Speciation of chilean Rhinocryptidae (Avian) based on their behaviour.

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The current classification of the chilean representatives of the passerine family Rhinocryptidae includes eight species. Three of them contain subspecies that don't exhibit clear differences. Moreover, differences among two lineages of *Scytalopus* genera and two species of *Pteroptochos* are very scarce. We propose a new methodology based on ecological and behavioural patterns in order to understand the concept of speciation in this group of birds. According to our results, we postulate that there is not a cut criteria to establish differences among three sister lineages of current classification. This way the methodology developed by us does not allow to establish divergence for a given common ancestor. Our methodology allows to establish comparison among previously determined phylogenetic lineages. Our results show how when integrating behaviour and ecological terms as biological traits next to morphological characters of the plumage, it allows us to conclude that there is decrease of the distances among sister lineages in the cluster tree.

According to current classification of Chilean lineages of Rhinocryptidae, there are four genera containing eight species of Rhinocryptidae three of which include subspecies[1,2,3,4,5,6,7] (Tab. 1). Five of these species are endemic to the temperate forests in the south of Chile[8] (A.C, unpublished data). These species of birds have benefited greatly from the increased diversity in plant seed size and morphology during the tertiary [9,10] and also in this time[11].

The current classification of the lienages of chilean rhinocryptids has separated them in order to their morphological characters, plumage variations, geographical dispersion[1,2,3,12,5] and differences of vocalizations patterns [13,6].

In general, the Chilean Rhinocryptidae present very rapid corporal movements [14,5] (A.C, unpublished data) as well as highly developed exploratory vision and hearing acuity[14]. Their basal metabolic rates are 50-60% higher than those of other birds of their size[16]. Studies of the feeding ecology of these birds indicate that they have omnivorous and opportunistic diets[11].

There is no sexual dimorphism within species of this family. Males can be distinguished due to their conspicuous vocalizations in breeding season (A.C, unpublished data). The vocalizations in species of the family Rhinocryptidae are due to the presence of a modified syrinx denominated tracheophone syrinx[12,17] that allows to produce a wide spectrum of vocalizations in order to permit encounters among individuals of the same species (A.C, unpublished data).

The brain of the Rhinocriptydae possesses strong structural and functional similarities with those of mammals, specially with regard to the structures that enable multimodal integration capacity in the telencephalon[18]. Such anatomical characteristic

of the Rhinocryptidae family may be associated with the behavioural abilities to exploit diverse environments[16]. In turn, this behavioural plasticity might facilitate the use of diverse habitats and broad geographical distribution, as shown by the Chilean species (Fig. 1).

Here we discuss the differences and similarities among the lineages of the chilean rhinocryptids introducing new information on behavioral aspects and habitat use. Additionally, we carried out an integrated analysis, including ecology, morphology and behaviour to asses differences among the already described lineages.

The current classification of Chilean Rhinocriptydae is based on morphological characters of the feathers and ecological aspects used as shown in Table 1. We applied a cluster tree analysis to the data used in this classification (Fig. 2a) and found that in the lienages; *S. albicollis, S.rubecula* and *P. megapodius* there is no evidence supporting the distinction of sister lineages (Figs. 2a-2b). Moreover, between each of the pairs of sister lineages of tapaculos, Moustached turca (*Pteroptochos megapodius megapodius- P. m. atacamae*), White throated tapaculo (*Scelorchilus albicollis albicollis- S.a. atacamae*) and Tapaculo Chucao (*S. rubecula rubecula- S.r.mochae*), the values of Russel & Rao indexes were 1.0 (Figs. 2a-2b), and the analysis of distances gives a value of 0 indicating that these sister lineages can not be distinguished using these traits (Fig. 2a). Additionally, the two species of *Scytalopus* genera; Magellanic Tapaculo and Dusky Tapaculo (*Scytalopus magellanicus* and *S. fuscus*) showed differences, with a similarity rate of 0.79 (Figs. 2a-2b) and a distance analysis of 0.091 (Fig. 2b). The species of Black throated huet-huet (*P. tarnii*) and Chestnut throated huet-huet (*P. castaneus*) differed somewhat, with a similarity o rate value of 0.58 (Figs. 2a-2b). Distance analysis is 0.36 (Fig. 2b). Differences between them are in

some morphological characters of their plumage (17 of a total of 26 traits) and the fact that they inhabit different geographical regions (Fig. 1). Also, these superspecies are considered conspecific[7].

Our classification of chilean Rhinocrcripydae is made with behavioural and ecological data, adding to the morphological characters of the plumage (data described in Table 2, as shown in Figs. 2c-2d). We applied a Russel & Rao rate and constructed a cluster tree (Fig. 2c). The test indicates that the species; *S. albicollis, S.rubecula* and *P. megapodius* present no evidence to support the distinction of sister lineages that can be separated using these data (Figs. 2c-2d). The data obtained in the comparison of different species using the above test showed similarity indexes with high values (Table 6) These values indicate, in a certain way, that there exists a high degree of similarities between the species whose behaviour in a specific habitat was compared. For example, similarity between Black throated huet-huet and Chestnut throated huet-huet, two lienages considered separate species under the current classification, has a rate value of 0.71 (Fig. 2c, Table 6) and distance analysis is 0.36 (Fig. 2d). Both species live in different geographical regions. Chestnut throated huet-huet is distributed from Colchagua Province (34ºS; 71º W) until Concepción and Néuquen (Argentina)[19], while Black throated huet-huet is distributed from the Biobío river (37º S; 72º W) until the Canal de Messier in the province of Ultima Esperanza (53º S; 70º W) and in Argentina (37º S; 53º S). Differences are the morphological characters of plumage (12 of a total of 26 traits), involving only the extension of the reddish brown plumage to cover the entire throat and sides of the head in Chestnut throated huet-huet[1,2º]. The similarity index in the cluster tree involves different species (Fig.2c). However, both lineages live in the understory of the temperate rain forest, occupying the same ecological niches and

