

THE AUTOECOLOGY OF THE FÍO-FÍO (*ELAENIA ALBICEPS* LAFRESNAYE & D'ORBIGNY) IN SUBANTARCTIC FORESTS OF THE CAPE HORN BIOSPHERE RESERVE, CHILE.

AUTOECOLOGÍA DEL FÍO-FÍO (*ELAENIA ALBICEPS* LAFRESNAYE & D'ORBIGNY) EN LOS BOSQUES SUBANTÁRTICOS DE LA RESERVA DE BIOSFERA CABO DE HORNOS, CHILE.

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RESUMEN

Las aves son los vertebrados terrestres más diversos en el archipiélago del Cabo de Hornos. Por esta razón, muchas de las especies de aves potencialmente pueden desempeñar un papel clave en las interacciones bióticas de los ecosistemas subantárticos. Sin embargo, la falta de estudios ornitológicos a largo plazo en el sur de Sudamérica ha limitado la identificación de aspectos relevantes de la autoecología de las aves, incluso de las especies más comunes. Entre ellas, una especie muy abundante en el verano austral es el fío-fío (*Elaenia albiceps*). Ésta migra anualmente desde regiones de bosques tropicales de Sudamérica (Perú, Bolivia, Ecuador, Colombia, Paraguay y Brasil) hasta los bosques templados del sur de Chile y Argentina, alcanzando incluso los bosques del extremo austral de América en la Reserva de la Biosfera Cabo de Hornos (RBCH). Utilizando la base de datos del programa de anillamiento de Passeriformes de bosque en el Parque Etnobotánico Omora iniciada hace 8 años, se describen cinco aspectos de la autoecología del fío-fío en la RBCH: a) longevidad y filopatría, b) fechas de arribo y partida de la región, c) abundancia de adultos y juveniles, d) dieta y e) morfología. Durante el período de estudio se han anillado 827 fío-fíos. De éstos, 67 fueron recapturados, lo que permitió determinar que los fío-fíos pueden vivir hasta al menos 7 años. El primer y último registro de fío-fíos en el área de estudio fueron el 28 de octubre y el 15 de abril, respectivamente. Los juveniles abandonaron el nido en enero. La abundancia aumentó a partir de octubre hasta enero cuando constituyó el 35% del ensamble de aves de bosque. La dieta del fío-fío se compuso de 10 órdenes de invertebrados y a lo menos 5 especies de plantas. Los machos tuvieron colas y alas significativamente más largas que las hembras, mientras éstas

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fueron significativamente más pesadas en la estación pre-reproductiva (Oct-Dic). Este estudio provee nueva información de la autoecología del fio-fío en los bosques más australes del mundo.

Palabras clave: comunidad avifauna, nicho, rol ecológico, *Nothofagus*.

ABSTRACT

As the most diverse and abundant terrestrial vertebrates in the Cape Horn Archipelago, birds potentially play key roles in the ecology of subantarctic ecosystems. However, the lack of long-term ornithological studies in southern South America has previously hindered the identification of relevant aspects of the autecology of even the most common species. One abundant species in the austral summer is the fio-fío (*Elaenia albiceps*), which migrates annually between the tropical regions of South America (Perú, Bolivia, Ecuador, Colombia, Paraguay & Brasil) to as far south as the Cape Horn Biosphere Reserve (CHBR), Chile. Using the database accumulated during the eight year mist-netting program of Passeriformes forest birds at the Omora Ethnobotanical Park, it was possible to describe various aspects of the fio-fío's ecology in the CHBR by determining: a) longevity and site fidelity, b) arrival-departure dates, c) abundance of adults and juveniles, d) diet and e) morphology. A total 827 fio-fíos were banded during the study period. Of the 67 recaptures, it was possible to determine that fio-fíos may live at least up to 7 years. Fio-fíos arrived as early as 28 October and left as late as 15 April with juveniles fledging in January. Their abundance increased from October to reach approximately 35% of the forest bird assemblage by January. In the austral archipelago, the fio-fío's diet consisted of 10 invertebrate orders and at least 5 plant species. Males had significantly longer tails and wings than females, while females were significantly heavier in the pre-fledging season (Oct-Dec). This study provides new information on the autecology of fio-fío in the world's southernmost forests.

Key words: avian community, ecological role, niche, *Nothofagus*.

