ASSOCIATIVE RESEARCH PROGRAM

NATIONAL TENDER PROCESS FOR TEAM RESEARCH PROJECTS (ANILLOS) IN SCIENCE AND TECHNOLOGY AND IN ANTARCTIC SCIENCE 2009

APPLICATION FORM

I. INTRODUCTION

1. Project Title

STUDYING A MAJOR TRANSITION IN VERTEBRATE EVOLUTION, THE ORIGIN OF ENDOTHERMY IN BIRDS AND MAMMALS.

2. Key words and discipline(s)

KEY WORDS	DISCIPLINE(S)
Endothermy, mammals, birds, evolutionary physiology, genomics, vertebrate evolution.	Genetics and evolution

3. Main researchers

NAME	SIGNATURE
(Project Director) 1. ROBERTO NESPOLO ROSSI	
2. JUAN OPAZO CARVALLO	
3. CHRISTIAN FIGUEROA CARO	
4. LEONARDO BACIGALUPE CIRILLO	

4. Principal Institution

NAME	LEGAL REPRESENTATIVE'S SIGNATURE
UNIVERSIDAD AUSTRAL DE CHILE	

5. Associated institutions and third parties

NAME OF THE ASSOCIATED ENTITY OR INSTITUTION	LEGAL REPRESENTATIVE'S SIGNATURE
Universidad de Chile	

3. Project summary

Two pages printed both sides, font Arial 10 and singled spaced within the margins provided by this form.

Extend until the provided space of this section

An important fraction of multicellular organisms produce and store heat in their bodies in such a way that they can maintain and control body temperatures far above ambient temperature, irrespective of its changes. This phenomenon, also called *endothermy*, have appeared independently in several groups of living beings, including plants, insects, fish, reptiles, birds and mammals. Continuous endothermy, however, is distinctive of birds and mammals and represents a major transition in vertebrate evolution, and at the same time constitutes a striking evolutionary convergence. Endothermy in birds and mammals is explained by two general morpho-physiological characteristics: (1) a several-fold more thermogenic capacity of specific tissues of metabolically active organs such as liver, intestines, kidneys and heart, compared with ectotherms of same body size and at the same body temperature; (2) a high capacity to store heat, due the unusually high insulating properties of their cover (fur and feathers). The disproportionately high thermogenic capacity of the internal organs in birds and mammals is explained by the fact that the mitochondria of endotherms appear to be considerably "leakier" than the ones of ectothermic animals. As a consequence, birds and mammals exhibit an irreducible whole-animal metabolic rate which is characteristic of species and lineages; biomes and food habits, among other factors. This variable is known as the basal rate of metabolism (BMR), which determines endothermic body temperature (Tb). The ecological success of birds and mammals is in a good extent explained by endothermy, and there is consensus that endothermy is the adaptation that permitted the colonization of cold environments, attainment of comparatively high reproductive rates, better foraging and dispersion capacities, and ultimately the development of

encephalized nervous system with its subsequent cognitive advantages. However, these long term benefits are a problem in term of known microevolutionary mechanisms that give rise to adaptations (which include natural selection). Fossil structures that are associated with endothermy in therapsid reptiles (nasal turbinates and thorax expansion), unambiguously indicate that the elevation of metabolic rate that gave rise to endothermy was a gradual process that lasted at least 100 millions of years, from the first proto-mammals (synapsid reptiles) and proto-birds (theropod dinosaurs). Then,it is difficult to consider long-term benefits of endothermy of selective advantage since intermediary steps are clearly maladaptative. Accordingly, at least eight models suggesting how endothermy could have arisen have been proposed during the last twenty years. Among them, the most accepted hypotheses propose that natural selection acted directionally: (1) increasing body temperature (and BMR) as a target of selection (thermoregulatory hypotheses, including benefits of high temperature for parental care); (2) increasing maximum activity capacity (MMR) as target of selection and correlated response in BMR/Tb (aerobic capacity models, including benefits or high activity capacities in adults); and (3) reducing thermal conductance (the inverse of insulation).

