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Authors: Freile, Juan F., Greeney, Harold F., and Bonaccorso, Elisa

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REVIEW

Current Neotropical ornithology: Research progress 1996–2011

Juan F. Freile,[1]* Harold F. Greeney,[2] and Elisa Bonaccorso[3]

[1] Fundación Numashir, Quito, Ecuador
[2] Yanayacu Research Station and Center for Creative Studies, Quito, Ecuador
[3] Centro de Investigación en Biodiversidad y Cambio Climático, Universidad Tecnológica Indoamérica, Machala y Sabanilla, Quito, Ecuador
* Corresponding author: jfreileo@yahoo.com

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ABSTRACT

Two hundred years of Neotropical ornithology have resulted in comprehensive monographic guides and thousands of scientific papers. Nonetheless, information is not evenly distributed across the region. Replicating previous assessments of Neotropical ornithology, we performed searches at *Zoological Record* of publications on birds of Neotropical countries (1996–2011) using number of publications as an indication of current knowledge. We calculated the ratio of papers per species richness for each country and compared number of publications in different subjects during the 1979–1995 and 1996–2011 periods. Further, we quantified publications in two Neotropical journals: *Cotinga* and *Ornitología Neotropical*. As in previous assessments, Mexico, Argentina, and Brazil were the best-represented countries, accounting for 54% of all references. Most Central American and Caribbean countries, as well as Guianan states, Paraguay, and Uruguay, remain poorly represented. All top-12 better-documented countries experienced significant increases in publication numbers. However, only the four better-documented countries have a ratio per species higher than 1.00. Numbers of papers published in *Cotinga* were led by Brazil and Ecuador, whereas Brazil and Argentina are the better-represented countries in *Ornitología Neotropical*. Poorly documented countries in these journals from the entire Neotropics are similar to those in *Zoological Record*. Neotropical residents authored 74% of papers published in *Ornitología Neotropical*. Ornithologists are currently contributing an unprecedented wealth of data on systematics and taxonomy, biogeography, evolution, natural history, and conservation of Neotropical birds. Current, unprecedented technological advancements (Internet, powerful bioinformatics, open-source algorithms, DNA sequencing) provide promising perspectives for the further development of Neotropical ornithology.

Keywords: Neotropical countries, current knowledge state, ornithology, research priorities, Neotropics

Ornitología Neotropical actual: Avances en la investigación entre 1996–2011

RESUMEN

Doscientos años de ornitología Neotropical han resultado en numerosas guías de campo, monografías y miles de artículos científicos. Sin embargo, la información publicada no está repartida equitativamente en la región. Replicando análisis previos, realizamos búsquedas en *Zoological Record* de las publicaciones sobre aves de cada país Neotropical para el periodo 1996–2011, usando el número de publicaciones como indicador del estado actual del conocimiento. Calculamos la tasa de publicaciones por especie en cada país y comparamos el número de publicaciones en diferentes temas entre los periodos 1979–1995 *versus* 1996–2011. Además, cuantificamos el número de publicaciones en dos revistas Neotropicales: *Cotinga* y *Ornitología Neotropical*. Como en los análisis previos, México, Argentina y Brasil fueron los países mejor representados, contabilizando el 54% de las referencias. La mayoría de países centroamericanos y caribeños, al igual que los del escudo guyanés, Paraguay, y Uruguay siguen pobremente representados. Los 12 países mejor documentados (Brasil, Argentina, México, Chile, Costa Rica, Perú, Colombia, Ecuador, Venezuela, Panamá, Bolivia, y Cuba) experimentaron un incremento significativo en publicaciones. Sin embargo, solo los primeros cuatro países tuvieron una tasa por especie mayor a 1,00. Brasil y Ecuador predominaron en número de publicaciones en *Cotinga*, mientras Brasil y Argentina lo hicieron en *Ornitología Neotropical*. Los países menos estudiados en todo el Neotrópico fueron los mismos que en *Zoological Record*. Un 74% de artículos publicados en *Ornitología Neotropical* tuvieron autores residentes en la región. Los ornitólogos estan generando una cantidad de datos sin precedentes sobre sistemática, taxonomía, distribución, evolución, migración, fisiología, ecología, dieta, reproducción y conservación. Actualmente, la ornitología Neotropical cuenta con herramientas tecnológicas sin precedentes (Internet, bioinformática, algoritmos abiertos, secuenciación de ADN) que ofrecen perspectivas promisorias para su futuro desarrollo.

Palabras clave: países Neotropicales, estado actual del conocimiento, ornitología, investigación, neotrópico

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INTRODUCTION

Beginning with the explorations of Charles Darwin, Richard Spruce, Alexander von Humboldt, Aimé Bompland, and their contemporaries, ornithologists have explored the New World tropics for more than 200 years. In that time, Neotropical ornithology has blossomed (Walters 2003, Stiles 2008), resulting in myriad publications from complete and comprehensive country field guides, regional and taxonomic monographs, extensive compilation volumes and audio publications, to hundreds of thousands of scientific papers (Vuilleumier 2003; but see Vuilleumier 2004 for a critique of the scientific development of Neotropical ornithology).

Little more than a century ago, Neotropical ornithology was predominantly focused on descriptions of new taxa and expedition reports. Natural history studies became more numerous in the mid-twentieth century, particularly in some areas (e.g., Galapagos, Barro Colorado Island, Costa Rica; Lack 1945, Skutch 1950), while in recent decades taxonomic studies made a resurgence following advances in molecular phylogenetics (Cadena et al. 2007, Parra et al. 2009; see Vuilleumier 2003). This trend continues, and many studies currently combine molecular techniques with morphological and vocal analyses, in an attempt to unravel the phylogenetic history of clades across the taxonomic hierarchy (Isler et al. 2008, Cadena and Cuervo 2010), including studies revolutionizing our understanding of relationships within the entire class Aves (Hackett et al. 2008).