INTRODUCTION

The South American temperate forest biome occurs between 35° and 56°S (Arroyo *et al.* 1996; Armesto *et al.* 1996a) and is characterized by relatively low species richness and high levels of endemism, compared to Northern Hemisphere temperate forests (Armesto *et al.* 1995; Veblen *et al.* 1996). Close to 90% of the woody plant species found in this ecoregion are endemic to the temperate forests of South America, and among vertebrates we find endemic species representing: 50% of fishes (26 spp.), 80% of amphibians (30 spp.), 36% of reptiles (16 spp.), 30% of land birds (44 spp.), and 33% of mammals (33 spp.) (Armesto *et al.* 1996b). At the southern limit of this biome, we find the world's southernmost forested ecosystems, encompassed in the Cape Horn Biosphere Reserve (CHBR) (approx. 55°S), declared by UNESCO on June 25, 2005, which is the largest biosphere reserve in the Southern Cone and the only in Chile to include terrestrial as well as marine ecosystems and human populations (Rozzi *et al.* 2006, 2007).

Not only is the degree of endemism of the southern temperate forest region unusually high, but so is the frequency of plant-animal mutualisms, particularly related to seed dispersal and pollination (Aizen & Ezcurra 1998). A high percentage (67%) of plant species have fleshy fruits and avian seed dispersal, and more than 50% of the plant species require a biotic pollinator (Armesto *et al.* 1987; Armesto & Rozzi 1989; Riveros 1991¹; Rozzi *et al.* 1996a,b; Willson *et al.* 1996; Aizen & Ezcurra 1998). Most bird-plant pollination and dispersal studies, however, have been conducted in south-central Chile and the Valdivian rainforests (e.g., Rozzi *et al.* 1996a).

South of the Gulf of Penas (49°S), the Magellanic subantarctic forest ecoregion extends over the archipelagoes reaching Cape Horn (56°S), forming one of the most pristine wilderness areas remaining on the planet (Mittermeier *et al.* 2001;

¹ Riveros, M. 1991. Aspectos Sobre la Biología Reproductiva en Dos Comunidades del Sur de Chile (40°S). Ph.D. Dissertation, Facultad de Ciencias, Universidad de Chile. Santiago, Chile.

Rozzi *et al.* 2006). Given its recent glacial history and the biogeographic barriers presented by the numerous channels and fjords, the terrestrial vertebrate communities in this region are relatively species poor, and birds constitute a diverse and ecologically important component of the archipelago's fauna (Venegas & Sielfeld 1998; Anderson *et al.* 2006).

Seminal research on the songbirds of the Magellanic subantarctic forests has permitted a good understanding of the forest avian assemblage (Barros 1971, 1976; Sielfeld 1977; Venegas 1981, 1991; Anderson & Rozzi 2000). Nonetheless, the autecology of many species in this region remains poorly known (but see Schlatter & Vergara 2005). To fill this gap in our knowledge, the Omora Ethnobotanical Park, a Long-Term Ecological Research (LTER) site run by the University of Magallanes and Institute of Ecology and Biodiversity located near Puerto Williams (55°S) in the CHBR, began conducting a continuous mist-netting program of forest birds in January 2000. The program aims to provide answers to basic ecological questions about subantarctic avifauna, including life history, diet, morphology and migration patterns.

Among forest birds, the fío-fío (White Crested Elaenia or *Elaenia albiceps* Lafresnaye & d'Orbigny 1837) is a species of particular relevance due to its summer-time abundance and because it is the only member of the forest avian community that undertakes long-distance migrations between tropical and temperate forests of South America (Fjeldsa & Krabbe 1990; Rozzi *et al.* 1996a). It is known that *Elaenia* winters in the tropics, and based on observational studies conducted in its winter range, *E. albiceps* has been described as present in eastern Paraguay during the austral spring (October-November) and autumn (March-April) months (Hayes *et al.* 1994). Data from Chile in the fío-fío's summer habitat indicates that *E. albiceps* migrates down the eastern edge of the Andes and crosses laterally into Chile from Argentina in an east-west direction, arriving as far south as the subantarctic archipelago (Goodall *et al.* 1951; Araya *et al.* 1995; Espinoza & Egli 1997; Venegas & Sielfeld 1998).

