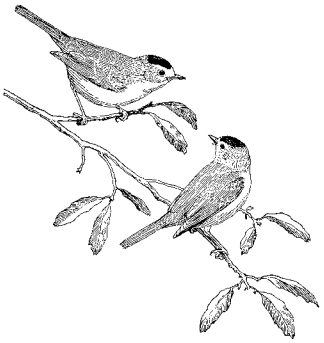
FRONTISPIECE. Male (top) and female (other three individuals) *Chaetocercus berlepschi,* Esmeraldas Woodstar, an endangered hummingbird endemic to western Ecuador visiting flowers of *Kohleria spicata* (Gesneriaceae) and *Cornutia pyramidata* (Lamiaceae). The original description of female *C. berlepschi* was incorrect because it came from mis-labeled specimens of juvenile males. Original painting by Paul J. Greenfield.



The Wilson Journal *of Ornithology*

Published by the Wilson Ornithological Society

VOL. 121, NO. 2 June 2009 PAGES 227–456

The Wilson Journal of Ornithology 121(2):227–239, 2009

DISTRIBUTION, PLUMAGE, AND CONSERVATION STATUS OF THE ENDEMIC ESMERALDAS WOODSTAR (*CHAETOCERCUS BERLEPSCHI*) OF WESTERN ECUADOR

J. BERTON C. HARRIS,[1,4,6] ANA E. ÁGREDA,[2] MERY E. JUIÑA,[1] AND BERND P. FREYMANN[3,5]

ABSTRACT.—The Esmeraldas Woodstar (*Chaetocercus berlepschi*) is a poorly known and endangered hummingbird endemic to lowland and foothill moist forest in coastal western Ecuador. We encountered 11 new localities, observed two copulations, and found 26 nests of the species from October 2007 to April 2008. We observed the generally accepted descriptions of the female must have come from mis-labeled specimens of juvenile males and were incorrect. We collected the first three confirmed females of the species and describe their characteristics. The correct identification of female *C. berlepschi* and recognition of the species' breeding habitat should facilitate more effective conservation of the species. *Received 17 June 2008. Accepted 24 November 2008.*

Chaetocercus (Trochilidae) is presently considered to comprise six species (*C. mulsant*, White-bellied Woodstar; *C. bombus*, Little Woodstar; *C. heliodor*, Gorgeted Woodstar; *C. astreans*, Santa Marta Woodstar; *C. berlepschi*, Esmeraldas Woodstar; and *C. jourdanii*, Rufous-shafted Woodstar) which inhabit semiarid to humid forest and woodland in northern and western South America from 0 to 4,000 m above sea level (Graves 1986, Schuchmann 1999). Four of the six species are generally rare to uncommon, three (*C. bombus*, *C. berlepschi*, and *C. astreans*) have restricted ranges, and two are globally threatened (*C. bombus*, Vulnerable; *C. berlepschi*, Endangered) (Schuchmann 1999; BirdLife International 2000, 2008a, b). *Chaetocercus* woodstars are difficult to detect in the field because of their small body size and inconspicuous behavior outside of the breeding season. Their small size makes collection and specimen preparation challenging and, coupled with a reduction in collecting effort, has resulted in a dearth of

[1] Fundación de Conservación Jocotoco, Avenida Los Shyris N37-146 y El Comercio, Quito, Ecuador.

[2] Aves & Conservación (Corporación Ornitológica del Ecuador), Pasaje Joaquín Tinajero E3-05 y Jorge Drom, Casilla 17-17-906, Quito, Ecuador.

[3] Alexander Koenig Research Institute and Museum of Zoology (ZFMK), Leibniz Institute for Terrestrial Biodiversity, Research Group: Biology and Phylogeny of Tropical Birds, Adenauerallee 160, 53113 Bonn, Germany.

[4] Current address: Research Institute for Climate Change and Sustainability, School of Earth and Environmental Sciences, University of Adelaide, Australia.

[5] Current address: Community and Conservation Ecology Group, Centre for Ecological and Evolutionary Studies, University of Groningen, P. O. Box 14, 9750 AA Haren, The Netherlands.

[6] Corresponding author; e-mail: john.harris@adelaide.edu.au

specimens for some species (Freymann and Schuchmann 2005). The great majority of specimens that exist were collected before 1960 (Freymann and Schuchmann 2005).

Female *Chaetocercus* woodstars are similar to each other in plumage and are, at times, considered to be inseparable in the field (Hilty and Brown 1986, Hilty 2003). These factors have combined to make the genus poorly known as evidenced by few recent records of several species and a paucity of detailed breeding biology information for any (Schuchmann 1999). All species except *C. jourdanii* were formerly placed in the genus *Acestrura* but most recent authors and checklists follow Schuchmann (1999) in merging these species into *Chaetocercus* because there was insufficient morphological justification for their separation (e.g., Dickinson 2003, Restall et al. 2006, Remsen et al. 2008).

One of the least-known *Chaetocercus* is the localized Ecuadorian endemic Esmeraldas Woodstar (Simon 1889). This hummingbird inhabits semi-deciduous to evergreen moist forest (~1,500 mm annual rainfall) along the Pacific coast of western Ecuador from near sea level to 750 m elevation (Becker et al. 2000, Ridgely and Greenfield 2001, Ágreda 2007) (Fig. 1). The vast majority of records come from the rainy season, mid October to late May. The species is found along a gradient from low elevation (0–250 m), partially disturbed areas (Becker et al. 2000, Ridgely and Greenfield 2001) to more intact, higher elevation (250–750 m), misty *garúa* forest in the hills of the Cordillera Chongón-Colonche (Ágreda 2007). Contrary to Mata et al. (2006), *C. berlepschi* is not known from subtropical or temperate forests. The species seems to breed in lower elevation, disturbed areas along the central Ecuadorian coast and move to northwestern Ecuador for the non-breeding season (MEJ, pers. obs.; C. D. Becker, pers. comm.). Data are still limited because movements and breeding biology of the species remain poorly known. Before this study, *C. berlepschi* had been recorded from 11 localities but was only regularly observed at two: Río Ayampe (01° 41′ S, 80° 48′ W; Manabí Province), and Reserva Ecológica Loma Alta (Loma Alta; 1° 50′ S, 80° 39′ W; Santa Elena Province) (Collar et al. 1992, Ridgely and Greenfield 2001, Ágreda 2007).

C. berlepschi is sympatric with *C. bombus*, and accurate identification of either species depends on careful consideration of the other. *C. berlepschi* males are characterized by green upperparts with a faint bluish sheen and white underparts with a narrow green chest band. They have a purple gorget (Purple 1; Smithe 1975), and a forked tail with a short and rounded rectrix 1 (R1), a longer and narrower pointed R2, and long, distinctive R3-5 reduced nearly to shafts (Ridgely and Greenfield 2001; Frontispiece). Males of *C. bombus* have a ruby-pink gorget, more extensive green on the underparts, a cinnamon-buff pectoral collar, and usually display bronzier green upperparts (Schuchmann 1999, Ridgely and Greenfield 2001, Gurney 2006, Mata et al. 2006, Restall et al. 2006, Schulenberg et al. 2007). Published works illustrate *C. berlepschi* females as white below with a white postocular stripe, and a buff-tinged throat (Meyer de Schauensee 1970, Schuchmann 1999, Ridgely and Greenfield 2001, Mata et al. 2006, Restall et al. 2006). The central rectrices of the female are green and R2-5 are cinnamon with a black subterminal band and white tips. Depictions of female *C. bombus* vary but all suggest that its cinnamon-buff underparts and postocular stripe are the main identifying features (Schuchmann 1999, Ridgely and Greenfield 2001, Gurney 2006, Mata et al. 2006, Restall et al. 2006, Schulenberg et al. 2007). The tail is shown as cinnamon with a black subterminal band (the tips are also cinnamon) and green is at times shown on the central rectrices. The short and narrow cheekstripe (extension of the auriculars) is also a diagnostic feature of female *C. bombus* (Gurney 2006).