During the most recent decades, development of Neotropical ornithology has been greatly aided by the publication of two international journals devoted entirely to the region's avifauna (*Ornitología Neotropical* and *Cotinga*) and further advanced by the publication of several regional journals and bulletins (*Ornitología Colombiana*, *Boletín Sociedad Antioqueña de Ornitología*, *Huitzil*, *El Pitirre*—now *Journal of Caribbean Ornithology*, and *Ararajuba*—now *Revista Brasileira de Ornitologia*). These fairly new publications have complemented the work of older ones (*Hornero*, *Boletín Chileno de Ornitología*), as well as that of international journals with a broader geographic focus (*Journal of Field Ornithology*, *Wilson Journal of Ornithology*, *Bulletin of the British Ornithologists' Club*, *The Condor*, among others), further improving on the advancement and dissemination of ornithological studies in the region.

Despite the accumulated wealth of published information from the Neotropics, new species are still regularly described (Carantón-Ayala and Certuche-Cubillos 2010, Whitney et al. 2010, O'Neill et al. 2011), and the systematics of all South American birds are under continued, exhaustive revision (Remsen et al. 2012). Moreover, information generated and published is not evenly distributed across the region. As noted by Winker (1998), some countries continue to accumulate a fair number of publications dedicated to their avifauna, whereas others remain poorly documented.

In 1987, P. C. James surveyed trends and deficiencies of Neotropical ornithology from a geopolitical perspective. Consulting *Zoological Record*, James found that 42% of papers published from 1972 to 1983 originated from only three countries (Mexico, Brazil, and Argentina), nine countries contributed 51%, and the remaining nine continental countries contributed only 9% (James did not include Caribbean countries in his assessment) (see table 2 in James 1987). A decade later, D. Winker (1998) reassessed the state of Neotropical ornithology by consulting *Zoological Record* from 1979 to 1995. In this study, the same three leading countries produced 41% of all publications, whereas 18 countries contributed 52%, and another 18 countries contributed 7%. Further, Winker found that no country, except for the United States, had a ratio of publications per species number higher than 1.0; in other words, no Neotropical country had at least one reference per species (see table 2 in Winker 1998).

Although these trends may have continued during the 15 years since Winker's study, the number of publications, particularly those by Latin American residents, has increased significantly (Navarro-Sigüenza et al. 2008). However, Levy (2008) reported that Caribbean ornithology is still dominated by nonresidents, with several Caribbean countries nearly or completely lacking resident ornithologists. This situation merits a new assessment of the current state of knowledge on Neotropical birds at a regional (country) level, which is provided in this paper. In addition, to offer a general assessment of the advance of different areas of knowledge across the region, we offer a summary of numbers of publications per subject during the periods 1979–1995 and 1996–2011.

METHODS

Using methods established by previous authors, we performed searches in *Zoological Record* (1996–2011) using two search words: birds and country name. After performing all searches, a careful visual revision, reference by reference, was performed to avoid searching pitfalls (e.g., *Pluvialis dominica* for Dominica; Brazil as the last name of Mark A. Brazil, a non-Neotropical ornithologist; New Mexico instead of Mexico). All filtered references for every country found in *Zoological Record* are available at http://avesamericanas.lifedesks.org/node/2389.

We included all 33 Neotropical countries as currently recognized by the Organization of American States (www.oas.org) and the United Nations (www.un.org), as well as 9 overseas territories or departments (from the United States, France, the United Kingdom, and The Nether-

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TABLE 1. Number of publications as an index of current ornithological knowledge in Neotropical countries. Data obtained in two-criteria searches in *Zoological Record*. Species numbers from Winker (1998) for comparison purposes.

Country	Refs.	spp.	Ratio	Country	Refs.	spp.	Ratio
Guadaloupe	0	134	0.00	Uruguay	92	365	0.25
St. Kitts & Nevis	3	99	0.03	Bahamas	97	222	0.44
Antigua & Barbuda	3	140	0.02	Dominican Republic	98	254	0.39
Aruba	8	-	-	Guatemala	106	669	0.16
Martinique	11	131	0.08	Paraguay	121	600	0.20
Haiti	15	220	0.07	Trinidad & Tobago	126	433	0.29
Cayman Islands	15	-	-	Jamaica	150	262	0.57
St. Vincent & Grenadines	16	129	0.12	Puerto Rico	202	239	0.85
St. Lucia	17	169	0.10	Cuba	280	342	0.82
Grenada	20	150	0.13	Bolivia	304	1,274	0.24
Netherlands Antilles	24	-	-	Panama	306	929	0.33
Suriname	26	673	0.04	Venezuela	382	1,296	0.29
Dominica	26	163	0.16	Ecuador	559	1,559	0.36
Virgin Islands	30	199	0.15	Colombia	580	1,695	0.34
El Salvador	39	420	0.09	Peru	582	1,678	0.35
Guiana	39	737	0.05	Costa Rica	602	850	0.71
Honduras	40	684	0.06	Chile	768	448	1.71
Barbados	59	172	0.34	Mexico	1,755	1,026	1.71
Nicaragua	60	750	0.08	Argentina	1,811	976	1.86
French Guiana	77	707	0.11	Brazil	3,250	1,635	1.99
Belize	80	533	0.15				
				TOTAL	**12,779**	**3,261**	**3.92**

lands), that were not included by Winker (1998), totaling 41 countries / territories (Table 1). We incorporated 4 territories not included by Winker (1998). In addition to the journals covered in Winker's review, we also analyzed *Cotinga*, first published in 1994 and also covered by *Zoological Record* (Figure 1). Likewise, *Ornitología Neotropical* (first published in 1990) was analyzed separately as *Zoological Record* did not cover it until 2002 (Figure 2). Also, we accounted separately for papers authored by authors residing in Neotropical countries in both journals, according to authors' affiliation institutions or addresses (Table 2). We used number of publications as an indication of current knowledge, and calculated the ratio of papers per species richness for each country. To facilitate direct comparisons, we used the same species numbers as Winker (Table 1).

We performed statistical comparisons to determine whether the number of articles published in the period analyzed by Winker (1979–1995) was significantly different from that analyzed herein (1996–2011). To compare both periods, we applied a chi-square goodness-of-fit test (or one-way chi-square test) with one degree of freedom, to data gathered from the "top-12" countries. Since both datasets include different time spans (17 vs. 15 years), the test was calculated by standardizing the expected number of publications per year. To assess the statistical significance of these 12 comparisons, each comparison was evaluated by adjusting the significance level (α) after a Bonferrroni correction ($\alpha = 0.05/12$).