As a migratory species inhabiting a very wide latitudinal range, the fío-fío has shown wide feeding plasticity and thus occupies a broad and diverse ecological niche (Armesto *et al.* 1987; Rozzi *et al.* 1996a,b). On Chiloé Island, in spring it is largely

a nectarivore (Smith-Ramírez & Armesto 1998, 2003), but in summer becomes principally frugivorous (Sabag 1993)², despite pertaining to the family of "flycatchers." On the other hand, in Argentina's Nahuel Huapi National Park, the summer diet of the fío-fío was constituted of 70% insects and 30% plant items (Grigera 1982). In Central Chile, López – Calleja (1990)³ recorded a diet composed mostly of seeds (41.67% summer and 1.22% spring) and insects (54.33% summer and 98.79% spring). Additionally, in its winter range, the genus *Elaenia* has been reported to be principally frugivorous in the Amazonian sector of northeastern Peru (Fitzpatrick 1980), and it is known to be an omnivorous fruit and insect eater in September and October in Paraguay (Foster 1987).

The goal of this study was to characterize five essential attributes of the autecology of *Elaenia albiceps* in the Magellanic subantarctic forests: a) longevity-site fidelity, b) arrival-departure dates, c) abundance of adult and juvenile individuals, d) diet and e) morphology. To develop this analysis, we used the database of the long-term mist-netting program at the Omora Ethnobotanical Park on Navarino Island in the Cape Horn Biosphere Reserve, Chile, with over 6,000 captures since the year 2000.

MATERIALS AND METHODS

Study area

The study was conducted at sites on Navarino Island in the CHBR (Fig.1). All surveyed locations were within 10 km of the coast on the northern and western slope of the island, which is characterized mixed *Nothofagus* forests with a mosaic of bogs, high-Andean and matorral ecosystems (Rozzi *et al.* 2006). The long-term mist-netting program is conducted within the Omora Ethnobotanical Park, which is approximately 4 km west of the town of Puerto Williams. Other sites outside the Omora Park were mist-netted only in summer and with point-count transects. These other study sites included:

² Sabag, C.E. 1993. El rol de las aves en la dispersión de semillas en un bosque templado secundario de Chiloé (42° S). Tesis de Magister. Universidad de Chile.

³ López Calleja, M.V. 1990. Variación estacional en el uso de los recursos alimenticios por algunos componentes de una taxocenosis de aves paseriformes en Quebrada de la Plata, Chile Central. Tesis de Magister. Universidad de Chile.

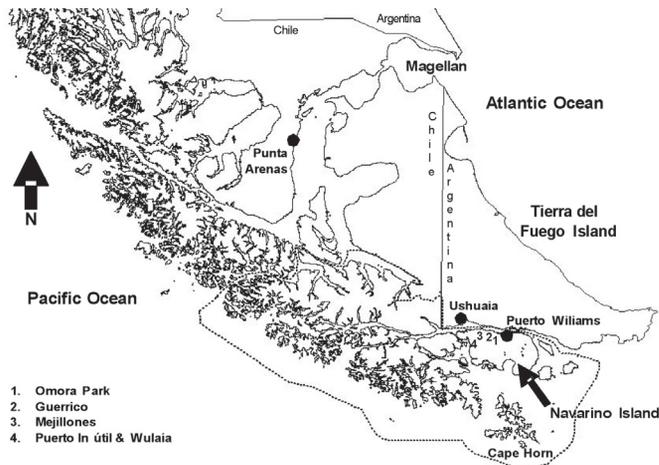


Fig.1. Mist-netting was conducted systematically from 2000-2007 at the Omora Ethnobotanical Park (University of Magallanes – Institute of Ecology and Biodiversity) on Navarino Island in the Cape Horn Biosphere Reserve (dotted line). Summer surveys were conducted as well at Guerrico, Mejillones, Puerto Inútil and Wulaia.

Mejillones and Guerrico on the island's north coast; Puerto Inútil and Wulaia on the west coast in the area of the Murray Channel; and Cerro La Bandera and Cerro Róbaló (adjacent to the Omora Park), which were the only high elevation sites studied (>350 m).