Much of the lowland humid forest in western Ecuador has been cleared, threatening numerous species including *C. berlepschi* (Dodson and Gentry 1991, Best and Kessler 1995), and the species is considered rare to uncommon (Becker et al. 2000, Ridgely and Greenfield 2001). The combination of these factors has led to the perception that the species is Endangered with an estimated population size of 250–999 individuals (Collar et al. 1992; BirdLife International 2000, 2008a) and should perhaps even be treated as Critically Endangered (Ridgely and Greenfield 2001).

The Esmeraldas Woodstar has received little research attention despite its restricted

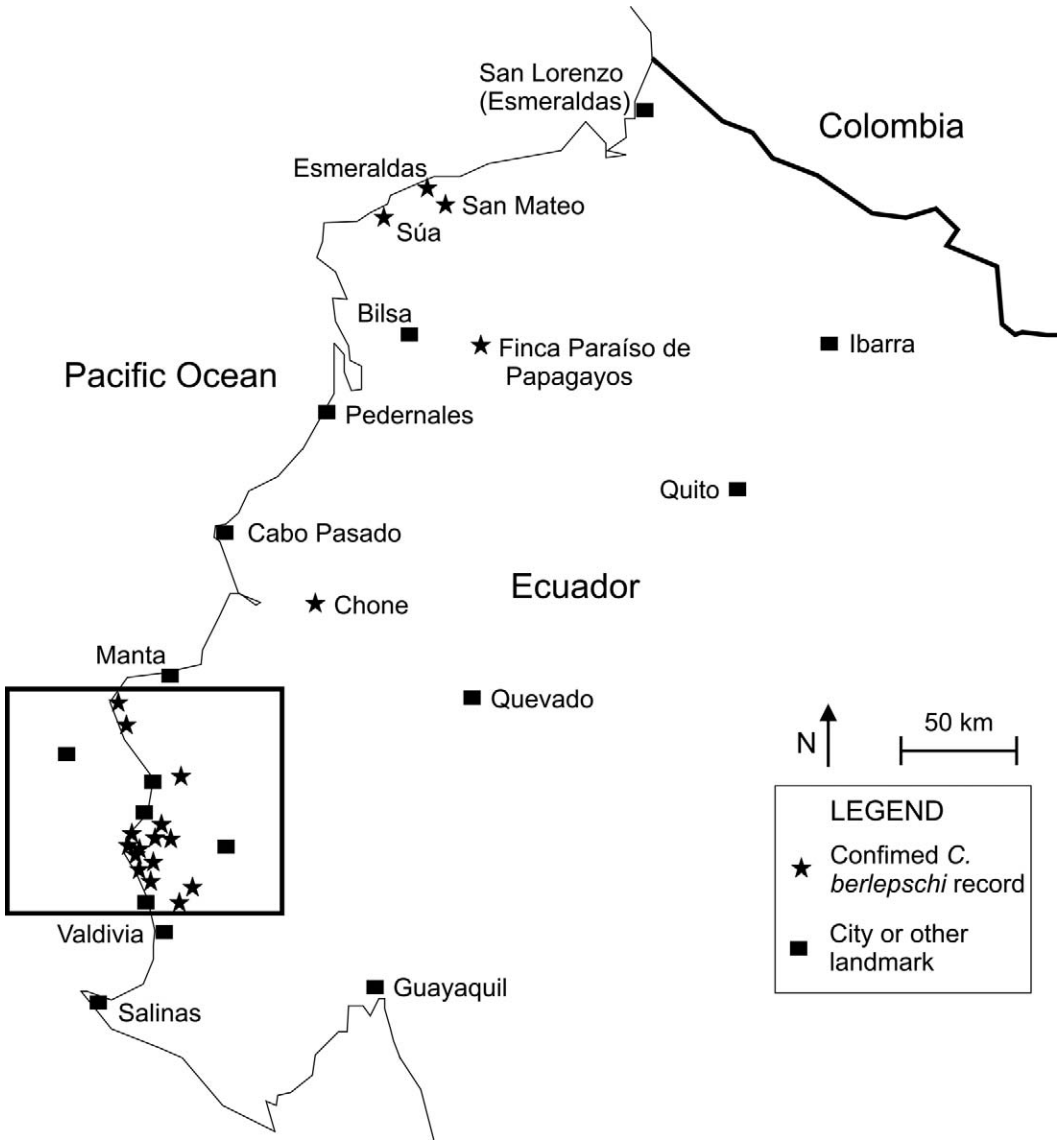


FIG. 1. Western Ecuador showing confirmed records of *Chaetocercus berlepschi* (Esmeraldas Woodstar) as well as larger cities and landmarks.

range and Endangered status, and little was known of its reproductive biology. The objectives of our study were to: (1) gather fundamental natural history and distributional information on the species, (2) assess its conservation status, and (3) recommend possible conservation actions.

METHODS

We searched for and observed *C. berlepschi* from October 2007 to April 2008 in Manabí and Santa Elena provinces, western Ecuador. We searched for the species at Ayampe in October and November and documented the arrival date of male and female *C. berlepschi*. We continued our searches from December 2007 to April 2008 along the coast from San José (1° 45′ S, 80° 45′ W; 30 m; Santa Elena Province) north to Cabo Pasado (0° 24′ S, 80° 29′ W; 25 m; Manabí Province; Figs. 1,2). We surveyed areas <20 km from the coast from 0 to 700 m elevation that varied from arid to

humid. We were based in Ayampe and data were collected from that site across all months of the study. We also documented the location and elevation of each *C. berlepschi* nest to obtain information on which areas are important for reproduction. We complemented breeding season observations with intensive searches in August and September 2008 that attempted to locate non-breeding localities. We searched along the coast from Ayampe to San Lorenzo (1° 4′ S, 80° 53′ W; Manabí Province) to Bilsa Biological Station (0° 22′ N, 79° 45′ W; Esmeraldas Province) from 3 to 20 August 2008. We also surveyed the northern and central Cordillera Chongón-Colonche in Manabí Province (0 to 700 m elevation) from 22 August to 9 September 2008. We searched from Agua Blanca (1° 32′ S, 80° 44′ W) to Pedro Pablo Gómez (1° 37′ S, 80° 33′ W) to Puerto Cayo (1° 21′ S, 80° 44′ W) to above Galán (1° 20′ S, 80° 40′ W), and back to Ayampe.

We recorded detailed field notes on plumage and took photographs with a 10 megapixel Canon EOS 40D digital camera with a 300 mm telephoto lens for future plumage analysis of each female that was courted by a male *C. berlepschi* ($n > 40$) or that was in attendance at a nest ($n = 21$).

We realized that female *C. berlepschi* were incorrectly described and collected three females on 4–6 March 2008 at Ayampe. The specimens (AS 1374, AS 1375, and AS 1377; MECN uncatalogued) were deposited at the Museo Ecuatoriano de Ciencias Naturales, Quito, Ecuador (MECN). We also saved tissue samples from all three specimens and blood from the two for which it was possible (AS 1375 and 1377) to enable future genetic analyses.