A response to natural selection needs genetic variation to occur. Standard quantitative genetics indicate that when a trait exhibits high genetic variation it also exhibits high inter-individual variation. Repeatability, an index of inter-individual variation (i.e., the time-consistency of a trait), is computed as the ratio between the variance component of individuals and total variance, from repeated-measures of the trait in a sample of individuals. In other words, repeatability indicates in how extent the ranking of the individuals in the population is maintained over time. With these assumptions, the existence of low repeatability in an actual species of an ancient lineage would suggest that its ancestors did not exhibit genetic variation (and hence, the trait did not exhibit potential to respond to selection). Low genetic variation could also arise because of fixation of all genes related to the trait after strong and persistent directional selection (i.e., disrupting the mutation/selection balance). But in this case, further descendants of this group (e.g., rodents, in the case of mammals and passerines, in the case of birds) would also exhibit low genetic and inter-individual variation. However, this is not supported by empirical evidence, which is abundant for many eutherian mammals and neognath birds. In this proposal we present a framework for studying the living representatives of actual groups of endotherms encompassing both “rudimentary” and “sophisticated” endotherms. We propose to use state-of-the-art genomics, bioinformatics and bioenergetic approaches to determine the moment and the target on which directional selection acted, that generated this evolutionary novelty.

Given that basal living representatives of birds and mammals actually exhibit lower consistency in thermoregulatory traits that modern species, we propose to address the questions of how and when endothermy arised in the phylogeny of birds and mammals, by measuring the consistency of physiological traits in 26 species of living mammals and birds (but also a few amphibians and reptiles for comparative purposes), representing the most important groups. With a genomic approach, we propose to identify selection signatures in the genes of endothermy, across the phylogeny of birds and mammals. Also, we propose to study the functional genomics of such genes in the living species we will use, in order to test whether its natural activity changes across the phylogeny. Because the difference in aerobic metabolism between endo- and ectotherms is mainly attributed to energy consuming cellular processes (e.g. ion gradient maintenance, protein synthesis), our study will be focused on the genes participating in the oxidative phosphorylation pathway. This is defined as a metabolic pathway that uses energy released by the oxidation of nutrients to produce the molecule that supplies energy to metabolism (ATP), and emerges as the natural target for Darwinian positive selection to explain (in part) the appearance of endothermy. The electron transport chain is found in the inner membrane of the mitochondria and is composed by five supramolecular complexes, where each complex represents an assembly of nuclear and mitochondrial encoded genes (except complex II). Cases where genes of the electron transport chain have experienced an acceleration in the rate of non-synonymous substitutions (as evidence of Darwinian positive selection), in relation to the emergence of phenotypes that are energy costly, have been reported in the literature, being likely that natural selection have left its signature during the emergence of the endothermy. Molecular changes driven by natural selection represent an exciting topic to evolutionary biologist, because changes at this level (genes and genomes) are ultimately responsible for evolutionary innovations (e.g. endothermy). Natural selection acts as a filter removing deleterious mutations, while fixing changes that produce a difference in fitness. After the advantageous changes became fixed, purifying selection

acts preserving them. Because adaptive molecular evolution occurs in an episodic fashion on a few nucleotide sites and during shorts periods of time, pairwise comparisons typically fails to reveal positive selection. Several methods exist for testing positive selection, being an agreement that phylogeny based tests represent the best alternative to infer evolutionary changes driven by Darwinian positive selection. For protein coding sequences the most popular (and effective) approach to infer Darwinian positive selection is comparing the rates at which synonymous and non-synonymous mutations are fixed. If selection has not occurred, then non-synonymous mutations will be fixed at the same rate as synonymous mutations, so the ratio between them will be equal to one ($d_N/d_S=\omega=1$). If non-synonymous mutations are deleterious, is expected than purifying selection will reduce their fixation rate, so that $d_N < d_S$ and $\omega < 1$. Finally, if non-synonymous changes are favored by Darwinian positive selection they will be fixed at a higher rate than synonymous mutations, resulting in $d_N > d_S$ and $\omega > 1$. A significant higher non-synonymous rate than synonymous rate is thus evidence for adaptive protein evolution.