possess an identical behavioural traits (A.C, unpublished data). However these species are sister taxa[36]. An interesting case also worth mentioning are the species of Magellanic Tapaculo and Dusky tapaculo; *S. magellanicus* and *S. fuscus*, two lineages considered separate under the current classification. The value of rate is 0.88 (Fig. 2c) and a distance analysis is 0.09 (Fig.2d). However these two species differ in some variation of the plumage, because *S. fuscus* possess brown colorations with spotted light brown in the loin, breast and in the crown, and *S. magellanicus* has a gray brown plumage coloration and differs in some measures of morphometric characteristics (Table 3). These characters may be not sufficient to separate then as lineages. Both Rhinocryptidae species of the genera *Scytalopus* cover Chile in nearly all its geographical extension[7] (Fig.1) specially *S. magellanicus* in the south austral due to the smaller habitat specifity[21]. On the other hand *S. fuscus* spreads from Atacama (18º S; 70º W) until Biobío (37º S; 72º W) on Andean mountain habitat to 4,000 m of altitude. *S. magellanicus* is distributed geographically between the Bío-Bío river (37º S) and Cape Horn (55º S)(Fig.1) and the Malvinas Island[23,24,25] up to Los Andes from Ñuble (36º S; 71º W) to the north and in Argentina (38º S; 52º S). We observed that they dominate different types of habitat (Fig.1, Table 4). Also both are sympatric at least from Bio-bio to Santiago (possibly to Aconcagua)[26]. Therefore due to the high index of similarity among these lineages (Fig. 2c, Table 6), although the call of these species is very different[13,7]. However they have been classified as sister taxa[6,26].

An interesting rate value of 1.0 (Fig. 2c, Table 6) is obtained for the pair of subspecies Tapaculo Chucao; *S.r. mochae* and *S.r. rubecula* mentioned in the current classification, which occupy similar ecological niches in the understory of the temperate

rain forest but are located in different geographical regions. *S.r. mochae* is distributed geographically in Isla Mocha (38º S; 74º W) and *S.r.rubecula* is distributed from Colchagua province (43º S; 70º W) until Golfo de Penas (47º S; 74º W). Although from the description made by different authors, *S.r. mochae* is significantly larger than *S.r. rubecula*[1,20] a high index of similarity for these two sister lineages suggests a weak taxonomic separation (Fig. 2c).

In the case of lineages of White throated tapaculo *S. a. albicollis* and *S. a. atacamae* that possess a high similarity rate value of 1.0 (Fig. 2c), they occupy the same ecological niches of the mountainous sclerophyllous shrublands of the Andes and in the Coastal range but are located in different geographical regions: *S.a. albicollis* is distributed geographically between Los Vilos (Choapa Province) (31º S;71º W), until Curico (34º S; 71ºW) and *S.a. atacamae* is distributed geographically between Quebrada de Paposo (23º S; 70º W) (Antofagasta) until Coquimbo (29º S; 71ºW). Descriptions made by different authors of morphological characters indicate that the plumage of *S.r. atacamae* is significantly pale, without brownish on upperparts, and the bill is shorter than *S.r. albicollis*[1,20]. In fact the high index of similarity for these sister lineages does not justify a taxonomic separation (Fig. 2c, Table 6).

Interesting is the case of Moustached turca; *P.m. megapodius* and *P.m. atacamae* that possess a high value 1.0 (Fig. 2c, Table 6). They occupy the same ecological niches and habitat of the mountainous sclerophyllous shrublands of the Andes and shrublands of the Coastal range , but however they are located in different geographical regions. *P.m. megapodius* is distributed geographically among province of Elqui (29º S; 71º W) to Concepción (36º S;º73º W) and in Andean habitat up to 3,000 m altitude, and *P.m. atacamae* is distributed geographically in the Huasco

province (28º S; 70º W) (in sites de study FR, VE, PG, see Fig.1) . Descriptions made by different authors of the morphological characters indicated that in coloration of plumage of *P.m. atacamae* is significantly pale specially bellow, lacks rufous tinge on underparts, has lower underparts much whiter and corporal size is smaller than *P.m. megapodius*[1,20]. In fact high index of similarity for these sister lineages did not justify a taxonomic separation.