Collection of endangered species must be carefully considered and we collected the minimum number of individuals required to describe the female. Conservation measures for the species necessitate an accurate description of the female, and our judgment was the need to eliminate any possible uncertainties justified taking this small sample. Collecting, especially of under-represented genera such as *Chaetocercus*, is considered to be necessary and is amply supported in the literature (Winker et al. 1991; Remsen 1995, 1997; Winker 1996, 2005a, b; Peterson et al. 1998; Vuilleumier 1998, 2000; Freymann and Schuchmann 2005; Cuervo et al. 2006).

We described the plumage colors of our specimens with Munsell (1994) and Smithe (1975) color standards. Lower case color names refer to the Munsell (1994) classification; capitalized color names refer to Smithe (1975).

We compared our specimens to the nine *C. berlepschi* specimens (AMNH 37925, 118529–34, 119766, 119768) and specimens of the other five species of *Chaetocercus* (*C. astreans*, *C. bombus*, *C. jourdanii*, *C. heliodor*, and *C. mulsant*) at the American Museum of Natural History (AMNH). We examined all of the specimens of each species with particular attention to the plumage of the tail, underparts, postocular stripe, cheek stripe, and chest band. We drew detailed figures of the tail patterns of the plumages of greatest importance to this study (female *C. berlepschi*, female *C. bombus*, and juvenile male *C. berlepschi*; Fig. 3). We used a caliper accurate to 0.02 mm to measure wing chord, length of R1 and R5, and bill length from the anterior edge of the nostril to the bill tip to compare morphology of the different species. We measured a representative specimen-series of all congenerics (Table 1). We also analyzed measurements and photographs (when available) of the following specimens: an adult male *C. berlepschi* from the Academy of Natural Sciences, Philadelphia (ANSP 183118), a juvenile male from the Museum and Institute of Zoology, Polish Academy of Sciences, Warsaw, Poland (MIZPAN 44432), a male from Museu de Ciències Naturals, Zoologia, Barcelona, Spain (MCNC-MZB 85-0542), and an adult male *C. bombus* from Zoologisches Forschungsinstitut und Museum A. Koenig, Germany (ZFMK 9972). We also reviewed descriptions and measurements of the different species in the literature (Simon 1889, Hilty and Brown 1986, Schuchmann 1999, Clements and Shany 2001, Ridgely and Greenfield 2001, Hilty 2003, Gurney 2006, Mata et al. 2006, Restall et al. 2006, Schulenberg et al. 2007).

We used General Linear Models (GLMs) to test whether there were significant differences between means of the four measured morphometric parameters between female *C. berlep-*

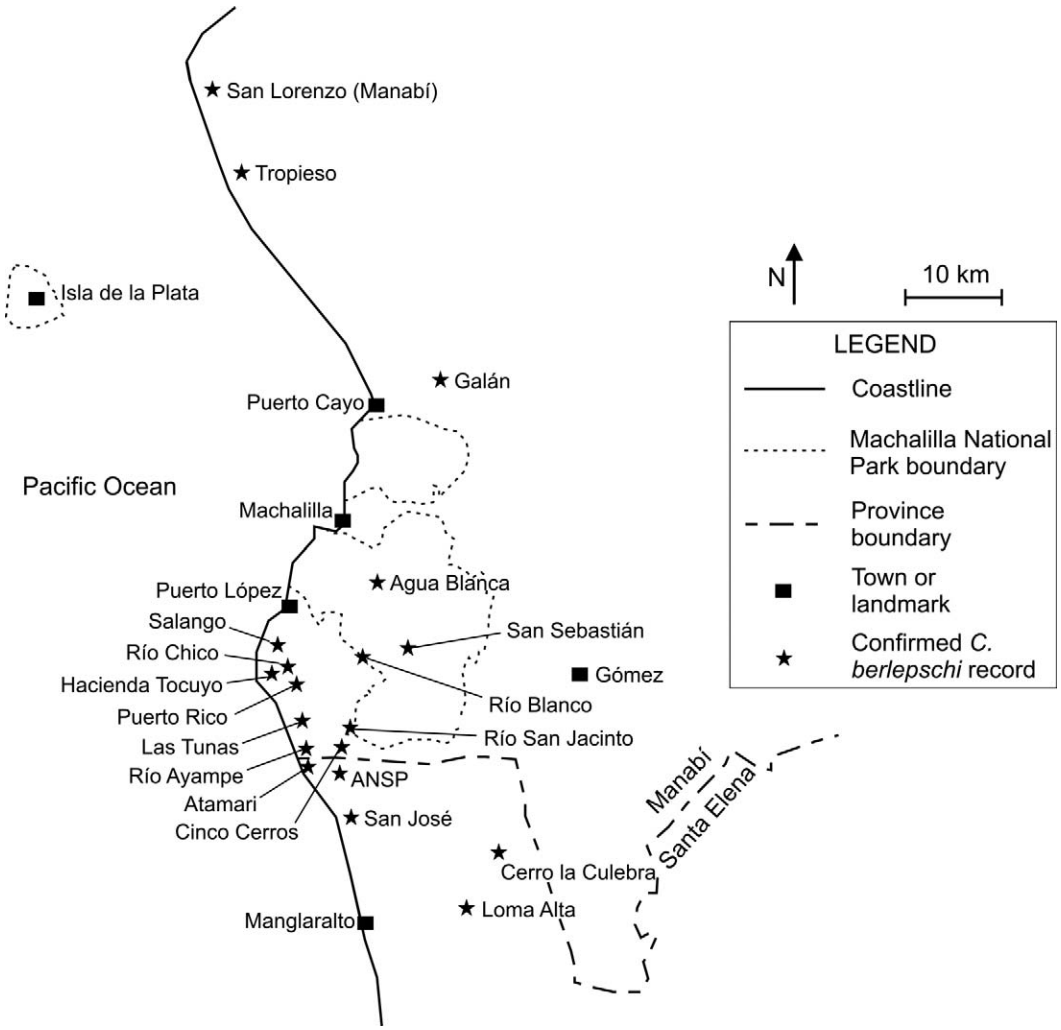


FIG. 2. Focal area of study (inset in Fig. 1) showing confirmed records of *Chaetocercus berlepschi* (Esmeraldas Woodstar) as well as towns and landmarks.

schi and *C. bombus*. Analyses were conducted in Statistica 6.1 (StatSoft Inc. 2003).

RESULTS

We encountered *Chaetocercus berlepschi* at 12 sites separated from each other by at least 2 km (Figs. 1,2): San Lorenzo (200 m), Tropieso (1° 9′ S, 80° 51′ W; 140 m; Manabí Province), above Galán (350 m), San Sebastián (1° 36′ S, 80° 42′ W; 675 m; Manabí Province), Río Blanco (1° 36′ S, 80° 45′ W; 175–240 m; Manabí Province), Salango (1° 35′ S, 80° 50′ W; 50 m; Manabí Province), Río Chico/Hacienda Tocuyo (1° 36′ S, 80° 49′ W; 40 m; Manabí Province), Puerto Rico (1° 37′ S, 80° 49′ W; 50–100 m; Manabí Province), Las Tunas (1° 39′ S, 80° 48′ W; 15 m; Manabí Province), Ayampe/Atamari/Cinco Cerros (30–140 m), Río San Jacinto (1° 40′ S, 80° 46′ W; 40 m; Manabí Province), and San José (30 m). *C. berlepschi* had been recorded in only one of these areas, Ayampe/Atamari/Cinco Cerros, before this study.