To explore the relative advance of different areas of knowledge in ornithological research across the region, we performed statistical comparisons to determine whether the number of articles per subject, published in the period 1979–1995, was significantly different from that of the period 1996–2011. This analysis included the "top-12" Neotropical countries, as well as 10 subjects: taxonomy, systematics, biogeography, evolution, ecology, diet, breeding, migration, physiology, and conservation. Although some of these subjects are broadly overlapping (e.g., ecology, diet, breeding, migration), we preferred having a redundancy of publications among subjects, rather than missing some publications that, for example, may focus on subject "breeding" but may not be identified by topic "ecology."

To delimit searches to Neotropical countries, as a first topic, we listed all Neotropical countries, separated by Boolean operator "OR" as a first topic (e.g., Mexico* OR Brazil* OR Venezuela*, etc.). This method allowed filtering all publications that mentioned any or more than one of the "top-12" countries. In the same search, we used Boolean operator "AND" with "bird" as a second topic and "subject" (e.g., taxonomy or systematics) as a third topic. To compare both periods, we applied a chi-square goodness-of-fit test with one degree of freedom by standardizing the expected number of publications per year. To assess the statistical significance of these 10 comparisons, each comparison was evaluated by adjusting the significance level (α) after a Bonferrroni correction ($\alpha = 0.05/10$).

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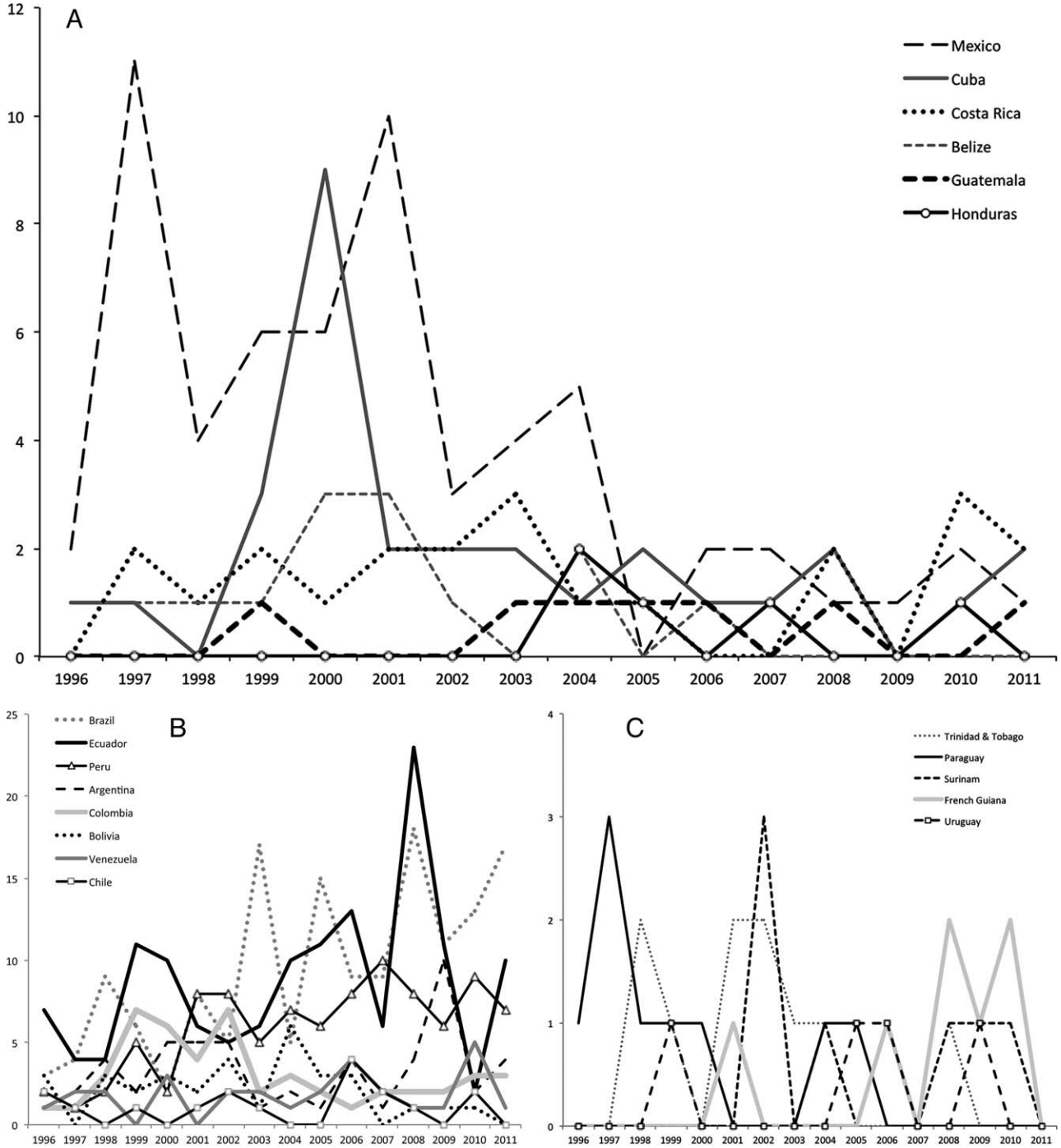


FIGURE 1. Number of publications for all Neotropical countries in *Cotinga* (1996–2011). (**A**) better-documented Mesoamerican and Caribbean countries; countries not shown have few publications or lack publications; (**B**) better-documented South American countries; (**C**) poorly documented South American countries. South American countries and states as covered by the South American Checklist Committee (Remsen et al. 2012).