Mist-netting program

From 2000 to 2002, mist-netting was conducted only during spring, summer and fall seasons. Systematic, year-round mist-netting began in January 2003, including six consecutive days each month with a minimum of five hours each day. Two permanent sites have been used: a) "Canelo Site," which has as dominant vegetation of Winter's bark (canelo in Spanish or *Drymis winteri*) in a mixed forest of Magellanic coigue (*Nothofagus betuloides*) and lenga (*N. pumilio*) and b) "Notro Site," which is an anthropogenically created shrubland with firebush (notro in Spanish or *Embothrium coccineum*), as well as fashine (*Chilotrichium difussum*) and box-leaved barberry (*Berberis buxifolia*). The six days of netting are divided with three days each in the Canelo and Notro sites.

To date, the program has produced a working database of more than six thousand bird captures, 827 of which are *fió-fíos* (excluding recaptures). The protocol of the banding program is as per Anderson *et al.* (2002). Once banded, each bird is subjected to a set of measurements including:

bill length, wing length, tarsal length, tail length, and total weight. A caliper (0.1 mm) was used to measure beak length at the culmen and the tarsal bone. Wing and tail lengths were recorded with a ruler (1 mm), and weight was taken with a spring scale (1 g). When possible, sex and age were also determined. Additionally, all birds heard and seen during the mist-netting period were recorded.

During the years 2002-2003, all birds that defecated during handling had their feces collected for subsequent diet analysis. Samples were preserved and dried in paper envelopes, and later contents were identified using a dissecting microscope. In addition, the *fió-fíos* caught from December to January 2002 were sampled for nectar consumption by using Scotch tape to remove pollen grains from above and below the beak of the bird. The tape was then placed on a microscope slide to be observed under a compound microscope. Reference collections of common plant seeds and pollen grains were made to determine the species of remains in feces and the pollen on slides.

Data analysis

Recapture data were examined to determine minimum age of recaptured *fió-fíos*. Individuals were classified as at least one year old at the time of their first capture, unless they were a fledgling. In addition, we used these data to determine the percent of individuals that returned to the same nesting-feeding

area each austral summer. Furthermore, arrival and departure dates were determined based on the first and last date in which fío-fíos were heard, seen or captured in the mist-nets.

Mist-netting capture data were standardized to account for sampling effort, whereby the number of fío-fíos captured was divided by the product of the area of the net used each sample day (m^2) multiplied by the time the net was open (h) to determine the abundance (number of individuals captured $m^{-2} \times h^{-1}$), as per Anderson & Rozzi (2000). The abundance of fío-fíos was then compared to the total abundance of songbirds over the eight breeding seasons to determine the mean relative abundance of *E. albiceps* in subantarctic forests on a monthly basis.

Dietary components found in the feces of the fío-fío were tabulated as the percent of individuals having a particular food item in their diet and presented as annual and seasonal (spring and summer) values. Items were determined to the level of order for insects and species for plants. Morphological differences between sexes and seasons (pre- and post-fledging) were compared using one-way ANOVA with a post-hoc HSD test (JMP 5.1, SAS). In the analysis, “pre-fledging months” were October, November and December, while “post-fledging” included January, February and March; this distinction was based on the dates that juvenile fío-fíos appeared in mist-nets. These data were finally compared to values reported for northern Chile by Espinoza & Egli (1997).

RESULTS

Longevity and site fidelity

A total of 67 fío-fíos were recaptured over the 8 breeding seasons included in the study. The majority of recaptures were of individuals 3 years old or less. However, a number of recaptures demonstrated that the fío-fíos of the subantarctic forests lived for at least up to 6 or 7 years (Table 1).

The year-to-year recaptures of fío-fíos have been consistent throughout the study period since the third breeding season: 2001-2002 (Table 2). The range of percent recaptured individuals since 2001-2002 has gone from 2.4% of total fío-fío captures to as high as 11.4%. During this time, no banded individual from one study site has been found in another location, which is to say that birds caught

TABLE 1. Of the 827 fío-fíos (*Elaenia albiceps*) captured in the Omora Ethnobotanical Park, 67 were individuals recaptured in more than one year. From this capture-recapture information the minimum age of individuals was determined.

Minimum age	Number of individuals
1	30
2	16
3	12
4	3
5	2
6	3
7	1
n	67

in one area along the north coast of Navarino Island (e.g., Omora Park, Guerrico, Mejillones, Cerro Róbal) were not crossing territories either within or between years.