We began to search the Ayampe area intensively on 11 October 2007 but did not encounter female *C. berlepschi* until 4 November. We did not monitor the area between 14 November and 6 December but, when we re-

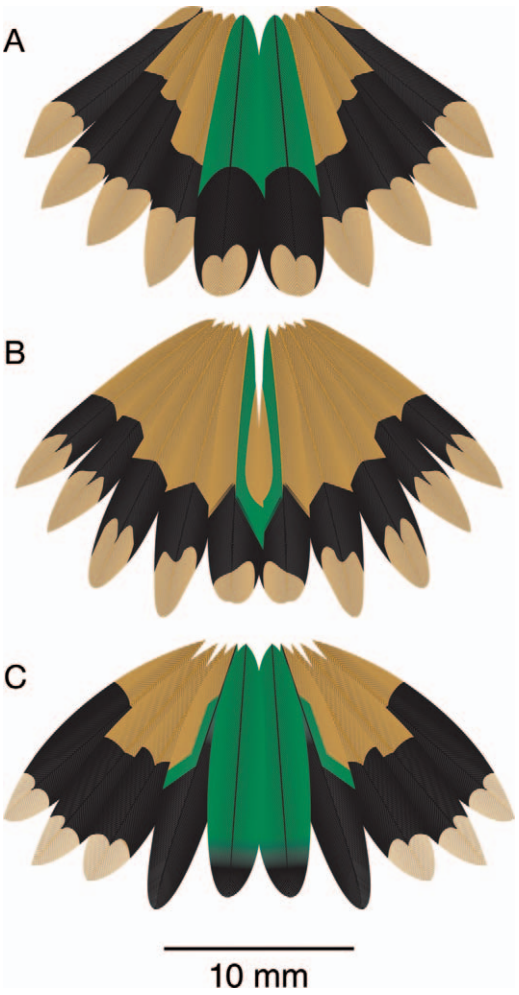


FIG. 3. Tail patterns of (A) adult female *Chaetocercus berlepschi* (Esmeraldas Woodstar), (B) adult female *C. bombus* (Little Woodstar), and (C) juvenile male *C. berlepschi*.

turned on 7 December, we observed the first male *C. berlepschi* of the season. *C. berlepschi* was seasonally (mid Nov–Apr) fairly common in partially disturbed forest and woodland along the Río Ayampe. We observed several individual *C. berlepschi* on nearly every visit to the field at Ayampe during that time period. We recorded the last male *C. berlepschi* on 4 May and the last female on 24 May 2008. We did not encounter *C. berlepschi* during our non-breeding season searches.

The most important floral resource for *C. berlepschi* at Ayampe was *Kohleria spicata*

TABLE 1. Measurements (mm) ($\bar{x}$ ± SE, range in parentheses) of *Chaetocercus* hummingbirds. Bill length was measured from the anterior edge of the nostril to the tip of the bill.

Taxon	Gender	Bill	Wing chord	Rectrix 1	Rectrix 5
C. berlepschi	Female (3)[a,b]	12.43 ± 0.41 (12.02–12.84)	28.55 ± 0.43 (28.1–29.4)	13.48 ± 0.15 (13.2–13.7)	12.63 ± 0.67 (11.3–13.3)
	Juv male (8)[c]	14.63 ± 0.1 (14.3–15.0)	28.08 ± 0.26 (27.0–29.0)	12.68 ± 0.24 (12.0–13.4)	12.88 ± 0.45 (11.5–14.1)
	Ad male (3)[d]	15.0 ± 0.3 (14.7–15.3)	25.9 ± 0.36 (25.4–26.6)	11.23 ± 0.18 (10.9–11.5)	14.5 ± 0.45 (13.6–15.0)
C. bombus	Female (15)	15.35 ± 0.17 (14.2–17.0)	30.46 ± 0.22 (29.2–31.8)	14.64 ± 0.25 (13.6–16.1)	13.98 ± 0.34 (12.0–15.0)
	Male (1)	14.4	25.8	9.3	13.7
C. jourdanii[e]	Female (4)	14.9 ± 0.36 (14.0–15.7)	36.85 ± 0.43 (35.9–37.8)	13.63 ± 0.19 (13.4–14.0)	12.63 ± 0.23 (12.0–13.0)
	Male (13)	14.4 ± 0.22 (12.9–15.3)	34.05 ± 0.19 (32.8–35.0)	10.09 ± 0.17 (8.9–11.1)	12.59 ± 0.32 (10.4–14.0)
C. astreans	Female (1)	16.2	33.9	14.1	14.1
	Male (1)	16.7	30.3	9.4	13.3
C. heliodor[f]	Female (8)	16.6 ± 0.22 (15.7–17.1)	32.3 ± 0.21 (31.2–32.9)	13.29 ± 0.4 (11.4–14.5)	12.55 ± 0.29 (11.7–13.8)
	Male (11)	15.86 ± 0.17 (15.0–16.7)	27.89 ± 0.13 (27.4–28.6)	8.81 ± 0.14 (8.1–9.7)	12.8 ± 0.23 (10.9–13.5)
C. mulsant	Female (13)	20.21 ± 0.44 (16.3–21.7)	39.09 ± 0.68 (32.7–41.6)	16.01 ± 0.22 (14.6–17.3)	14.43 ± 0.30 (13.0–15.6)
	Male (13)	19.6 ± 0.2 (18.1–20.7)	39.44 ± 0.27 (38.0–40.9)	15.85 ± 0.16 (14.9–16.8)	19.28 ± 0.16 (17.2–21.6)

[a] Sample size in parentheses.
[b] Bill destroyed on AS 1374, $n = 2$ for bill.
[c] For bill $n = 7$; $n = 6$ for R1 and R5.
[d] Bill destroyed on AMNH 118532, $n = 2$ for bill.
[e] Females: $n = 2$ for *C. j. andinus*, $n = 2$ for *C. j. rosae*. Males: $n = 2$ for *C. j. jourdanii*, $n = 7$ for *C. j. andinus*, $n = 4$ for *C. j. rosae*.
[f] Females: $n = 4$ for *C. h. heliodor*, $n = 4$ for *C. h. cleavesi*. Males: $n = 9$ for *C. h. heliodor*, $n = 2$ for *C. h. cleavesi*.

(Kunth) Oerst (Gesneriaceae, Frontispiece). *C. berlepschi* abundance was highest at Ayampe during the peak of the *Kohleria spicata* flowering event from January to March. At all other locations, *Cornutia pyramidata* (Lamiaceae) was the plant most commonly-visited. We did not encounter flowers of *Psychotria hazennii* Standl. (Rubiaceae) or *Razisea* cf. *ericae* Mildbraed ex Wassh. (Acanthaceae), both of which are important resources for the species in high elevation *garúa* forests. We observed *C. berlepschi* at several sites (e.g., Puerto Rico, Río Chico) along wooded riparian corridors in a matrix of deforested land. These riparian corridors connect lower elevation, deforested areas to large forest patches of the upland Cordillera Chongón-Colonche.

All *C. berlepschi* nests were <14 km from the coast from 30 to 350 m elevation and most were in areas disturbed by cattle ranching and agriculture, but adjacent to large forest patches. Nests at a few sites (e.g., Río Blanco) were in mature moist forest. Female *C. berlepschi* usually placed their nests near the top of small dead trees (~5 m tall) near creeks or roads. The nest, eggs, nestlings, nest placement, and parental care will later be described in detail (MEJ, in prep.).