RESULTS AND DISCUSSION

As in previous assessments (James 1987, Winker 1998), Mexico, Argentina, and Brazil were the best-represented countries in *Zoological Record* (1996–2011), accounting for 54% of all references, but in a new sequence: Brazil, Argentina, Mexico (Table 1). Nine additional countries accounted for 34%, and the remaining 30 countries accounted for the remaining 12%. Most Central American countries (except for Costa Rica and Panama) remain

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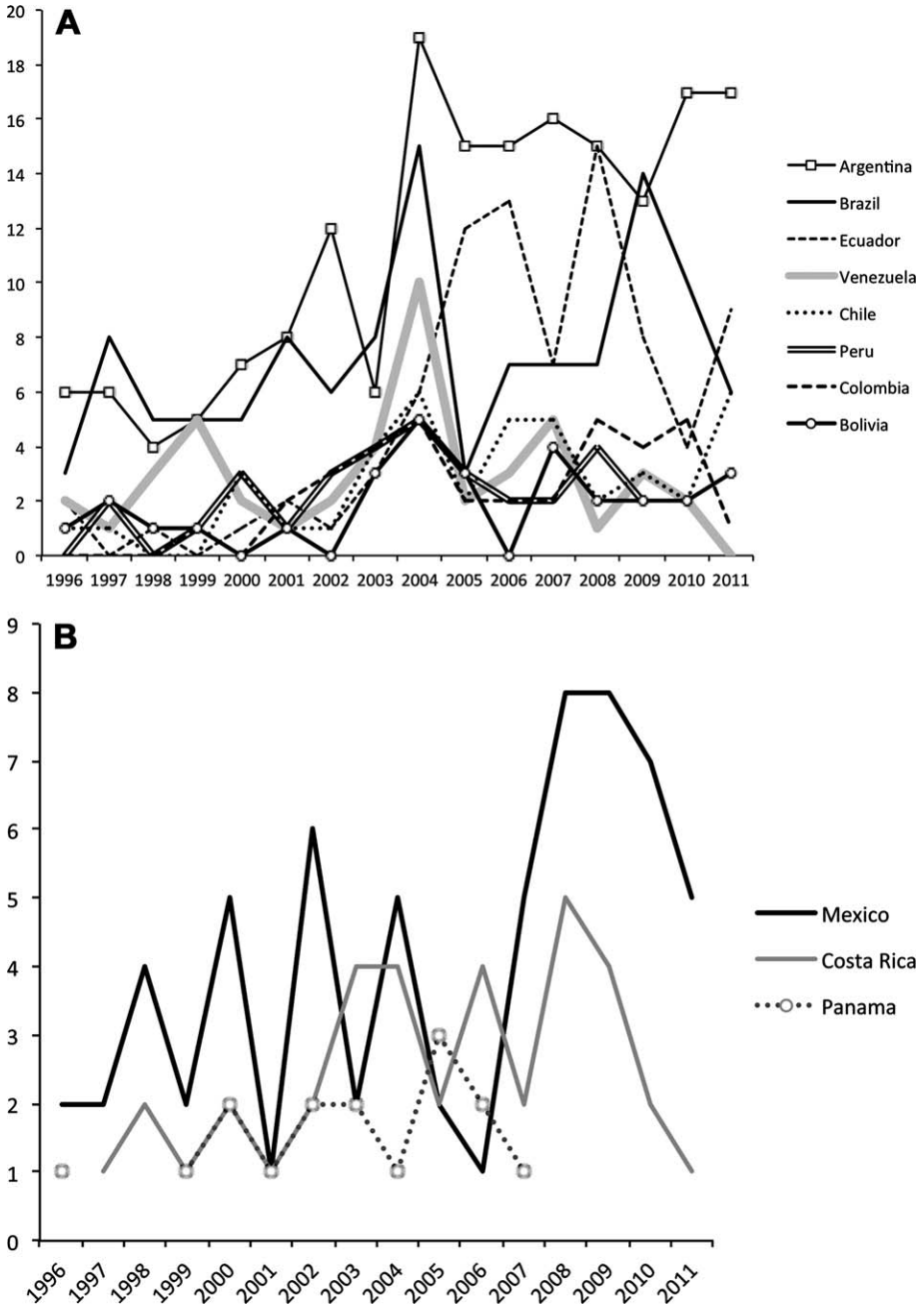


FIGURE 2. Number of publications for all Neotropical countries published in *Ornitología Neotropical* (1996–2011). (**A**) better-documented South American countries. South American countries and states as covered by the South American Checklist Committee (Remsen et al. 2012); (**B**) better-documented Mesoamerican countries; countries not shown have few publications or lack publications.

poorly represented, whereas only Cuba, Puerto Rico, and Jamaica are fairly well-represented in the Caribbean region. Countries from the Guianan shield remain poorly studied, and Paraguay and Uruguay are significantly behind the remaining South American countries.

Although *Zoological Record* is not complete—i.e. it does not cover some journals, magazines, books, or regional/national publications—it provides an accurate picture of current knowledge about Neotropical birds. Preliminary surveys across databases (i.e. *Zoological Record*, *ISI Web of Knowledge*, *Scopus*, *Latindex*, *SciELO*) showed that title coverage of *Zoological Record* was, overall, more complete than other options usually associated to Neotropical or Latin American scientific literature. Only 4 out of 10

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TABLE 2. Number of publications by Latin American resident authors in *Ornitología Neotropical* (1990–2011). Countries without papers authored by Neotropical residents are not included.

Country	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	Total
Grenada																			1				1
Nicaragua																			1				1
Guiana																		1					1
El Salvador																1					1		2
Trinidad & Tobago									1							1							2
Dominican Republic													1			1							2
Panama																	1	1					2
Uruguay													1	1				1			1		4
Belize													1		1		1	1					4
Paraguay	1					1									2				1				5
Guatemala								1		1	2			1								1	6
Cuba		1		2				1	2	1	1	1		2		1	1						13
Puerto Rico		2		1		1					1				3		2	2		1	1		14
Peru								1		1		1			3	1	1		3			3	14
Costa Rica								1	2		2		2	2	2	2	2		1	2	2	1	21
Bolivia		1										1		3	5	2		3	2	1	2	2	22
Colombia		2	1									1	2	3	5	2	2	2	5	4	5	1	35
Chile			1								2	1	1	3	6	2	5	3	2	3	2	5	36
Venezuela					1	3	1		3	3	1	1	2	2	7	2	3	5	1	3	1		39
Mexico		1					1	2	5	1	3	1	6	2	4	2	1	3	6	7	6	5	56
Ecuador		1	1		2		1		1			1	1	2	6	11	11	7	12	6	2	4	69
Brazil	1		3	1	4	1	2	8	5	5	5	8	6	8	13	3	5	8	6	12	10	6	120
Argentina	1	2		3	2	1	5	6	4	5	7	8	12	5	18	15	15	15	15	11	16	17	183
Junior author	1	2	1	1	1	2		4	1	3	5	2	2	4	10	7	8	6	3	4	2		69

journals covered by *Zoological Record* were also found in *ISI Web of Knowledge*, *Scopus*, and *SciELO*. Journals not covered by one or all these databases include regional and non-regional journals known as important repositories of Neotropical ornithological literature (i.e. *Bulletin of the British Ornithologists' Club*, *Journal of Caribbean Ornithology*, *Huitzil*, *Cotinga*).