Seasonality of arrival/departure and abundance

In the CHBR, the fío-fío's spring arrival occurred during a month-long period from late October to late November. Departure times were more variable, ranging from mid-March to as late as April (Table 3A). In 2007, most fío-fíos apparently left by late February, even though one individual was seen as late as 29 March. This year was also particularly cold, with snow even in February.

There was no observed trend regarding the arrival of adults in the spring with relation to the sex of the first arrivals (Table 3B). Males were more frequently caught in mist-nets, however, but displayed a similar percentage each month compared to females. Notably, the latest individuals captured in mist-nets were juveniles (Fig. 2). Furthermore, after the beginning of the breeding season in the

TABLE 2. The total of fío-fíos captured and the number and percent that constituted recaptures during the 8 year study period.

	Captures N	Recaptures #	Recaptures %
1999 - 2000	8	0	0
2000 - 2001	134	0	0
2001 - 2002	82	2	2.44
2002 - 2003	42	3	7.14
2003 - 2004	165	14	8.48
2004 - 2005	164	10	6.10
2005 - 2006	149	17	11.41
2006 - 2007	83	8	9.64

TABLE 3. A. The arrival and departure of the migratory fio-fio has been recorded since 2003 based on the first and last capture dates in the Omora Ethnobotanical Park's mist-netting program. *Last mist-net capture, but last individual was seen on 29 March 2007 in Guerrico. B. The percentage of each sex arriving per month in the austral spring.

A. First and last mist-net captures of fio-fios			
Year	First Capture	Last Capture	
2003 - 2004	28-Oct	26-Mar	
2004 - 2005	28-Oct	15-Apr	
2005 - 2006	20-Nov	12-Mar	
2006 - 2007	20-Nov	24-Feb*	

B. Spring arrival of male and female fio-fios			
	October	November	December
	% (n)	% (n)	% (n)
Female	0.8 (1)	35.8 (44)	63.4 (78)
Male	1.6 (3)	32.3 (62)	66.2 (127)

austral spring, fio-fios increased their proportional representation, attaining approximately 35% of the summer forest bird abundance from November to February (Fig. 3).

Diet

The fio-fio was clearly omnivorous in the austral archipelago, including both insects (10 orders) and plant material (at least 5 species) (Table 4) in its diet. Plant components of the fio-fio's diet were both more diverse and more common in summer than in spring (Table 4). The fruit of Winter's bark (*Drimys winteri*) was the most consumed plant item. Lesser and relatively equal contributions came from box-leaved barberry (*B. buxifolia*), dwarf maiten (*Maytenus disticha*), wild currant (*Ribes magella-*

nium), and grasses. Of the 113 fio-fios analyzed for pollen, 88.5% had pollen grains of *Embothrium coccineum* on their beaks, but no other plant's pollen was collected from fio-fios.

Regarding insects in the fio-fio's diet, adult flies (Diptera) were the most abundant insect prey in both spring and summer (Table 4). Other commonly found (10% - 40%) insect prey included: Coleoptera, larval Lepidoptera, Hymenoptera, Hemiptera, Homoptera and Arachnida. Less common (<10%) insect diet items were: adult Lepidoptera, Psocoptera, adult and larval Neuroptera and Acari.

Morphological measurements

Morphological measures showed that males and females were of the same size for beak and tarsal length, but significant differences between the sexes were detected for wing length, tail length and weight (Table 5). Males had significantly longer wings and tails than females, while a closer examination of the differences in weight between males and females showed that females were significantly heavier than males, but only in pre-fledging season (sex*season, $F_{3,450} = 7.73$; $p = 0.001$, post-hoc HSD test $p < 0.05$) (Fig. 4).

DISCUSSION

The ecological role of the fio-fio in subantarctic forests

The study of subantarctic forest birds has been very thorough in describing community composition (e.g., Venegas 1981, 1991; Fjeldsa & Krabbe