Male *C. berlepschi* and female *Chaetocercus* woodstars with pale buffy underparts, white postocular stripes, and distinctive tail patterns (Frontispiece, Fig. 3A) were seasonally fairly common at all of our observation sites, while male and female *C. bombus* were rare or absent. *C. bombus* has a different tail pattern (no green on the outer webs of the central rectrices, a narrower black subterminal band, and less black on R5; Fig. 3B), a buffier postocular stripe, and richer buff underparts compared to the females we observed. We initially assumed these females were variable individuals of *C. bombus* because their buffy underparts differed strikingly from published descriptions of female *C. berlepschi*.

Male *C. berlepschi* defend perches at the top of small (~10 m tall) dead trees. When a female arrives at a perch, the male flies vertically above the perch until no longer visible to the naked eye, and then quickly drops to the perch while making a mechanical noise. The mechanical noise is likely produced by the distinctive narrow rectrices (R. S. Ridgely, pers. comm.). We observed males perform these displays at six localities (San Lorenzo, Tropieso, Galán, Río Chico, Puerto Rico, and Ayampe). All displays involved females with pale buffy underparts; none involved females with white underparts. We observed two copulations on 9–10 February 2008 between male *C. berlepschi* and females of the above description. We encountered 26 *Chaetocercus* nests, of which 21 were active, at nine sites. All active nests were attended by females with pale buffy underparts, white postocular stripes, and the same characteristic tail pattern. Female nestlings ($n = 10$) were buffy below with green central rectrices tipped cinnamon in a pattern similar to the females we collected, and unlike adult female *C. bombus*. A begging male fledgling observed on 11 March 2008 was distinguishable from female nestlings. Its tail and underparts were similar to that of other juvenile males, but it lacked any obvious purple gorget feathers.

We observed birds that generally matched the illustrations of ''female *C. berlepschi*'' on several occasions. Our data suggest these birds were juvenile male *C. berlepschi* rather than females. These birds have white underparts similar to that of adult males and have a buff-tinged throat with several gorget feathers that are the same color purple as adult males. Their tails are distinctive: R1 is relatively short, rounded and green, R2 is long, narrow and dusky, and R3-5 have a rufous-cinnamon base, black subterminal band, and tips that are pale cinnamon to whitish with a pale pinkish buff tinge (Fig. 3C; the tips are shown as white without any buff tinge in the sources that illustrate the ''female'' of the species). We usually observed birds of this description when they challenged adult males for display perches and we did not observe them copulate.

Museum specimens provide strong support for our conclusion. AMNH specimen 37925 and MIZPAN 44432, labeled as juvenile males, display the same white underparts and tail pattern of the juvenile males we observed in the field. AMNH specimens 118533, 119766, and 119768, and MCNC-MZB 85-0542, which are labeled as males but were not classified to age, also show these characteristics and are likely juvenile males. Two AMNH specimens labeled as females (118529 and 118534) seem to be the basis for the original

description of the female of the species (R. S. Ridgely, pers. comm.). These two skins show the characteristics of juvenile male *C. berlepschi*, most notably their tail pattern (Fig. 3C). The only difference between the juvenile males and one of these ''females'' is the lack of purple gorget feathers in specimen 118529, an absence that is probably related to age. The third ''female'' (118531) which, like AMNH 118529–530, 118532–534, 119766, and 119768, was collected by W. B. Richardson, is also mis-labeled. The skin is actually an adult male with a fully-grown adult male tail (measurements of each rectrix are similar to the morphometric measurements of the other 2 adult males). The specimen had lost most of its gorget feathers (only skin remained) but the remnant gorget feathers were all purple and it is likely that if the other feathers had not been lost, the specimen would have a full adult gorget. This obvious error, along with the more subtle errors, suggests the gonads were not carefully examined on some of the AMNH specimens collected by W. B. Richardson. It is not especially surprising that mistakes were made because gonads of *Chaetocercus* are extremely small. We conclude there actually are no specimens of female *C. berlepschi* currently in any museum collection and describe the gender.

Description of Female

C. berlepschi females are characterized primarily by their green central rectrices with unique small, unevenly bi-lobed cinnamon-rufous tips and their white postocular stripe (Frontispiece; Fig. 3A). *C. berlepschi* is subtly different from all other *Chaetocercus* females, but the species shows several characteristics similar to other members of the genus such as buffy underparts, green central rectrices, cinnamon R2-4 with a black subterminal band, and green patches on the sides of the chest connected by a faint dusky band. *C. berlepschi* is best distinguished by a combination of plumage characteristics, morphometrics, and distribution. The only sympatric *Chaetocercus* is *C. bombus* which is similar in size (Table 1), but shows a different tail pattern with green present only as a sheen on parts of the inner webs of the central rectrices, a narrower black subterminal band on R2-5, and much more brown on R5 (Fig. 3B). The cinnamon tips of R3-5 in *C. bombus* are at times shaped into distinctive diamonds by the subterminal band, but this is variable. *C. bombus*'s postocular stripe tends to be rich cinnamon while the postocular of *C. berlepschi* is white and only occasionally includes some buff feathers. *C. berlepschi* shows a long and wide cheek stripe that is often mostly green compared to *C. bombus*'s usually short, narrow, and dusky cheek stripe. In addition, the underparts of *C. bombus* are usually rich cinnamon-buff compared to the pale buff underparts of *C. berlepschi*. The most posterior feather tracts of the uppertail coverts in *C. bombus* are at times buffy, while the uppertail coverts of *C. berlepschi* are green.

C. bombus is significantly larger than *C. berlepschi*. Females of *C. bombus* have significantly longer bills (GLM: $F_{1,12} = 40.91$, $P < 0.001$), longer wings (GLM: $F_{2,14} = 13.36$, $P = 0.002$), and longer R1 (GLM: $F_{2,9} = 5.96$, $P = 0.032$), whereas the length of R5 is not significantly different between females of the two species (GLM: $F_{2,8} = 4.87$, $P = 0.052$; Table 1).

Among the other four *Chaetocercus*, *C. berlepschi* females are most similar to *C. mulsant* in tail pattern. *C. mulsant* usually has green central rectrices with a black subterminal band and extensive cinnamon-rufous tips. The tail pattern of *C. berlepschi* is subtly different; the cinnamon-rufous tips are small in extent and unevenly bi-lobed in shape (Fig. 3A). The central rectrices of *C. mulsant* are variable and, at times, are different from the pattern in *C. berlepschi*. *C. mulsant* can display a small area of rufous-brown in the outer web of the basal part of the central rectrix. The central rectrices at times can be almost entirely dusky with a greenish sheen and a small cinnamon-rufous tip. *C. mulsant* is noticeably larger than *C. berlepschi* (Table 1) and the species are not known to be sympatric. *C. jourdanii* and *C. astreans* differ from *C. berlepschi* in their entirely green central rectrices and R2 differs in pattern from R3-5. *C. heliodor* is distinguished by its rich cinnamon-rufous rump and underparts. *C. heliodor* also has the least amount of green on the central rectrices of any *Chaetocercus* (just a fleck of green proximal to the subterminal band).

The following description is based on the sexually mature female collected 5 March

TABLE 2. Characteristics of three female *Chaetocercus berlepschi* (Esmeraldas Woodstar) specimens collected at Río Ayampe (Manabí Province, Ecuador) in March 2008.