As previously documented by James (1987) and Winker (1998), publications concerning the avifauna of some Neotropical nations remain deficient. Fifteen of the 20 most poorly represented countries are shared between Winker's assessment and ours. Nineteen of the 41 countries did not show a significant increase, remained equal, or even decreased. It should be noted that the large number of publications concerning Dominica's avifauna documented by Winker might be better explained by the fact that *Zoological Record* did not discriminate Dominica, the country, and *dominica*, the species epithet of several taxa (*Oxyura*, *Pluvialis*, and *Dendroica*). In fact, the unfiltered result of our *Zoological Record* search was 1,271 references from Dominica (179 in Winker), but removing references to taxon names reduced it to 26.

Six countries have experienced notable increases in number of publications (Figure 3): Brazil, Argentina, Mexico, Chile, Ecuador, and Colombia. Nonetheless, the remaining 6 of the "top-12" countries experienced only small increases in publication numbers (Figure 3). The chi-square goodness-of-fit test indicated that for all "top-12" countries, the number of articles published during 1996–2011 was significantly higher than in the period 1979–1995 (all $p < 0.001$; $\alpha = 0.0042$, adjusted after Bonferroni correction).

If the ratio of publications per species is considered, however, even well-represented countries remain understudied; only the four better-represented countries exceed an index of 1.00 (Table 1). Even for these, however, a more careful species-by-species evaluation will undoubtedly reveal many publications for only a few well-studied species, and none for the majority of species. This trend has recently been documented for Ecuador, where about 74% of the avifauna lacked specific publications as of 2004, and the bulk of published material concerned the Galapagos' avifauna, Ecuador's least species-diverse region (Freile et al. 2006). Therefore, research needs and priorities remain on several fronts, notably poorly known countries, little-studied regions within countries, specific subjects, taxonomic groups, and species (Alves et al. 2008). A simple comparison with non-Neotropical countries from the Western Hemisphere indicates that Neotropical ornithology is still far from "maturity" (Vuilleumier 2003). Winker (1998) found that the United States (USA) alone had more than 4,100 publications from 1979 to 1995 and a 5.36 ratio of papers per species. The sum of publication totals for three of the four best-documented countries in our study (Argentina, Mexico, and Chile) barely surpasses this total. These three countries together show a 1.76 publications

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TABLE 3. Associations, congresses, and discussion groups in Neotropical countries, as indicators of the current state of integrative efforts in the region.

Country	Associations	Congresses/meetings	Discussion groups
Argentina	Asociación Ornitológica del Plata	Reunión Argentina de Ornitología (13 since 1985)	Foro Alertaves: http://ar.groups.yahoo.com/group/alertaves Americaves: http://ar.groups.yahoo.com/group/Americaves/
Belize	Belize Audubon Society	–	http://belizeaudubon.org/news/forum/
Bolivia	–	Congreso de Ornitología y Conservación de Aves en Bolivia (8 since 1994)	–
Brazil	Sociedade Brasileira de Ornitologia	Congresso Brasileiro de Ornitologia (16 since 1991)	Lista Brasileira de Ornitologia: http://br.groups.yahoo.com/group/ornitobr Birdwatching: http://br.groups.yahoo.com/group/birdwatchingbr/ Ornitobracademica: http://br.groups.yahoo.com/group/ornitobracademica/ Birds of prey: http://br.groups.yahoo.com/group/avesderapinabr/ Ecoavis: http://br.groups.yahoo.com/group/ECOAVIS/ (mostly for Minas Gerais state)
Chile	Unión de Ornitólogos de Chile	Congreso Chileno de Ornitología (9 since 1991)	Red de Observadores de Aves y Vida Silvestre de Chile: http://ar.groups.yahoo.com/group/obschile/
Colombia	Asociación Colombiana de Ornitología	Encuentro Nacional de Ornitología (22 since 1987)	Red Nacional de Observadores de Aves de Colombia: http://espanol.groups.yahoo.com/group/RNOACOL
	Red Nacional de Observadores de Aves de Colombia	Congreso de Ornitología Colombiana (4 since 2004)	
Costa Rica	Unión de Ornitólogos de Costa Rica	Congreso de Ornitología de Costa Rica (2 since 1993)	http://uniondeornitologos.com/?post_type=forum
Cuba	Asociación Nacional Ornitológica de Cuba	Congreso Nacional Ornitológico de Cuba (1 since 2009)	Society for the Conservation and Study of Caribbean Birds (SCSCB)*: http://groups.yahoo.com/neo/groups/birdscaribbean/
Dominican Republic	Sociedad Ornitológica de la Hispaniola	–	Sociedad Ornitológica de la Hispaniola on Facebook
El Salvador	–	–	Grupo de Trabajo de Conservación de Aves de El Salvador: http://espanol.groups.yahoo.com/group/aves-sv/
Ecuador	–	Reunión Ecuatoriana de Ornitología (3 since 2005)	Grupo Aves_Ecuador: http://espanol.groups.yahoo.com/group/Aves_Ecuador
French Guiana	–	–	http://fr.groups.yahoo.com/group/ornithoguyane
Guatemala	Sociedad Guatemalteca de Ornitología	–	Guatemala Birding Club: http://www.avesdeguatemala.org
Haiti	Société Audubon Haïti	–	–
Mexico	Sociedad para el Estudio y Conservación de las Aves en México	Congreso para el Estudio y Conservación de las Aves en México (11 since 1980)	Sociedad para el Estudio y Conservación de las Aves en México: http://mx.groups.yahoo.com/group/ornitologica_de_mexico/ Mexico-Birding: http://groups.yahoo.com/neo/groups/MexicoBirding/
Nicaragua	Alianza para la Vida Silvestre (ALAS)	–	Grupo Guardabarranco: http://espanol.groups.yahoo.com/group/grupoavesguardabarranco/
Paraguay	–	–	–
Peru	Unión de Ornitólogos del Perú	Congreso Nacional de Ornitología (8 since 1995)	Unión de Ornitólogos del Perú: http://groups.yahoo.com/neo/groups/unoperu/info Birding Peru: http://es.groups.yahoo.com/group/incaspiza http://groups.yahoo.com/neo/groups/birdingperu/info
Puerto Rico	Sociedad Ornitológica Puertorriqueña	n.d.	Society for the Conservation and Study of Caribbean Birds (SCSCB)*: http://groups.yahoo.com/neo/groups/birdscaribbean/

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TABLE 3. Continued.

