and illegal poisoning. Reinforcement with individuals from continental areas is not recommended, on the basis of the genetic differences showed by the Canarian birds with respect to those of neighboring populations.

ACKNOWLEDGMENTS

The Consejería de Medio Ambiente del Cabildo Insular de Fuerteventura and the Project REN 2000–1556 GLO funded this research. Our special thanks to Manuel Miranda and Carlos Alba who stimulated the project and provided logistic support. Gorgonio Díaz and María Asunción Delgado (Consejería de Política Ambiental, Gobierno de Canarias) gave scientific banding permits. We thank very much Manuel de la Riva, José A. Sánchez Zapata, Gema García, Reyes López-Alonso, Manuel Vázquez, Yohama Enríquez, Ana Calero, Gema Mosquera, Nemesio Hernández, Dámaso Santana, Francisco García, José Hernández, and Eduardo Castilla for assistance throughout the research. DNA sequencing as well as the sexing of live-trapped birds was done in the Laboratory of Molecular Ecology (Estación Biológica de Doñana). Drs. Mark Adams and Robert Prys-Jones from the British Museum of Natural History (Tring) and Manuel Barcell (Zoo of Jerez de la Frontera) permitted access to specimens in their care. Dean Amadon, José L. Tella, and Clayton M. White provided valuable criticism of the manuscript.

LITERATURE CITED

- AVISE, J.C., J. ARNOLD, R.M. BALL, E. BIRMINGHAM, T. LAMB, J.E. NEIGEL, C.A. REEB, AND N.C. SAUNDERS. 1987. Intraspecific phylogeography: the mitochondrial DNA

- bridge between population genetics and systematics. *Ann. Rev. Ecol. Syst.* 18:489–522.
- BANNERMAN, D.A. 1963. Birds of the Atlantic Islands. Vol. I. A history of the birds of the Canary Islands and of the Salvages. Oliver & Boyd, Edinburgh & London, U.K.
- AND W.M. BANNERMAN. 1965. Birds of the Atlantic Islands. Vol. II. A history of the birds of Madeira, the Desertas, and the Porto Santo Islands. Oliver & Boyd, Edinburgh & London, U.K.
- AND ———. 1968. Birds of the Atlantic Islands. Vol. IV. A history of the birds of the Cape Verde Islands. Oliver & Boyd, Edinburgh & London, U.K.
- BLANCO, J.C. AND J.L. GONZÁLEZ. 1992. Libro rojo de los vertebrados de España. Ministerio de Agricultura, Pesca y Alimentación, Madrid, Spain.
- BROWN, L.H. AND D. AMADON. 1968. Eagles, hawks and falcons of the world. Country Life Books, London, U.K.
- CRAMP, S. AND K.E.L. SIMMONS. 1980. Handbook of the birds of the western Palearctic. Vol. II. Oxford Univ. Press, Oxford, U.K.
- DEL HOYO, J., A. ELLIOTT, AND J. SARGATAL. 1994. Handbook of the birds of the world. Vol. 2. Lynx Editions, Barcelona, Spain.
- FORERO, M.G. AND J.L. TELLÁ. 1997. Sexual dimorphism, plumage variability and species determination in nightjars: the need for further examination of the Nechisar Nightjar *Caprimulgus solala*. *Ibis* 139:407–409.
- GEMMELL, N.J. AND S. AKIYAMA. 1996. An efficient method for the extraction of DNA from vertebrate tissue. *Trends Genet.* 12:338–339.
- GRANT, P.R. (ED.). 1998. Evolution on islands. Oxford Univ. Press, New York, NY U.S.A.
- HAZEVOET, C.J. 1995. The birds of the Cape Verde Island. British Ornithologists' Union, Dorset, U.K.
- JUAN, C., B.C. EMERSON, P. OROMÍ, AND G.M. HEWITT. 2000. Colonization and diversification: towards a phylogeographic synthesis for the Canary Islands. *Trends Ecol. Evolution* 15:104–109.
- LORENZO, J.A. 1995. Estudio preliminar sobre la mortalidad de aves por tendidos eléctricos en la isla de Fuerteventura (Islas Canarias). *Ecología* 9:403–407.
- MARTÍN, A. 1987. Atlas de las aves nidificantes en la isla de Tenerife. Instituto de Estudios Canarios. Monografía XXXII. Tenerife.
- MINDÉLL, D.P., M.D. SORENSON, AND D.E. DIMICHEFF. 1998. Multiple independent origins of mitochondrial gene order in birds. *Proc. Natl. Acad. Sci. U.S.A.* 95:10693–10697.
- PALACIOS, C.J. 2000. Decline of the Egyptian Vulture (*Neophron percnopterus*) in the Canary Islands. *J. Raptor Res.* 34:61.
- PETREN, K. AND T.J. CASE. 1997. A phylogenetic analysis of body size evolution and biogeography in chuckwallas (*Sauromalus*) and other iguanines. *Evolution* 51:206–219.
- PRELEUTHNER, M. AND A. GAMAUF. 1998. A possible new subspecies of the Philippine Hawk-Eagle (*Spizaetus philippensis*) and its future prospects. *J. Raptor Res.* 32:126–135.
- SAFFORD, R.J., J.S. ASH, J.W. DUCKWORTH, M.G. TELFER, AND C. ZEWDIE. 1995. A new species of nightjar from Ethiopia. *Ibis* 137:301–307.
- SMITH, E.F.G., P. ARCTANDER, J. EJELDSA, AND O.G. AMIR. 1991. A new species of shrike (Laniidae: *Laniarius*) from Somalia, verified by DNA sequence data from the only known individual. *Ibis* 133:227–235.
- Swofford, D.L. 2000. Phylogenetic analysis using parsimony (PAUP). Version 4. Sinauer Associates, Sunderland, MA U.S.A.
- THALER, L. 1973. Nanisme et gigantisme insulaires. *La Recherche* 4:741–750.
- WILSON, A.C., R.L. CANN, S.M. CARR, M. GEORGE, U.B. GYLLENLEU, K.M. HELM-BYCHOWSKI, R.G. HIGUCHI, S.R. PALUMBI, E.M. PRAGER, R.D. SAGE, AND M. STONEKING. 1985. Mitochondrial DNA and two perspectives on evolutionary genetics. *Biol. J. Linn. Soc.* 26:375–400.
- YOSEF, R., G. VERDOORN, A. HELBIG, AND I. SEIBOLD. 2000. A new subspecies of the Booted Eagle from southern Africa, inferred from biometrics and mitochondrial DNA. Pages 43–46 in R.D. Chancellor and B.-U. Meyburg [Eds.], Raptors at risk. WWGBP, Hancock House, U.K.

Received 24 January 2001; accepted 23 September 2001