Specimen number[a]	AS 1374	AS 1375	AS 1377
Collection date	4 Mar 2008	5 Mar 2008	6 Mar 2008
Wing chord (mm)	28.2	29.4	28.1
Anterior edge of nostril to tip of bill (mm)	NA[b]	12.8	12.0
Rectrix 1 length (mm)	13.4	13.4	13.7
Rectrix 2 length (mm)	14.6	14.5	15.1
Rectrix 3 length (mm)	14.4	14.5	15.4
Rectrix 4 length (mm)	13.4	13.4	14.5
Rectrix 5 length (mm)	11.3	13.3	13.3
Body mass (g)	2.0	2.1	1.9
Molt	strong general	none	light general
Ovary dimensions (mm)	3.0 × 2.0	3.0 × 2.0	1.6 × 1.0
Number ovarian follicles	none-ovary smooth	nine	none-ovary very smooth
Dimensions of largest follicle (mm)	NA	1.0 × 1.0	NA

[a] Specimens are deposited in Museo Ecuatoriano de Ciencias Naturales, Quito, Ecuador (MECN; uncatalogued).
[b] Bill destroyed on AS 1374.

2008 by Aldo Sornoza M. (AS 1375), in Río Ayampe, Manabí Province, Ecuador, (01° 41′ S, 80° 48′ W; 40 m). Our small sample did not permit us to distinguish between First Basic and Definitive Basic plumages in female *C. berlepschi*. Upper tail coverts, rump, scapulars, crown, and wing coverts are Parrot Green (260) with a weak bronzy sheen. Green of upperparts is darkest and dullest on the crown. Central rectrices are mostly Parrot Green but fade into dusky and are finally tipped with a small, unevenly bi-lobed area of pale pinkish buff (7.5 YR 7/6). Tips of other rectrices are the same pale pinkish buff. Rectrices 2–5 have cinnamon-rufous (2.5 YR 5/8) base and black (GLEY, diagram 1, 2.5/N) subterminal band. Shafts of rectrices match color of surrounding feather barbs except for proximal shaft of R1 which is black surrounded by green barbs. The remiges are dusky and the postocular stripe is white. The long and wide cheek stripe (auriculars and below) is Parrot Green with some dusky feathers. The throat, upper breast, and central belly are pale pinkish buff (7.5 YR 7/5) (slightly grayer than 7/6). Sides of breast have patches of Parrot Green that are connected by a vague dusky chest band. The upper breast is similar in color to the throat but slightly more rufescent above the chest band. Sides and lower edge of green patch on sides of the breast are vinaceous pink (5 YR 5/6). Undertail coverts are dull cinnamon-rufous (5 YR 5/8). Flank feathers are white and extend onto sides of rump. Leg puffs are white. In life the iris was dark brown, and the tarsi and bill were black. The stomach contained insect remains. The other two specimens, a sexually immature female (AS 1374) and a juvenile female (AS 1377) were similar to AS 1374 (Table 2) but differed in the following ways.

AS 1374 has upperparts Parrot Green but with a stronger bronzy sheen, except for central rectrices and uppertail coverts. In contrast to AS 1375, the crown is not duller than back. The cheek stripe is dusky and the green patch on sides of chest is much reduced. One throat feather is Purple (1) as for male. The postocular stripe is white with a few pallid pinkish buff feathers (7.5 YR 8/3 to 8/4). The dusky chest band is seemingly absent but difficult to identify because of specimen condition. The longest uppertail covert feathers are tipped dusky.

AS 1377 is a juvenile female with a yellow gape. The entire upperparts (back, crown, upper tail coverts) appear scaly because the feathers have thin blackish subterminal bars and cinnamon-rufous (2.5 YR 5/8) tips. The belly is uniform vinaceous pink (5 YR 5/6) without the areas of lighter buff shown by AS 1375. The throat is pallid pinkish buff (7.5 YR 8/3 to 8/4), paler than AS 1375. The cheek stripe is dusky with cinnamon-rufous (2.5 YR 5/8) tips. The tail is similar to other two specimens but both proximal and distal edges of the subterminal band are more regular; black is not as extensive down shaft or along sides of feather. The green patch on sides of breast and dusky chest band are seemingly absent.

The soft parts and stomach contents of AS 1374 and 1377 were similar to AS 1375. All specimens had little fat.

DISCUSSION

We present the first description of female *Chaetocercus berlepschi* to facilitate the correct identification of the gender which will be important in future studies of the species. Our new distributional records significantly augment the number of known localities for *C. berlepschi* and suggest the species may not be as threatened as previously thought. We identify an important breeding zone which advances our understanding of the breeding biology of *C. berlepschi* and should enable more effective conservation of the species.

C. berlepschi was known from 10 published and two previously unpublished specimens from western Ecuador before this study, only 10 of which have certain locality data (Collar et al. 1992, Ridgely and Greenfield 2001). Three males and three ''females'' (AMNH 118529-34) were collected in October to December 1912 at Esmeraldas (~0° 58′ N, 79° 39′ W; Esmeraldas Province) (Fig. 1). Two males (AMNH 119766 and 119768) were taken in December 1912 at Chone (~0° 42′ S, 80° 05′ W; Manabí Province). A previously unpublished specimen of a male (MCNC-MZB 85-0542) was collected in September 1934 at San Mateo (~0° 54′ N, 79° 37′ W; Esmeraldas Province). Among the specimens collected at uncertain localities are a juvenile male (AMNH 37925), probably collected in the late 19th century and supposedly from ''Río Napo, eastern Ecuador'', and a previously unpublished juvenile male (MIZPAN 44432) collected in ''Ecuador''. One adult male specimen mentioned by Collar et al. (1992), labeled as *C. berlepschi*, is at the Muséum d'Histoire Naturelle, Paris, France (MNHN CG2003-17), but BPF identified the skin to be *C. jourdanii* in 2002. After the MCNC-MZB specimen, the species went unrecorded for nearly 60 years until an adult male was collected (ANSP 183118) in January 1991 in the hills south of the lower Río Ayampe in what is now northwest Santa Elena Province (~1° 43′ S, 80° 46′ W; ~75 m elevation).

C. berlepschi has been reported since 1991 on single occasions from two sites in Esmeraldas Province: Finca Paraíso de Papagayos, north of Quinindé (~0° 20′ N, 79° 28′ W) and southwest of Súa (~0° 50′ N, 79° 53′ W) (Ridgely and Greenfield 2001). Recent sites in Manabí Province are Agua Blanca (50 m; Becker et al. 2000) (Fig. 2), Río Ayampe (40 m; Ridgely and Greenfield 2001), and nearby Cinco Cerros (1° 41′ S, 80° 46′ W; 151 m; C. D. Becker, pers. comm.). Reports further south in Santa Elena Province are from Loma Alta (400–750 m; Becker and López Lanús 1997, Ágreda 2007) and 7 km northeast of Loma Alta, at Cerro La Culebra above Dos Mangas (1° 47′ S, 80° 37′ W; 500–600 m; Ágreda 2007).

We regard the report of the species from Isla de la Plata (1° 16′ S, 81° 04′ W; 50 m; Manabí Province; Becker et al. 2000) as uncertain. The island is more arid than any other site from which the species is known; the bird was viewed from 25 m and might have been confused with Short-tailed Woodstar (*Myrmia micrura*), a common species on the island. Four weeks of avian sampling (Cisneros-Heredia 2005) and frequent visits by scientists and birdwatchers have not produced any further records for this area.