A notable and special case occurs among species of different genera, Ochre flanked tapaculo (*Eugralla paradoxa* in sites LS, CO, CU, CO, MI, CH, see Fig. 1) with White throated tapaculo (in sites CA, FA, LV) with half similarities indexes (Fig.2c); that possess a value of 0.51 (Fig. 2c, Table 6) and the analysis of distances is 0.81 (Fig. 2d). This lineages are located in different geographical areas and live in different habitats. This similarity can be attributed to the facta they posses the same behavioral traits and lifestyle. We have observed Ochre flanked tapaculo nesting in the shrubs of the rainforest of southern Chile near to paths (41º S; 73º W). It is distributed from Maule region (35º S; 71ºW) until Chiloé (41º S; 73º W) and Isla Mocha (38º S; 74º W), and in Argentina (35º S; 41º S) whereas White throated tapaculo occupied the ecological niches near shrubs to roads and paths of the mountainous sclerophyllous shrublands of the Andes and in the Coastal range. These lienages have not been reported sharing the same habitat or in the same geographical region. However the half value of the index obtained among this species, could indicate that they have a similar life style (Table 5).

In the other hand Ochre flanked tapaculo with Andean tapaculo has an index of 0.51 (Fig. 2c, Table 6) and the analysis of distances is 0.72 (Fig. 2d). This suggests that they possess similar modes of life. We have detected a low specificity of

habitat[27,22] (A.C, unpublished data), along with similar behavioral traits, which may indicate in part the great similarity between these lineages.

On the other hand, the half similarities among species that share the same habitat indicates a high grade of interaction among them. The rate values obtained in the analyses of the similarity between species are 0.46- 0.44 - 0.46, respectively (Table 6). The rate values are half because of smiliar behaviour and additionally, all of them occupy the exuberant understory of the temperate rain forest, formed by *S.magellanicus- P. tarnii*; *S.magellanicus- S.rubecula*; *P.tarnii- S.rubecula* (VI, LS, CH, MI in Fig. 1) with local sympatry between them[14,15,28], conform an sympatric group of sister taxa (A.C., unpublished data), Additionally the half similarities among species that shared the same habitat indicate a high degree of interaction between them because othey present similar behavioral traits and lifestyle[28,14,15].

We have observed *E. Paradoxa, S. fuscus*, *P. castaneus* and *S. rubecula* coexisting locally in similar habitats of Cordillera of the Central Coast[22] (in sites CU, CO, QC). In fact we found a high degree of interaction among these lineages in the same habitat, conform an sympatric group of sister taxa (A.C., unpublished data), and rates are 0.51, 0.44, 0.46, 0.40, 0.44, 0.48 (Table 6), because the behavioral traits are identical and they possess oneself lifestyle.

S. fuscus- P. megapodius; S. fuscus- S. albicollis; *P.megapodius- S.albicollis* show half rate indexes 0.44 - 0.42- 0.48 (Table 6), due a great interaction with them and their habitat, being constituted an sympatric group of sister taxa (A.C., unpublished data), because possess the same behavioral traits and lifestyle. These occupy the habitat of the mountainous sclerophyllous shrublands of the Andes (LV, FA) and in Cordillera of the Central Coast (CA) (Fig. 1 and Table 7).

Our results indicate there are no clear cut-criteria to establish differences among the following three subspecific sister taxa of the current classification of Chilean Rhinocryptidae; *S.a. albicollis* with *S.a. atacamae*, *S.r. rubecula* with *S.r. mochae*, *P.m. megapodius* with *P.m. atacamae.* Moreover, integration of behaviour, terms of ecology and morphological characters of the plumage allows us to conclude that there is a decrease of the distances among sister lineages in the cluster tree (see Figure 2a, 2b,2c,2d), therefore we are convinced that the behaviour is an evolutionary clue that determine the speciation in this taxonomic group of birds, further supporting the notion that the current classification of the Chilean Rhinocryptidae should be revised and modified.

Methods

Fieldwork

We visited most sites for several weeks during at least one breeding season (may through early February and August- October in one opportunity). Sites of observation; CAB, CO, VI, MI, CU, QC, FR, PG. Some sites were visited more than once (CH, twelve season; VE, six season; LV, fourteen season; FA, four season and CA, four season).

Collection of samples for morphological traits

To obtain field observations in Chile[34,35,1,3,28,37,4,12,5,38,11,26,40,7,41,27,42,30,14,15] (A.C. Correa, unpublished data with Bardon, Willson, De Santo, Rozzi, Torres- Mura) and information for every bird we measured morphological traits in general[40,11] (beak length, tarsus length, wing length, tail length) and feathers traits obtained from the collection of Rhinocryptidae individuals deposited at the Museo Nacional de Historia Natural, Chile.

Review data

In order to evaluate the current classification of Chilean Rhinocryptidae species, we first review data on ecological aspects, morphological characters of feathers, and behavioural traits of these lienages reported by a variety of authors[31,32,33, 34,35,1,3,28,37,4,12,5,38,11,26,40,7,41,27,42,30,14,15] (Correa, unpublished data with Bardon, Willson, De Santo and Rozzi).

Similarities indexes

Using these data we constructed Table 2 with the following traits: morphological characters of the feathers in different parts of the body and ecological aspects. Additionally constructed Table 3 using the following variables: behavioural pattern and ecological aspects. From these data, we applied a Russel & Rao similarity index, based on analysis of attributes or qualities among pairs of individuals[43,44,49]. The Russel & Rao index has also be used to calculate genetic distances[45,47,48] characterized by their qualities or attributes[46,47,49] (see appendix). Is possible to express the presence or an absence of a phenotype pattern by numerical codes and consider these numerical codes like a justified measure[44,50]. We compare the resemblance of subspecies in terms of their ecology, morphological characters of plumage (Tab. 2) and compared the similarities among individuals. From these data we construct a Cluster tree (Figs. 2-3). We make an integrated analysis of all characters including; ecology, morphological characters of plumage and behaviour (Figs. 4-5-6) by means of an analysis of conglomerates (distance metric is normalized percent disagreement, Boostrap software Systat) (Fig. 6).