Country	Associations	Congresses/meetings	Discussion groups
Suriname	Suriname Birdwatching Association	n.d.	www.surinamebirds.org
Uruguay	Asociación Conservacionista Uruguaya de Ornitología	–	Asociación Conservacionista Uruguaya de Ornitología in Facebook
Venezuela	Unión Venezolana de Ornitólogos	Congreso Venezolano de Ornitología (1 since 2009)	http://www.uvovenezuela.org.ve/lista_ovum.php

* The SCSCB is a regional association that incorporates members from most Caribbean countries and territories.
n.d. No data available.

per species ratio, reflecting higher species richness and poorer knowledge when compared to the USA. Brazil is a notable case within the region, as the number of publications in the 1996–2011 period is vastly superior to the next countries on the list.

Totals for *Cotinga* differ from those of *Zoological Record* in several aspects. First, Ecuador and Brazil account for 37% of all publications, followed by Peru and Mexico with 20%; 8 countries account for 32%, and 30 countries account for the remaining 11%. Mexico and Argentina ranked fourth and fifth, respectively. Publication rates in *Cotinga* and *Zoological Record* were similar for Central America; aside from Costa Rica and Belize, most countries were poorly represented. Similarly, together all Caribbean countries (excepting Cuba) had only 31 references, while alone Cuba had 30 (Figure 1).

Patterns of publications in *Ornitología Neotropical* also differed from those of *Zoological Record*. Argentina and Brazil accounted for 37% of published papers, followed by 8 countries accounting for 48%, 6 countries summing 9%, and the remaining 26 countries with the remaining 6%. Again, Costa Rica and Panama accounted for 63% of all Central American references, whereas among Caribbean countries only Cuba and Puerto Rico are not on the bottom of the list. Among South American countries, the three Guianan states (Guyana, French Guiana, and Suriname), Uruguay, and Paraguay together sum fewer references than Bolivia, which ranked eighth among South American countries (24 vs. 32) (Figure 2).

Of 865 papers published in *Ornitología Neotropical*, a notable 74% (641) were authored by residents from Neotropical countries (this includes 59 papers in which residents are "only" junior authors; Table 2). Notably, for 11 countries, the majority (67–100%) of papers were generated by Neotropical authors. In Argentina and Brazil nearly 95% of the 322 papers published for those countries were produced by residents, primarily nationals. Similarly, Colombians and Mexicans published nearly 83% of all references on their countries' birds.

Even though not previously assessed by James or Winker, the numbers of Neotropical authors have notably increased, for most countries, over the last decade (personal observation). The exceptions are Brazil, Argentina, and Mexico, where a longer-standing tradition of ornithology in museums and academic institutions has resulted in high productivity by residents (Di Giacomo and Di Giacomo 2008, Alves et al. 2008, Navarro-Sigüenza et al. 2008; see also Naranjo 2008, Pitman et al. 2011). Some countries, such as Ecuador and Bolivia, have fairly large numbers of publications authored by residents (Table 2). It should be pointed out, however, that nearly 60% of those are authored by non-nationals, reflecting the need to continue strengthening national ornithology programs (Naranjo 2008, Pitman et al. 2011).

Comparing numbers of publications by area of knowledge between the 1979–1995 and 1996–2011 periods was informative as it allowed exploration of current and future directions of ornithology in Neotropical countries (Figure 4). Not surprisingly, numbers of publications on all subjects have increased (all $p < 0.001$; $\alpha = 0.005$, adjusted after Bonferroni correction). Numbers of papers in taxonomy, systematics, evolution, migration, and physiology increased 160–200%; papers in ecology, diet, and breeding increased 222–253%, and papers in conservation had more than a three-fold increase, with 378%. Finally, papers in biogeography are still relatively few (in raw numbers) compared with those in all other areas, but experienced a 484% increase. It is important to notice that ecology is still the leading subject in Neotropical ornithology (Dayton 2003). Conservation is now the second-most published subject, still close to breeding, and reflecting an ever-increasing global awareness of the current biodiversity crisis.

An Overview on the Current State of Neotropical Ornithology

Without a doubt, these are exciting times for Neotropical ornithology. Regardless of the great challenges ahead, it