The distributional records we present confirm the importance of the southern Manabí Province coastal zone for *C. berlepschi*. Our data, along with previous observations (Ridgely and Greenfield 2001; D. M. Brinkhuizen, pers. comm.), indicate that *C. berlepschi* is present in the Ayampe area from mid-October to late-May. Future research should seek to identify which areas and habitats are used by *C. berlepschi* during the non-breeding season from June to September. The lack of records from our non-breeding season searches in the northern Cordillera Chongón-Colonche, combined with the dearth of sightings from Ayampe (Ridgely and Greenfield 2001), Loma Alta (C. D. Becker, pers. comm.), and San Sebastián (R. S. Ridgely, pers. comm.) suggest that *C. berlepschi* leaves the Cordillera during this season. We hypothesize the species migrates to Esmeraldas Province for the non-breeding period. The only two non-breeding records of the species come from Esmeraldas: a juvenile male (MCNC-MZB 85-0542) from San Mateo in September 1934, and a male seen at Finca Paraíso de Papagayos from 15 to 23 September 1995. We searched Esmeraldas for only 3 days in August, and it is likely that future sampling in the province during the non-

breeding season will record *C. berlepschi*. Intensive searches combined with stable isotope (Hobson et al. 2003, Fraser et al. 2008) and mark-recapture techniques should produce the most data on movements of *C. berlepschi*. Effective long term management of this species will depend upon knowledge of its non-breeding distribution.

CONSERVATION IMPLICATIONS

C. berlepschi was considered rare to uncommon (Becker et al. 2000, BirdLife International 2000) and Ridgely and Greenfield (2001) proposed that Critically Endangered may be the appropriate conservation status for the species (IUCN 2001). The large number of observations we made suggest the species may not be as seriously threatened as previously thought. *C. berlepschi* seems to be seasonally more numerous in disturbed, lower elevation areas where we made our observations than in high-elevation *garúa* forest at Loma Alta where it appears to be genuinely uncommon (C. D. Becker, pers. comm.). Our data suggest the global population size of the species is likely to be ~1,000 to 3,000 individuals, although more work is needed to confirm this estimate. The species is localized in a small range that has been mostly deforested (Dodson and Gentry 1991) and, in our view, should still be considered Endangered. Our data suggest that *C. berlepschi* meets criterion A4 (suspected population reduction of ≥50% over a 10-year period) and possibly C1 (population size <2,500 mature individuals with an estimated continuing decline) (IUCN 2001). *C. berlepschi* is a high priority species that should receive conservation action as soon as possible.

Our sampling area was limited to within 20 km of the coast; the large number of nests we encountered suggests this coastal zone from 0 to 700 m elevation from San José (Santa Elena Province) north to San Lorenzo (Manabí Province) is an important breeding area for *C. berlepschi*. Future conservation actions for this species should prioritize habitat protection in this coastal area. That *C. berlepschi* individuals and nests were found at least adjacent to large patches of forest suggests the species may require large areas of intact forest, even though the species is a seasonal resident in partially disturbed areas. More research is needed to identify the habitat requirements of *C. berlepschi*.

Two of our observation sites, San Sebastián and Río Blanco, and one previously published site, Agua Blanca (Becker et al. 2000), are within the boundaries of Machalilla National Park (Fig. 2). The park provides nominal protection for the species but problems with regulation enforcement in the park have been noted in the past (BirdLife International 2000). We observed adverse human impacts such as logging, hunting, and farming inside the park during our study, and several small human settlements are within the boundaries of the park. Significant changes in the management of Machalilla National Park should be implemented to help ensure the survival of *C. berlepschi* and numerous other range-restricted species that occur there. These problems are not limited to Machalilla National Park; a major priority for Ecuadorian bird conservation is to strengthen management of the country's protected areas (Freile and Rodas 2008).

Currently, Machalilla National Park does not provide reliable protection for *C. berlepschi*. The only other protected area where the species is known to occur is Reserva Ecológica Loma Alta, a 3,000 ha community-owned reserve that protects higher elevation moist forest and drier forest at lower elevations (Becker 1999, Becker et al. 2005). *C. berlepschi* is regularly recorded in the reserve but no evidence of breeding has been observed. The establishment of a new protected area in the breeding habitat of *C. berlepschi* would help ensure the long-term persistence of the species. This protected area should ideally be placed along the coast somewhere between San José and Salango, and should include as much intact forest and as many riparian corridors as possible.

The description error corrected by this study emphasizes there is still much to be learned about the avifauna of northern South America. Our findings underscore the need for more fundamental natural history research on the lesser known birds of this extremely diverse continent.

ACKNOWLEDGMENTS

We are grateful to the American Bird Conservancy (William Belton conservation grant) and the World Land Trust for funding. We thank the executive direc-

tor and board of Fundación Jocotoco for placing continued emphasis on this project, and for providing funding and logistical support throughout. We are indebted to Aldo Sornoza M. for his efforts in collecting the specimens. AEÁ thanks the Ministerio del Ambiente for issuing national investigation and collection permits. Specimen collection was supported by sources separate from the American Bird Conservancy and World Land Trust funds. This project depended on the hard work of our field assistants: Matt Brady, B. R. Hickman, J. D. Ritterson, and R. S. Terrill, J. G. Loor, P. A. Parraga, Nildo Parrales, and Francisco Sornoza M. also provided valuable assistance in the field. We thank Matt Brady, B. E. Lyon, and R. S. Terrill for discussions on the Ayampe woodstar situation. We are grateful to P. J. Greenfield for work on the magnificent frontispiece, and Scott Panciera for work on figure 3. Niels Krabbe provided valuable assistance with the color description of the specimens. We are grateful to the following individuals for their generous help at the museums: Peter Capainolo, M. E. Hart and P. R. Sweet at AMNH, N. H. Rice at ANSP, Albert Burgas R. and E. G. Franquesa at MCNC-MZB, Dominika Mierzwa at MIZPAN, and P.-Y. Henry and Eric Pasquet at MNHN. David Agro, A. A. Chenault, G. R. Graves, P. J. Greenfield, J. M. Harris, Salvador Herrando-P., J. L. Reid, R. S. Ridgely, B. R. Scheffers, K.-L. Schuchmann, N. S. Sodhi, L. W. Traill, and T. C. Wanger provided helpful comments on the manuscript. We also thank C. D. Becker, D. M. Brinkhuizen, D. F. Cisneros-H., M. P. L. Fogden, Johan Ingels, R. L. Mumme, Peter Pyle, H. V. M. Stein, S. M. Wethington, and the Fundación Jocotoco office staff for assistance. AEÁ is grateful to the Royal Society for the Protection of Birds and the Percy Sladen Fund for financial support, and Aves & Conservación for institutional and logistical support. BPF thanks the German National Merit Foundation for financial support.

LITERATURE CITED

ÁGREDA, A. E. 2007. Feeding ecology and conservation of Esmeraldas Woodstar *Chaetocercus berlepschi* in the Chongón-Colonche Hills, western Ecuador. Cotinga 27:38–41.

BECKER, C. D. 1999. Protecting a *garúa* forest in Ecuador: the role of institutions and ecosystem valuation. Ambio 28:156–161.

BECKER, C. D. AND B. LÓPEZ LANÚS. 1997. Conservation value of a *Garua* forest in the dry season: a bird survey in Reserva Ecologica de Loma Alta, Ecuador. Cotinga 8:66–73.

BECKER, D., A. ÁGREDA, A. RICHTER, AND O. RODRIGUEZ. 2000. Interesting bird records from the Colonche Hills, western Ecuador. Cotinga 13:55–58.