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FIG. 1. Study sites in Chile and taxa of Rhinocryptidae occurring in each area.

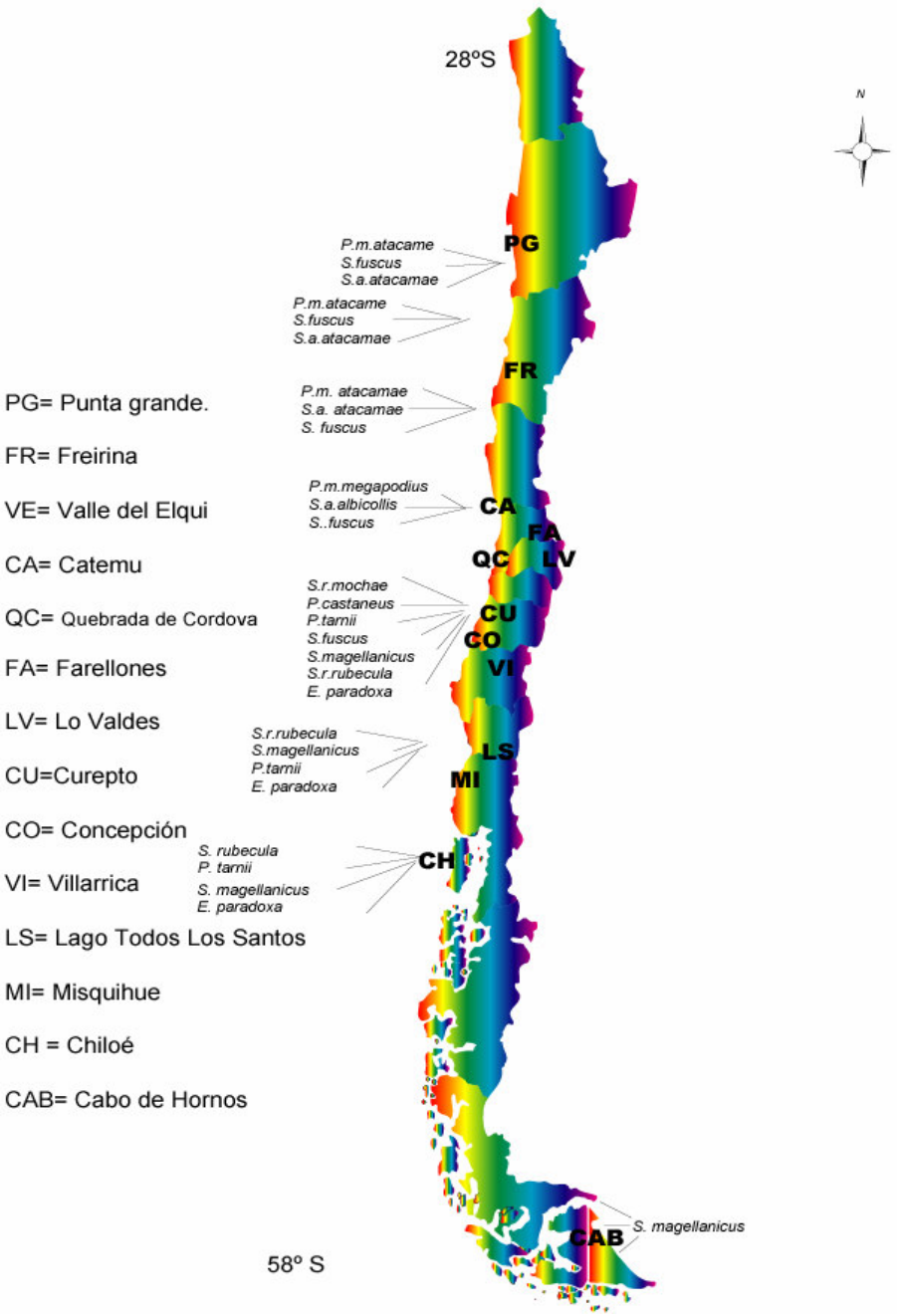

Figure 2(a,b,c,d) In the cluster tree, see simultaneously Fig. 2a and Fig. 2c (index of similarities of Rusel &Rao) our results indicate show how when integrating behaviour and ecological terms as biological traits next to morphological characters of the plumage, it allows us to conclude that there is decrease of the distances among sister lineages. When we compare both cluster tree simultaneously Fig. 2b and Fig. 2d (integrating behaviour and ecological terms as biological traits next to morphological characters of the plumage by means of an analysis of conglomerates boostrap Systat tree), doesn't make any discrimination when the behavioural patterns are used added as variable to this test, because the behavioural patterns are same in these birds. However when we observe these birds *in situ* in their habitat, we are convinced that the behaviour is an evolutionary clue that determine the speciation in this taxonomic group of birds.