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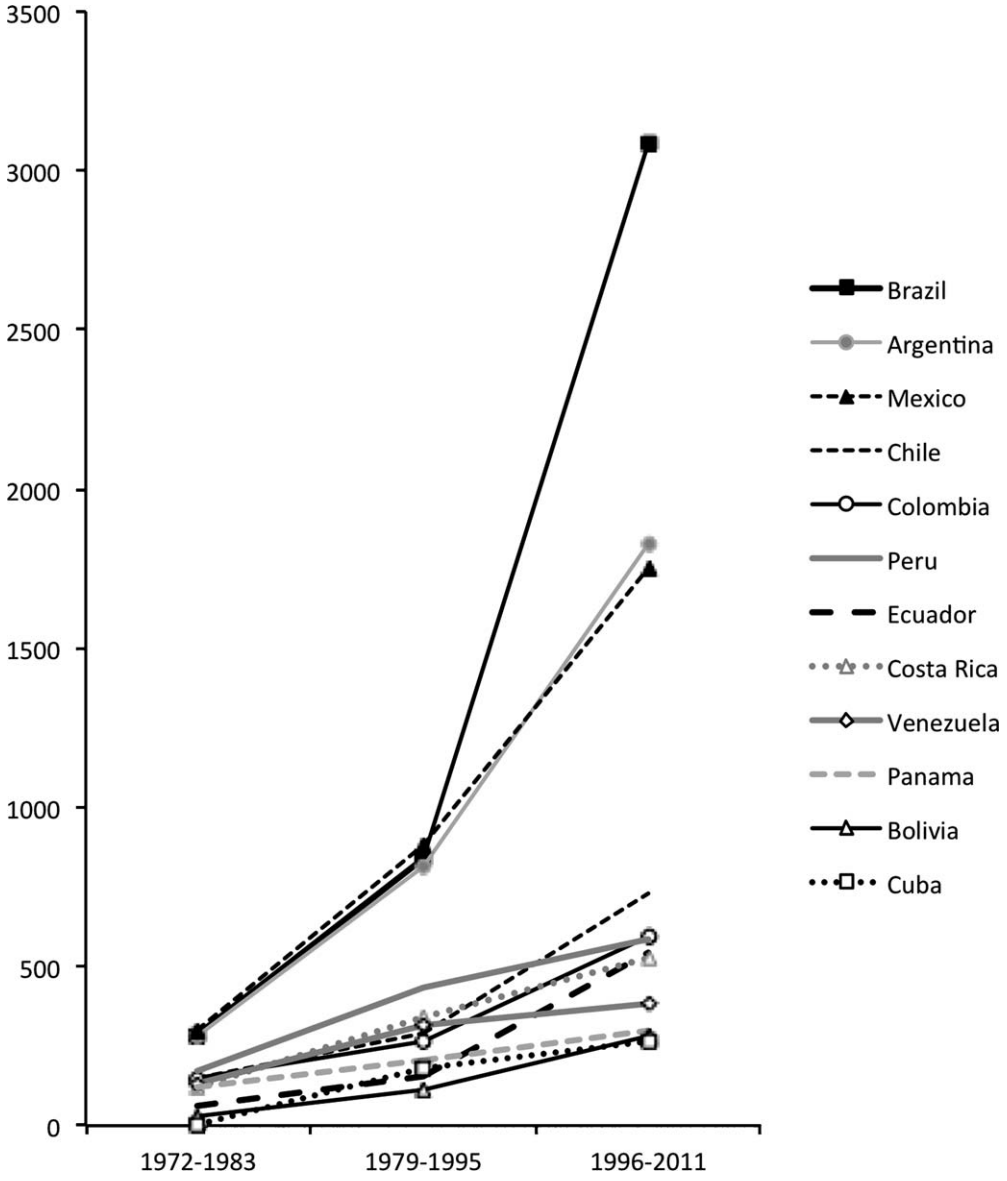


FIGURE 3. Trends in number of publications on the 12 best-documented Neotropical countries (1972–2011). Data from James (1987), Winker (1998), and current assessment.

seems clear that ornithologists in Neotropical countries have begun contributing a wealth of data on bird distributions and natural history that was previously unavailable internationally. In fact, in the majority of South American countries, Neotropical residents produced most publications. In our opinion, this trend is the result of an increased interest in birds (reflected by the growing number of local ornithological societies; Table 3) and the availability of alternative (electronic) publishing outlets, most of which also include the option of publishing in the author's native language.

Additionally, national institutions and NGOs now organize well-established initiatives such as waterbird censuses, Christmas bird counts, annual monitoring programs, and monitoring and study of threatened species. These programs provide constant sources of data and important training opportunities for young ornithologists. The big challenge remains in publishing or distributing these data in ways that allow integrated analyses of demographics, geographic distributions, species richness and abundance, and reproductive seasonality (Brooks et al. 2008).

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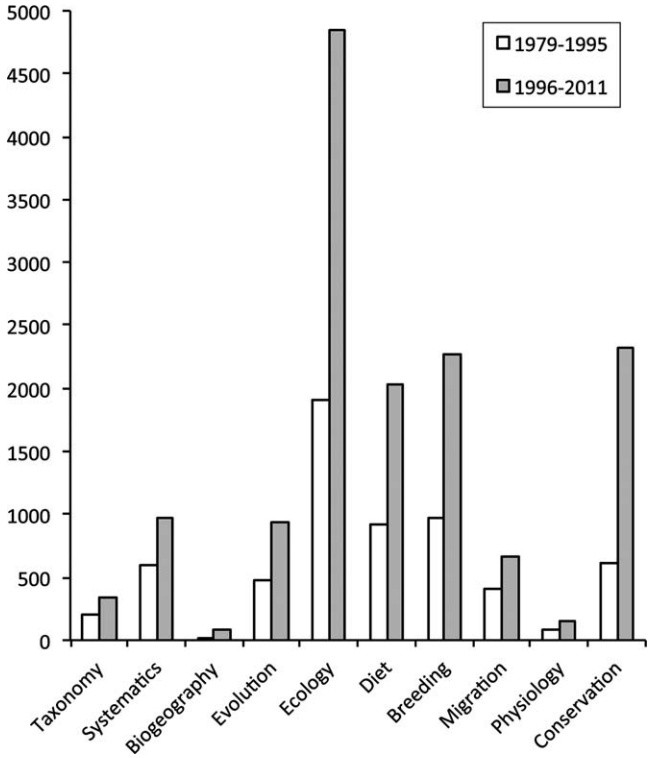


FIGURE 4. Number of references by subject area for all Neotropical countries. Data from searches in *Zoological Record* for the periods covered by Winker (1998) in white and this study in gray.

Recently, the integration of molecular techniques, vocal analysis, and traditional morphology has facilitated, more than ever, discovery of new species (e.g., Krabbe et al. 2005, O'Neill et al. 2011). In particular, improvements in the methods and cost-effectiveness of molecular analyses, in conjunction with increased higher education opportunities for Neotropical ornithologists, have significantly augmented the contributions of native ornithologists in this field (for a selection of representative examples, see Bertelli and Giannini 2005, Pérez-Emán 2005, García-Moreno et al. 2006, Ribas et al. 2007, Chaves et al. 2009, Parra et al. 2009, Tello et al. 2009). These outstanding publications are the result not only of improved academic training, but also of increased opportunities for international and inter-institutional collaboration (Naranjo 2008).

Within Neotropical countries, many museums have experienced substantial growth, despite the difficulties in funding and maintaining bird collections. Modern, in-country collections, including parasites, photos, vocalizations, and tissues, are increasingly accessible and better curated. Although collecting and exporting has become more restrictive (see below), inter-institutional collaborations are producing high-quality results. For an updated list of bird collections, including those housing Neotropical birds, visit http://www.museum.lsu.edu/~Remsen/AVECOLlections.html.