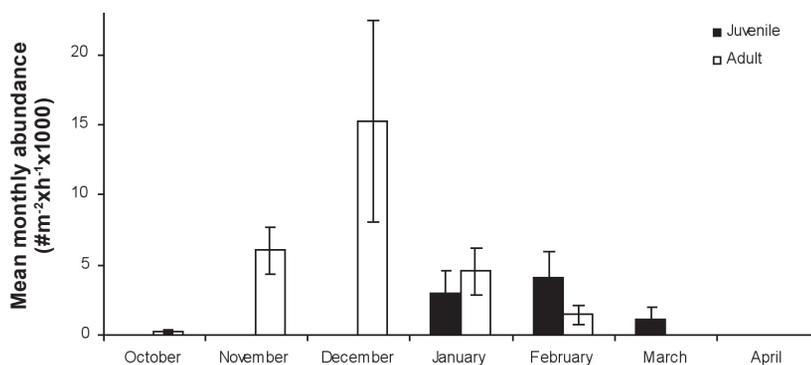


Fig. 2. Mean monthly abundance of adult and juvenile fio-fios (*Elaenia albiceps*) (\pm S.E.) was standardized for sample effort based on 8 breeding seasons of mist-net captures in the Cape Horn Biosphere Reserve.

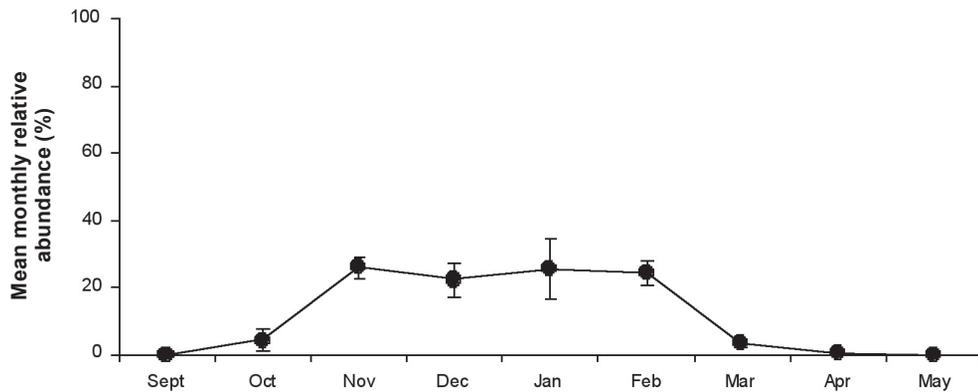


Fig. 3. Mean monthly relative abundance (\pm S.E.) of fio-fíos, as a percentage of the total forest bird assemblage, was calculated based on 8 breeding seasons of mist-net capture data.

TABLE 4. Diet of the fio-fío was determined using feces collected from captured individuals. Dietary components were categorized to the order level for insects and the species level for plants and separated based on season. Values represent the percentage (%) of individuals whose feces contained a particular food item.

Invertebrate Diet		% Total n=51	% Spring n=10	% Summer n=41
Coleoptera	Adult	21.6	40	17.1
Diptera	Adult	60.8	50	63.4
Lepidoptera	Adult	2	0	2.4
	Larva	19.6	40	14.6
Hymenoptera		25.5	30	24.4
Psocoptera		7.8	10	7.3
Hemiptera	Adult	11.8	20	9.8
	Nymph	5.9	10	4.9
Homoptera		23.5	10	26.8
Neuroptera	Adult	5.9	0	7.3
	Larva	2	0	2.4
Arachnida		27.5	40	24.4
Acari		3.9	0	4.9
Unidentified Insects		5.9	0	7.3
Total Invertebrate		88.2	100	87.5
Plant Diet				
<i>Drimys winteri</i>		33.3	10	39
<i>Berberis buxifolia</i>		5.9	0	7.3
<i>Ribes magellanicum</i>		5.9	0	7.3
<i>Maytenus disticha</i>		3.9	10	2.4
Gramineae		6	0	7.3
Unidentified seeds		17.6	0	22
Amorphous plant material		37.3	20.0	41.5
Total Plant		88.4	30	90

1990; Anderson & Rozzi 2000) and recently has been extended to understanding the effects of forest management on avian assemblages (e.g., Venegas & Schlatter 1999; Deferrari *et al.* 2001; Lencinas *et al.* 2005), including reports that timber practices that reduce canopy cover adversely affect the *E. albiceps* (Vergara & Schlatter 2006). Nonetheless, comparatively little is known about the long-term life histories, behavior and ecological role of these diverse and potentially important species found in the extreme austral tip of the Americas. As the most speciose and abundant group of terrestrial vertebrates south of the Strait of Magellan, filling our gap in knowledge about austral avifauna is a high priority for ecological understanding as well as conservation planning in the Cape Horn Biosphere Reserve, Chile.