Figure 2a

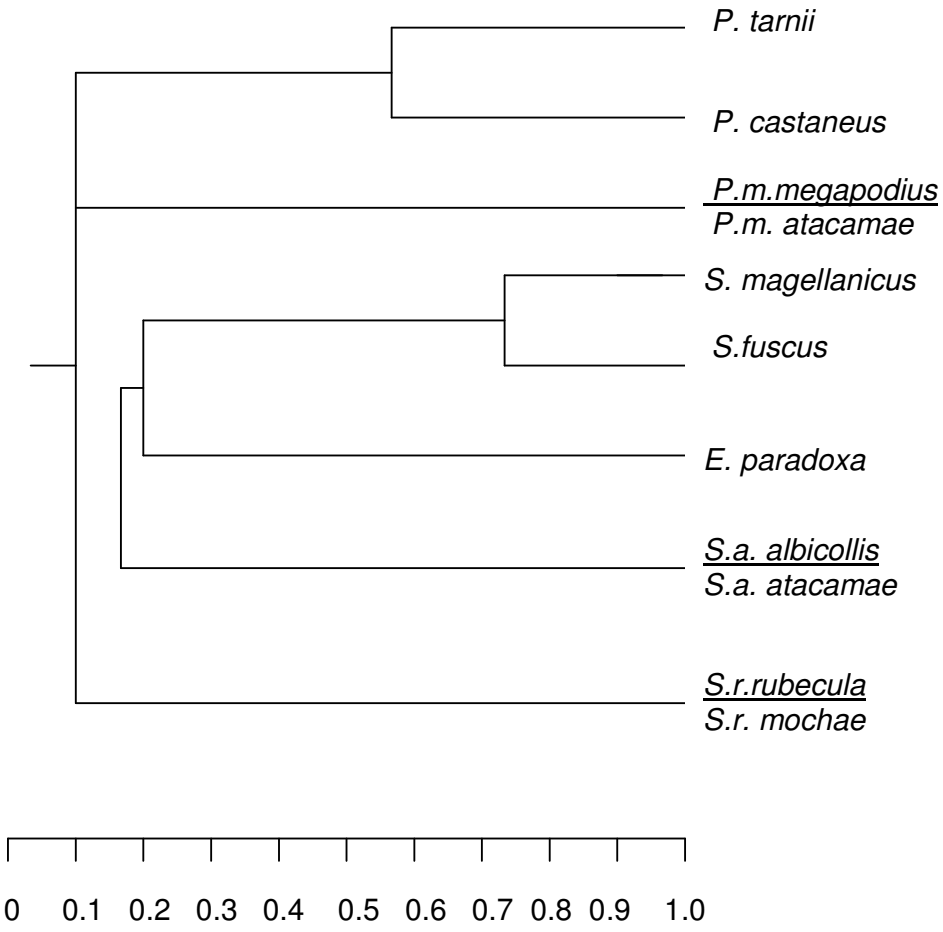

Figure 2b

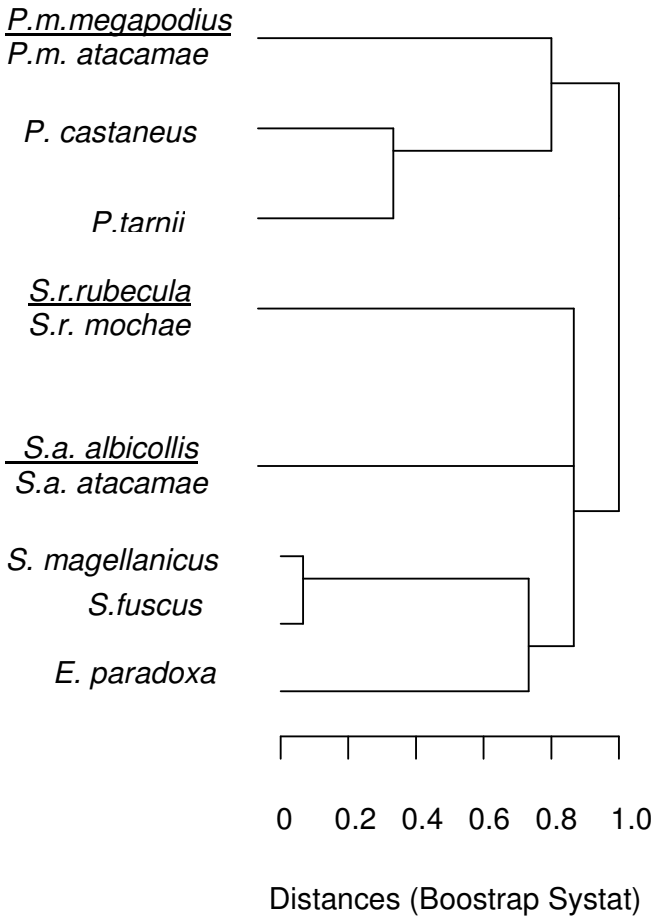

Figure 2c

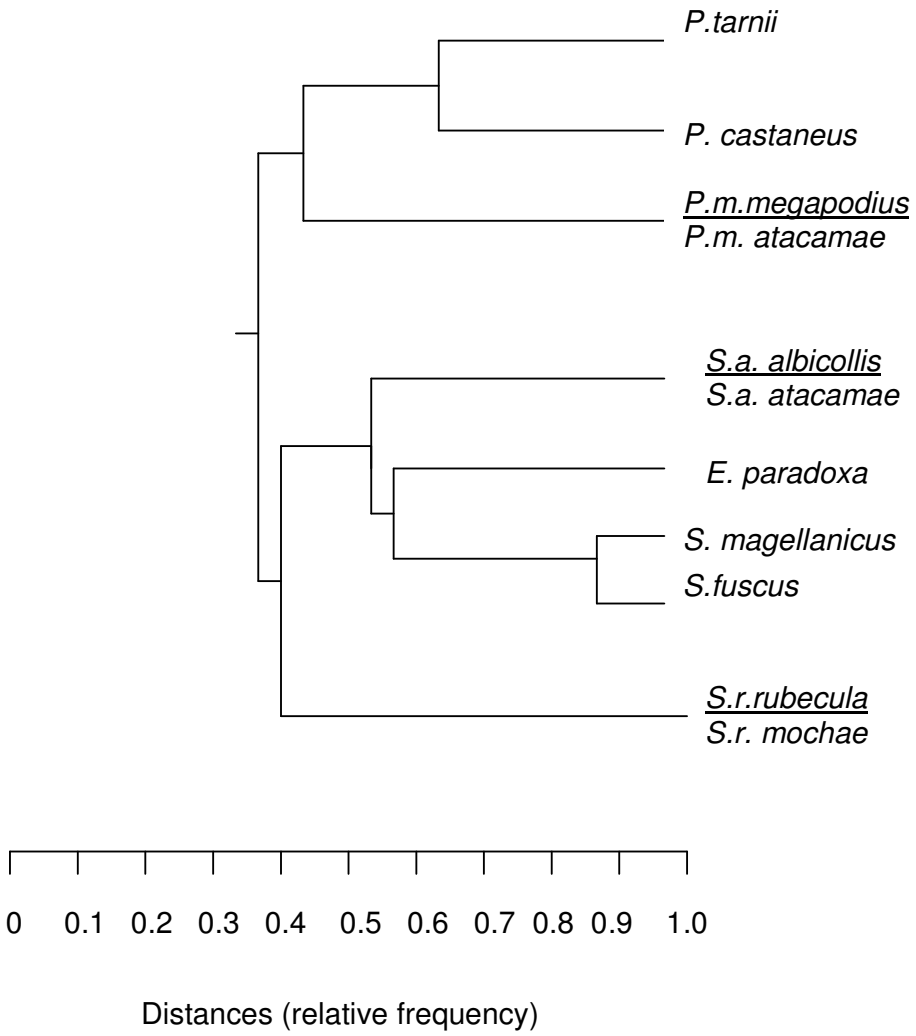

Figure 2d