As mentioned in the Introduction, yet not fully covered in our analysis due to the limited nature of *Zoological Record*, recent years have witnessed an encouraging increase in number and quality of journals based in South and Central American countries, providing an outlet for the publication of natural history information on Neotropical birds. Although such data provide invaluable support for empirical and theoretical studies in avian ecology and evolution, many of the journals that once published most of these data (i.e. *Ibis*, *The Auk*, *The Condor*) have moved in different thematic directions. Apart from occasional "first nest" descriptions, such journals no longer provide an outlet for smaller discoveries, which are of no less importance to the advancement of our understanding of avian natural history (Dayton 2003).

Fortunately, international journals such as *Ornitología Neotropical* and *Cotinga* have stepped up to fill this gap, supported immensely by numerous high-quality national or regional journals such as *Ornitología Colombiana*, most of which additionally provide publications in authors' native tongues (see Introduction for additional examples). Even though the diminished emphasis on baseline natural history studies across the field of biology have been lamented by some authors (Greene 1994, Noss 1996, Futuyma 1998, Dayton 2003), we take this opportunity to point out the value of publishing such studies and short notes, even on putatively well-studied species. Such investigations will continue to uncover myriad anomalous and fascinating life-history strategies that challenge theories of life-history evolution (Sterns 1992, Martin 1996, Ricklefs and Wikelski 2002). An unfortunate by-product of increased publication outlets for "natural history notes" is a greater diffusion of such information in the literature, and we thus encourage more studies that compile and synthesize information on individual species or species groups (Greeney et al. 2008).

Beyond accounting for advances in specific fields, this decade perhaps defies direct comparisons with previous decades analyzed by James (1987) and Winker (1998) because of the development and use of the Internet, which provides a plethora of digital, bioinformatic platforms previously undreamed of. International and local initiatives for data sharing have grown immensely (e.g., *Searchable Ornithological Research Archive—SORA*, *Biodiversity Heritage Library—BHL*, *ORNIS*—museum specimens in North American and some Latin American collections). These electronic databases, combined with the implementation of powerful, open-source algorithms for ecological niche modeling (e.g., GARP, Maxent), have opened a new and promising field in Neotropical ornithology. Applications are numerous, including setting conservation priorities (Ortega-Huerta and Peterson 2004), understanding bioge-

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ography and distributions (Cadena and Loiselle 2007), predicting impact of invasive species (Devenish and Arzuza 2007), and exploring potential effects of climate change (Nunes et al. 2007).

One of the most fruitful endeavors has been the establishment of the South American Classification Committee website (Remsen et al. 2012), an Internet-based publication produced by an international group of ornithologists led by J. V. Remsen, which provides up-to-date taxonomic information and encourages contributions from all concerned. Increased and fluent communication has been achieved through establishment of several email lists, at both regional and country levels (Table 3); open and fast exchange of information is now routine and an important tool for Neotropical ornithologists. Also, a great number of regional and national congresses, workshops, and symposia are now well-established and held regularly (Table 3).

In the conservation realm, growing interest in the subject is clear from a more than three-fold increase in numbers of publications (Figure 4). How conservation science has taken an important role in Neotropical ornithology is probably explained by multiple phenomena, including growing public awareness about the global biodiversity crisis and increasing fund investments.

Broad application of the concept of Important Bird Areas (Devenish et al. 2010) has motivated species protection, enhanced management practices in protected areas, increased public awareness of bird conservation issues, and generated conservation-oriented economic activities in many local communities. As reviewed by Sekerçioglu (2002) and Steven et al. (2013), bird-oriented tourism has proven important for conservation, because it often produces an important income for local individuals and organizations. Many of these initiatives even provide support for conservation-oriented research, especially on endangered birds. Conservation programs need to be promoted and multiplied across the Neotropics, particularly in those countries where rates of habitat loss by deforestation are the highest and knowledge about threatened bird species is deficient (Brooks et al. 2008).

The Future of Neotropical Ornithology

Although the rapid advancements indicated by our assessment are encouraging, the number of ornithologists and amount of funds dedicated to Neotropical ornithology clearly must continue to grow, especially in deficiently known regions and on poorly studied species (Brooks et al. 2008), if we wish a bright future for Neotropical birds. Otherwise, we will continue to struggle when meeting the challenges posed by the current biodiversity crisis (Bowles et al. 1998, Brooks et al. 2008). Recent progress in funding, data-digitization, and sharing initiatives notwithstanding, significant effort is needed to promote a data-sharing philosophy among data holders in museums, field stations, and other institutions across the region.

The importance of maintaining and increasing specimen holdings in local and international museums is another important issue under extensive discussion (Remsen 1995, Cuervo et al. 2006). Current anti-collecting trends resulting from more restrictive permit policies and misinformation need to be confronted and discussed further. Host-country researchers especially should also lobby their local environmental agencies when these restrictions are excessive and effectively limit the progress of ornithology and other sciences. Researchers from the Colombian Consejo Nacional de Biología have set one excellent example of a proposal for productive reforms (http://www.consejoprofesionaldebiologia.gov.co/entidad.php). If modern collecting efforts cease, then one of the cornerstones of studies on Neotropical birds will remain permanently out of date.

In our view, among the most important developments in Neotropical ornithology are the empowerment and academic training of local ornithologists (Brooks et al. 2008, Pitman et al. 2011); the increasingly common international collaborations (Naranjo 2008); and, in the case of countries such as Mexico, Argentina, and Brazil, the willingness of local governments to allocate significant funds to science and technology (Pitman et al. 2011). Nonetheless, Neotropical ornithology still needs to establish common programs and objectives in order to foster a Neotropical ornithological science (Naranjo 2008). Still, changing funding priorities remains a huge challenge in most countries, where applied research and global climate change obtain most of the available funding for biodiversity research. The study of biodiversity in poorly known regions, natural history, ecology, systematics, population biology, and the dissemination of data are all important priorities. This situation demands creative solutions for promoting more appropriate allocation of existing funds while appeasing the needs of local and federal governments.

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