BECKER, C. D., A. ÁGREDA, E. ASTUDILLO, M. CONSTANTINO, AND P. TORRES. 2005. Community-based monitoring of fog capture and biodiversity at Loma Alta, Ecuador enhance social capital and institutional cooperation. Biological Conservation 14:2695–2707.

BEST, B. J. AND M. KESSLER (Editors). 1995. Biodiversity and conservation in Tumbesian Ecuador and Peru. BirdLife International, Cambridge, United Kingdom.

BIRDLIFE INTERNATIONAL. 2000. Threatened birds of the world. Lynx Edicions and BirdLife International, Barcelona, Spain and Cambridge, United Kingdom.

BIRDLIFE INTERNATIONAL. 2008a. Species factsheet: *Chaetocercus berlepschi*. BirdLife International, Cambridge, United Kingdom. www.birdlife.org/datazone/ (accessed 9 October 2008).

BIRDLIFE INTERNATIONAL. 2008b. Species factsheet: *Chaetocercus bombus*. BirdLife International, Cambridge, United Kingdom. www.birdlife.org/datazone/ (accessed 9 October 2008).

CISNEROS-HEREDIA, D. F. 2005. La avifauna de la isla de la Plata, Parque Nacional Machalilla, con notas sobre nuevos registros. Cotinga 24:22–27.

CLEMENTS, J. F. AND N. SHANY. 2001. A field guide to the birds of Peru. Ibis Publishing Company, Temecula, California, USA.

COLLAR, N. J., L. P. GONZAGA, N. KRABBE, A. MADROÑO NIETO, L. G. NARANJO, T. A. PARKER III, AND D. C. WEGE. 1992. Threatened birds of the Americas: the ICBP/IUCN Red Data Book. International Council for Bird Preservation, Cambridge, United Kingdom.

CUERVO, A. M., C. D. CADENA, AND J. L. PARRA. 2006. Seguir colectando aves en Colombia es imprescindible: un llamado a fortalecer las colecciones ornitológicas. Ornitología Colombiana 4:51–58.

DICKINSON, E. C. (Editor). 2003. The Howard and Moore complete checklist of the birds of the world. Third Edition. Princeton University Press, Princeton, New Jersey, USA.

DODSON, C. H. AND A. H. GENTRY. 1991. Biological extinction in western Ecuador. Annals of the Missouri Botanical Garden 78:273–295.

FRASER, K. C., T. K. KYSER, AND L. M. RATCLIFFE. 2008. Detecting altitudinal migration events in neotropical birds using stable isotopes. Biotropica 40:269–272.

FREILE, J. AND F. RODAS. 2008. Conservación de aves en Ecuador: ¿cómo estamos y qué necesitamos hacer? Cotinga 29:48–55.

FREYMANN, B. AND K.-L. SCHUCHMANN. 2005. Collecting history of the hummingbird genera *Chaetocercus* Gray 1855 and *Lophornis* Lesson 1829. Journal of Ornithology 146:61–64.

GRAVES, G. R. 1986. Systematics of the gorgeted woodstars (Aves: Trochilidae: *Acestrura*). Proceedings of the Biological Society of Washington 99:218–224.

GURNEY, M. 2006. Identification of Little Woodstar *Chaetocercus bombus* in Ecuador. Neotropical Birding 1:38–41.

HILTY, S. L. 2003. Birds of Venezuela. Princeton University Press, Princeton, New Jersey, USA.

HILTY, S. L. AND W. L. BROWN. 1986. A guide to the birds of Colombia. Princeton University Press, Princeton, New Jersey, USA.

HOBSON, K. A., L. I. WASSENAAR, B. MILÁ, I. LOVETTE, C. DINGLE, AND T. B. SMITH. 2003. Stable isotopes as indicators of altitudinal distributions and movements in an Ecuadorean hummingbird community. Oecologia 136:302–308.

INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN). 2001. IUCN Red List categories and criteria. Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, United Kingdom. www.iucnredlist.org (accessed 8 November 2008).

MATA, J. R. R., F. ERIZE, AND M. RUMBOLL. 2006. Birds of South America, nonpasserines: rheas to woodpeckers. Princeton University Press, Princeton, New Jersey, USA.

MEYER DE SCHAUENSEE, R. 1970. A guide to the birds of South America. Academy of Natural Sciences, Philadelphia, Pennsylvania, USA.

MUNSELL COLOR. 1994. Munsell soil color charts. Macbeth Division of Kollmorgan Instruments Corporation, New Windsor, New York, USA.

PETERSON, A. T., A. G. NAVARRO-SIGÜENZA, AND H. BENÍTEZ-DÍAZ. 1998. The need for continued scientific collecting; a geographic analysis of Mexican bird specimens. Ibis 140:288–294.

REMSEN JR., J. V. 1995. The importance of continued collecting of bird specimens to ornithology and bird conservation. Bird Conservation International 5:145–180.

REMSEN JR., J. V. 1997. Museum specimens: science, conservation and morality. Bird Conservation International 7:363–366.

REMSEN JR., J. V., C. D. CADENA, A. JARAMILLO, M. NORES, J. F. PACHECO, M. B. ROBBINS, T. S. SCHULENBERG, F. G. STILES, D. F. STOTZ, AND K. J. ZIMMER. 2008. A classification of the bird species of South America. American Ornithologists' Union. www.museum.lsu.edu/~Remsen/SACCBaseline.html (accessed 1 April 2008).

RESTALL, R., C. RODNER, AND M. LENTINO. 2006. Birds of northern South America: an identification guide. Yale University Press, New Haven, Connecticut, USA.

RIDGELY, R. S. AND P. J. GREENFIELD. 2001. The birds of Ecuador. Cornell University Press, Ithaca, New York, USA.

SCHUCHMANN, K.-L. 1999. Family Trochilidae (hummingbirds). Pages 468–680 *in* Handbook of the birds of the world. Volume 5 (Barn Owls to hummingbirds) (J. del Hoyo, A. Elliot, and J. Sargatal, Editors). Lynx Edicions, Barcelona, Spain.

SCHULENBERG, T. S., D. S. STOTZ, D. F. LANE, J. P. O'NEILL, AND T. A. PARKER III. 2007. Birds of Peru. Princeton University Press, Princeton, New Jersey, USA.

SIMON, E. 1889. Description d'une espèce nouvelle du genre *Chætocercus*. Mémoires de la Société Zoologique de France 2:230–231.

SMITHE, F. B. 1975. Naturalist's color guide. American Museum of Natural History, New York, USA.

STATSOFT INC. 2003. STATISTICA. Version 6.1. StatSoft Inc., Tulsa, Oklahoma, USA.

VUILLEUMIER, F. 1998. The need to collect birds in the Neotropics. Ornitología Neotropical 9:201–203.

VUILLEUMIER, F. 2000. Response: further collecting of birds in the Neotropics is still needed. Ornitología Neotropical 11:269–274.

WINKER, K. 1996. The crumbling infrastructure of biodiversity: the avian example. Conservation Biology 10:703–707.

WINKER, K. 2005a. Bird collections: development and use of a scientific resource. Auk 122:966–971.

WINKER, K. 2005b. Natural history museums in a postbiodiversity era. BioScience 54:455–459.

WINKER, K., B. A. FALL, J. T. KLICKA, D. F. PARMELEE, AND H. B. TORDOFF. 1991. The importance of avian collections and the need for continued collecting. The Loon 63:238–246.