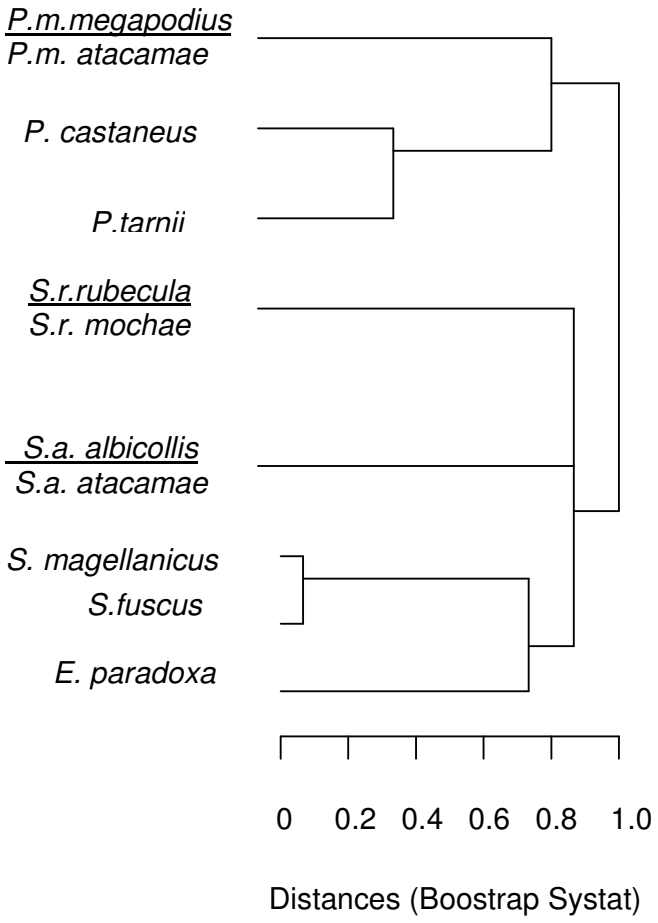

Table 1 Data base of; phenotypes traits of plumage, habitat use, diet and geographical distribution of eight species of Rhinocryptidae in Chile.