These data allowed us to determine certain aspects of the autecology of the fio-fío (*Elaenia albiceps*) at the southern extent of its range in the CHBR. We now know that both males and females arrive at approximately the same time in the austral spring and occupy the austral forests from late October to late March with some individuals, particularly juveniles, remaining into April. These arrival and departure dates for the fio-fío's migration to and from the CHBR agree with expectations drawn from the reports cited by Espinoza & Egli (1997) for areas farther north in Chile. These authors described arrival dates to central and southern Chile (IV to X Regions) principally from mid-September to mid-October. Consistent with the extension of the migration to the south, the arrival of the fio-fío

TABLE 5. Mean morphological measurements of the fio-fio (*Elaenia albiceps*) (± 1 S.D.) from the Cape Horn Biosphere Reserve. Significant differences between male and female characteristics were determined with ANOVA and Tukey HSD post-hoc test, $p < 0.05$).

	Wing mm	Tarsus mm	Beak Length mm	Tail mm	Weight g
Male	76.2 (2.7)	20.3 (1.6)	8.8 (0.8)	64.2 (3.3)	16.0 (1.1)
Range	66 - 86	16.5 - 23.4	5.3 - 11.2	50 - 76	12.3 - 22.4
n=272	n=249	n=196	n=194	n=167	n=256
Female	73.8 (2.4)	20.18 (1.72)	8.6 (0.7)	63.0 (2.5)	16.3 (1.3)
Range	63 - 81	12.8 - 24.4	7.1 - 11.0	56 - 71	13.7 - 21.1
n=222	n=210	n=163	n=160	n=137	n=208
F	101.15	0.21	2.67	14.02	9.53
p	<0.0001	0.65	0.1	0.0002	0.002

in the CHBR occurred largely from late October to late November. In addition, as with our results, farther north in Chile the fio-fio's departure date was more variable, ranging from late March to late May (Espinoza & Egli 1997). In contrast, when we take into account these reports from Chilean temperate forests, the dates presented by Hayes *et al.* (1994) for Paraguay were somewhat unexpected. These authors confirmed the presence of *E. albiceps* passing through eastern Paraguay during its migrations in the austral spring (October-November) and autumn (March-April), during the same months that the fio-

fio was also found much farther south in the CHBR. The results from Paraguay would indicate that the population of fio-fios resident in the austral summer in Cape Horn do not pass through this area on their migratory route to the tropical forests of Brazil.

Based on 8 years of field work, we were also now able to determine the abundance of the fio-fio on a monthly basis as well. In the study site, fio-fios reached as much as one-third of all mist-net captures from November to February, which is higher than we previously reported based on only one field season of data (January to May 2000),

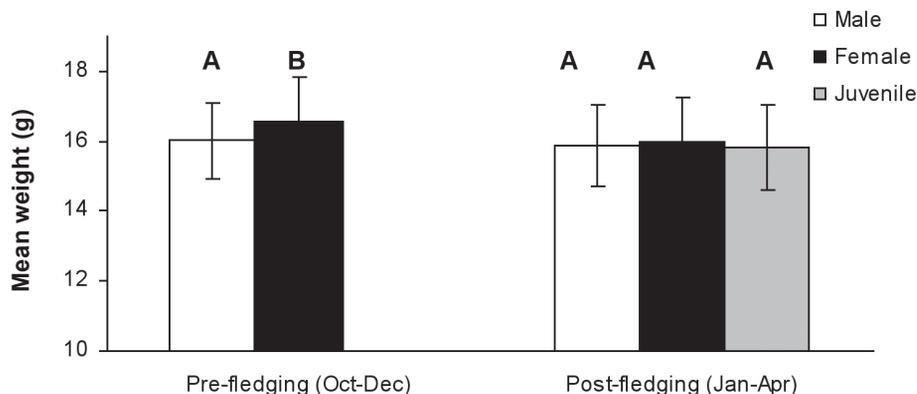


Fig. 4. Mean weight (\pm S.E.) of fio-fios was compared between males, females and juveniles in pre- and post-fledging seasons (Oct-Dec and Jan-Apr, respectively). Significant differences are indicated with different letters (Tukey HSD post-hoc test $p < 0.05$).