Charac.*/**sp.	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
Forehead	1	1	35	5	11	11	14	14	17	17	8
Shoulders	1	1	5	5	11	11	14	14	12	12	5
Mantle	1	1	8	6***	5	5	14	14	12	12	22
Tail	1	1	7	7	5	5	14	14	12	12	5
Breast	34	34	35	35	2	2	5	5	22***	41***	22
Throat	13	13	8	5	11	11	5	5	12	12	4
Beak	3	3	3	3	7	7	7	7	6	6	6
Foot	3	3	3	3	7	7	7	7	7	7	7
Wings	1	1	12	10	5	5	14	14	12	12	22
Bridles	1	1	3	3	11	11	5	5	12	12	22
Belly	37	37	36	36	11	11	38	38	16	16	4
Nape	1	1	5	5	11	11	14	14	12	12	22
Undertail coverts	1***	1***	3	10	5	5	14	14	42***	41***	5
Sec. feathers	1***	1***	3***	10***	5***	5***	14***	14***	13*	13***	5***
Primary feathers	1***	1***	3***	3***	5***	5***	14***	14***	13***	13***	5***
Flanks	1	1	7	7	5	5	14	14	27	27	27
Inferior parts	9	9	13	13	9	9	22	22	22	22	23
Crown	1	1	8	6	11	11	14	14	10***	41***	18
Eyebrow	29	29	3***	5	11	11	27	27	12	12	10
Ear coverts	14***	14***	8***	3	5***	5***	15***	15***	12***	12***	10***
Loin	27	27	5	5	5	5	15	15	42***	41***	22
Uppertail coverts	1	1	5***	28	28	28	15	15	42***	41***	22
Lower breast	31	31	5	30	32	32	33	33	7	7	23
Rump	1	1	35	40	39	39	15	15	27	27	27
Coverts feathers	1***	1***	12***	10***	5***	5***	14***	14***	42***	41***	22***
Tertial feathers	1***	1***	12***	10***	5***	5***	14***	14***	12***	12***	22***
Habitat use	20	20	21	21	20	20	21	21	20	20	21
Geogr. Distr.	18	18	18	18	18	18	18	18	19	19	18
Diet	24	24	26	26	24	24	26	26	24	24	24

Table 2 Data base of; Behaviour traits, habitat use and diet of the eight species of Rhinocryptidae in Chile.

General traits*/**sp	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
Habitat use	1	1	2***	2	1	1	2***	2	1***	1	2***
Use of water courses	3	3	3***	3	3	3	3***	3	3***	3	3
Use of holes for shelter	4	4	4***	4	4	4	4***	4	4***	4	5***
Breeding period	6	6	6***	6	6	6	6***	6	6***	6	6***
Diet	7	7	7	7	7	7	7	7	7	7	7
Curiosity	8	8	8***	8	8	8	8***	8	8***	8	8
Aggressiveness	9	9	9***	9	9	9	9	9	9	9	9
Nest construction	10	10	10***	10	10	10	10***	10	10***	10	10***
Climbing behaviour	11	11	11***	11	11	11	11***	11	11	11	11
Vocalisation behaviour	12	12	12***	12	12	12	12***	12	12***	12	12***
Type of flight	13	13	13***	13	13	13	13***	13	13***	13	13
Escape movement	14	14	14***	14	14	14	14***	14	14***	14	14
Family interaction	15	15	15***	15	15	15	15***	15	15	15	15
Use of foot paths	16	16	16***	16	16	16	16***	16	16***	16	16
Ritual Movements	17	17	17	17	17	17	17	17	17	17	17
Visual sensitivity	18	18	18	18	18	18	18	18	18	18	18
Acoustic sensitivity	19	19	19	19	19	19	19	19	19	19	19
Corporal movements	20	20	20***	20	20	20	20***	20	20***	20	20***
Territoriality	21	21	21***	21	21	21	21***	21	21***	21	21***
Coop. in the nest	22	22	22***	22	22	22	22***	22	22***	22	22
Chick feeding	23	23	23***	23	23	23	23***	23	23***	23	23
Habit schedule	24	24	24***	24	24	24	24***	24	24***	24	24

*

1 = shrubs, meadow, mountains
2= trees, shrubs, mountains
3= near streams
4 = nests, burrows, trees, cliffs
5= in shrubs
6 = same season
7= omnivorous
8 = to reply vocalis. of ind.
9= during the breeding season
10= similar structure
11= in rocks, branches, trees.
12 = conspicuous in males
13 = short and intense bursts
14 = fast response
15 = during the breeding season
16= during the breeding season
17= during the breeding season
18= high
19= high
20= very fast
21= dur. br. sea.
22 = both adults
23 = both adults
24 = along of his life

Table 3 Morphological measurements of species of genera Scytalopus. Data made for the author based in the collection of Museo de Historia Natural, Santiago, Chile. Average and standard desviation are indicated.

Character */Specie	*S. fuscus*(n=2)	*S. magellanicus*(n=2)
Beak lenght	1,2± 0,10	1,1± 0,13
Wide of beak lenght	0,41± 0,10	0,36± 0,014
Head lenght	2,02± 0,16	2,12± 0,021
Body lenght	10,9± 0,35	10,47± 0,60
Thigh lenght	0,94± 0,22	1,45± 0,11
Tarsus lenght	2,17± 0,10	2,11± 0,22
Wide of head lenght	1,62± 0,38	1,73± 0,26
Central front finger	1,7± 0	1,93± 0,13

* Average length in centimeter (cm).

Table 4 Relative frequency of two species of the genera of Scytalopus carried out in different habitat types. Observations carried out for *S. magellanicus* in Misquihue (Puerto Montt) and in Chiloé during the 1987 - 1990 and in the Cabo de Hornos (2002). Observations carried out for *S. fuscus* during the years 1989 and 1999 in the mountain range of The Andes (Lo Valdés) and in Concepción near the mountain range of Nahuelbuta (2004). Standard desviation are indicated.