where we found fio-fíos to be just 9.5% of the forest bird assemblage on Navarino Island (Anderson & Rozzi 2000). These are furthermore the only data of which we are aware that make it possible to determine the longevity of this species in the extreme south, where one recaptured individual has lived and migrated annually to the CHBR for at least 7 years. Furthermore, these recaptured specimens demonstrate a great precision in returning to the same nesting sites. It is important to point out that the mist-netting program in the Omora Park uses almost exactly the same positions for its mist-nets since 2000. Therefore, the fact that as many as 11.4% of the fio-fíos caught each year are recaptures from previous years demonstrates that these birds not only return to the same area, but to exactly the same nesting site year after year. This site fidelity for the austral breeding sites in Cape Horn also might be matched with high site fidelity in wintering areas in Paraguay, Bolivia, Ecuador, Colombia or Brazil, where such behavior has been demonstrated in the congeneric species *Elaenia parvirostris* in Venezuela (McNeil 1982) and *Elaenia strepera* in Peru (Marantz & Remsen 1991). Our results not only confirm this remarkable behavioral trait in *Elaenia albiceps*, but also the need for coordinated international conservation programs in South America for the protection of habitats used by migratory bird species (Rozzi & Feinsinger 2006).

Latitudinal considerations in the ecological role of the fio-fío.

It has previously been shown that certain aspects of the autecology of birds, such as clutch size (Young 1994), can vary with latitude, making it relevant to understand the ecological role of fio-fíos at the extreme southern limit of their distribution on the grounds of basic understanding of this species as well as testing broader ecological theory that attempt to test the underlying mechanisms to explain patterns of biodiversity and ecological phenomena. As a migratory species with a long latitudinal range, the fio-fío must confront a variety of ecosystems and food resources. In tropical regions, the winter diet of species in the genus *Elaenia* has alternatively been described as frugivorous and omnivorous (Fitzpatrick 1980; Foster 1987), and data from central Chile and northern Argentine Patagonia re-confirm this dietary

plasticity for the fio-fío, including a wide variety of feeding modes: nectivory, insectivory, granivory and frugivory (Grigera 1982; López-Calleja 1990; Sabag 1993; Smith-Ramírez & Armesto 1998, 2003).

It was clear from our dietary analyses that in subantarctic forests the fio-fío is an opportunistic omnivore as well, consuming large proportions of plant and animal materials in both spring and summer, even though the spring diet has relatively less contribution of plant items. Furthermore, the high percentage of fio-fíos that were found with pollen grains of the firebush (*E. coccineum*) showed that nectar can be an important source of energy in subantarctic forests, as has also been recorded on Chiloé Island (Smith-Ramírez & Armesto 1998), in spite of the fact that in subantarctic forests there are much fewer flowering plant species.

Detailed studies of behavior and life history of the fio-fío are lacking in other parts of the Chilean temperate forests for comparative purposes. However, we were able to compare our data with studies that have reported morphological features from populations farther north. Overall male and female fio-fíos in the CHBR had similar morphological measurements, except tail and wing feather length. In contrast, the weight of females was significantly greater than males, but only in spring, which suggests this is related to egg laying. In contrast, Foster (1987) reported males of *E. albiceps* being on average heavier than females (16 g versus 15 g) in the tropics of Paraguay. Espinoza & Egli (1997) did not separate sexes, but found that the average weight of the *Elaenia albiceps chilensis* was between 16.63 and 16.46 in the Valparaiso and Lakes Region of Chile, respectively. In comparison, the fio-fíos from the CHBR were somewhat smaller, which conflicts with expectations from Bergman's Law that hypothesizes larger individuals within the same species will occur at higher latitudes (Bergmann 1847).

CONCLUSION

These data should help establish a better understanding of the ecological role of the fio-fío in subantarctic forests and serve for comparisons with other parts of its long migratory range. Determining aspects of life history, behavior and ecology of species in the extremes of their ranges will allow us in the future to test questions in evolution and relations-

hips of biodiversity and ecosystem function along the natural transect gradient provided by Chilean temperate forests and the long-term ecological study network established from Fray Jorge National Park (33°S) to Chiloé Island (43°S) to Cape Horn (55°S) by the Millennium Institute of Ecology and Biodiversity. By establishing long-term ecological research in these sites, it is hoped that not only can greater information be generated to aide resource managers conserve this biodiversity, but also provide a natural laboratory to test fundamental questions in ecology and evolution.

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