Habitat /bird specie	*S. magellanicus*	*S.fuscus*
Rain forest interior	0,21±0,55	-
Swampy terrains with trees	0,01±0,70	-
High Andean shrubs	-	0,30±0,49
Felling and burning forest	0,08±0,65	-
Srubs near forest	0,35±0,45	0,40±0,42
Rain forest exterior	0,25±0,53	0,30±0,49
Subantarcticus rain forest	0,10±0,63	-
Total bird	1,00	1,00

Table 5 Relative frequency of two especies of Rhinocryptidae in different types of shrubs. Observations for *E. paradoxa* in the Mountain range of Piuchue (Chiloé) and in Ancud during 1988 -1995 and observations carried out for *S. albicollis* during the years 1982-2004 in the mountain range of La Costa (Catemu) and Mountain range of Los Andes; Lo Valdés, Farellones and Valle de Elqui. Standard desviation are indicated.

Bird specie/shrub sp.	*E. paradoxa*	*S. a.albicollis*
Chusquea sp.	0,20±0,56	-
Ulex sp.	0,70±0,21	-
Acacia caven	-	0,28±0,50
Chaura sp.	0,10±0,63	-
Baccharis sp.	-	0,47±0,37
Azara sp.	-	0,10±0,63
Rubus ulmifolius	-	0,15±0,60
Total obs.	1,00	1,00

Table 6 similitude index Russel & Rao, show similarities index among sp. of chilean rhinocryptidae by means of the following traits: phenotype of plumage, including ecology and behavioural patterns.

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
A		1.00	0.46	0.46	0.48	0.48	0.40	0.40	0.44	0.44	0.44
B	1.00	-	0.46	0.46	0.48	0.48	0.40	0.40	0.44	0.44	0.44
C	0.46	0.46	-	0.71	0.44	0.44	0.46	0.46	0.46	0.46	0.46
D	0.46	0.46	0.71	-	0.46	0.46	0.48	0.48	0.40	0.40	0.44
E	0.48	0.48	0.44	0.46	-	1.00	0.46	0.46	0.42	0.42	0.51
F	0.48	0.48	0.44	0.46	1.00	-	0.46	0.46	0.42	0.42	0.51
G	0.40	0.40	0.46	0.48	0.46	0.46	-	1.00	0.44	0.44	0.46
H	0.40	0.40	0.46	0.48	0.46	0.46	1.00	-	0.44	0.44	0.46
I	0.44	0.44	0.46	0.40	0.42	0.42	0.44	0.44	-	1.00	0.51
J	0.44	0.44	0.46	0.40	0.42	0.42	0.44	0.44	1.00	-	0.51
K	0.44	0.44	0.46	0.44	0.51	0.51	0.46	0.46	0.51	0.51	-

A= P.m.megapodius
B= P.m.atacamae
C= P.tarnii
D=P.castaneus
E= S.a. albicollis
F= S.a. atacamae
G= P.tarnii
G= S.r.rubecula
H= S.r. mochae
I=S. magellanicus
J=S. fuscus
K= E. paradoxa

Table 7 Relative frequence of three species of Rhinocryptidae in relation to their behaviour carried out in Lo Valdés during the summers 1989 -2003 and in Catemu 2000-2004, cohabiting in surface of C. 2 ha. Standard desviation are indicated.

* /**	1	2	3	4	5	6	7	Tot.
A	0,10±0,63	0,12±0,62	0,14±0,60	0,14±0,60	0,35±0,45	-	0,05±0,67	1
B	0,12±0,62	0,20±0,56	0,18±0,57	-	0,25±0,53	0,15±0,60	0,10±0,63	1
C	-	0,25±0,53	0,26±0,53	-	0,33±0,47	0,16±0,59	-	1
Tot.	0,08±0,65	0,33±0,47	0,28±0,50	0,02±0,69	0,18±0,57	0,012±0,069	0,098±0,63	1

***** Species
A=S. fuscus
B= S.a. albicollis
C= P.m.megapodius

****** Traits

1= Aggressiveness
2= Breeding
3= in shrubs
4=Feeding
5= Territoriality
6= Movement of rock
7= Go to water courses

Appendix

Variables rates

We incorporate new variables to calculate the genealogical distances between individuals. This should be the first time that we incorporate the behaviour, ecological pattern and phenotype traits of plumage, as biological variables to calculate phenotype distances between individuals. We use the rate of similarity (Russel & Rao) for the same presence of similar characters of pair of individuals (**i = n1**/**N**) (Jacquard , 1973), then the rate of similarity in this way :

(i = n1/**N)** rate of Russel & Rao, were the variable **n1**, as; **i = ∑an**/ **N**, where n1 = ∑an, and ∑an = ∑ (a1 +…….+ an), **N** is total of characters, the expression **an** is similar characters of a subgroup (eg. a1= phenotype characters of plumage), so, the characters incorporate to the subgroups of expression **n1**, as an addition of the denominated subgroups, as: (a1+,….,+ an) they indicate the presence of different subgroups with similar characters between two individuals, in our study we will use three subgroups with different characters and they should be expressed the identity in this mode;

I = ∑(a1 + a2 + a3)/**N** , as if;

N =total number of characters for a determined individual,

i) a1= similarities in the plumage patterns between two individuals, were a1 is the addition of similar characters of the plumage of the subgroup.

ii) a2= presence of the similar characteristic in the ecology between two individuals.

iii) a3= presence of similar characteristic in the behaviour between two individuals.

We denominate this expression in this term: **(i = ∑an/ N)** to identify the presence of the different characteristic in the different subgroups between two individuals.