This is a higlhy multidisciplinary project, which combines several fields and technologies, such as evolutionary physiology, functional genomics, and bioinformatics, aimed to solve what is recognized as a scientific puzzle. In order to accomplish these ambitious aims, we plan to establish a collaborative, international network of scientists in Chile, Australia, Spain, Poland, and South Africa, composed by up to 50 people including main and associated researchers, postdocs, PhD students, undergraduate students and technicians. The project has a strong educational emphasis, as is closely linked with a graduate program in biological sciences and two undergraduate careers. We plan to offer theses in the aims of the project, for which we have strong support from MECESUP programs for travel and equipment funding, in addition to the funds asked in the proposal. The project also has a strong outreach emphasis, especially through a “rapid outreach” strategy that we plan to develop in order to penetrate the society with our latest findings, but also improving the common knowledge about the facts of evolution and its teaching. We expect to produce knowledge that will be published in scientific journals of general interest, along with a platform to devolp a larger centre for evolutionary and genomic studies. Finally, as the history of science suggests, we are convinced that several spin-off application will be produced as a consequence of such an interdisciplinary team analyzing genes, gene-expression and phenotype in diverse animals.

II. PROJECT DESCRIPTION

Twenty pages printed both sides, font Arial 10 and singled spaced within the margins provided by this form.

Background: endothermy in birds and mammals

An important fraction of multicellular organisms produce and store heat in their bodies in such a way that they can maintain body temperatures above 30°C, within a broad range of ambient temperatures. This phenomenon, also called *endothermy* have appeared independently in several groups of living beings, including plants (PatiÏo et al. 2000), insects (Bishop and Armbruster 1999), fish (Block et al. 1993), reptiles (Madsen and Shine 1999), birds and mammals. Currently, studying the origin and evolution of endothermy in mammals and birds represent one of the most fascinating and puzzling topics in evolutionary physiology as is regarded as one of the most important transitions in vertebrate evolution (see reviews in Hayes and Garland 1995; Ruben 1995; Grigg et al. 2004; Koteja 2004; Kemp 2006).

Endothermy in birds and mammals is considered one of the causes for their ecological success, and there is no much controversy regarding its multiple benefits in the long-term. For instance, having a higher body temperature (Tb) than average ambient temperature (Ta) represents an advantage for thermoregulatory systems as physiological systems are more efficient at heating bodies than cooling them (Crompton et al. 1978; Willmer et al. 2005). Also, higher and constant Tb provides a more efficient and stable environment for enzyme reactions, permitting the development of a considerable more complex nervous system (Armstrong 1983), and in general has allowed for a higher reproductive rate (Koteja 2004). The unique aspect of bird and mammal's endothermy reside in that the heat needed to maintain Tb at rest comes mainly from the visceral organs (heart, kidneys, liver, intestines) (Hulbert and Else 1989; Hulbert 1990). Those organs have a higher metabolism *per gram* of tissue and thus contribute disproportionately in warming up the body (Konarzewski and Diamond 1995a). The proximal mechanism that explain this thermogenic capacity is related to the leakiness of mitochondria plasma membranes to Na+, K+ and protons (Else et al. 2004; Hulbert and Else 2004). These leaky membranes provoke that ion gradient across membranes are being constantly dissipated, releasing *heat* instead of *work*, in the same fashion as futile cycles, with the need of considerable more metabolic energy to maintain normal ion gradients (Hulbert 2004). Despite its multiple benefits, however, the permanent endothermy of most birds and mammals is different from other types of facultative endothermy. Birds and mammals are not able to switch-off these expensive organs when they do not need them (e.g. hot weather), and consequently their constant maintenance seems a wasteful strategy from an energetic point of view (Pough 1980; Koteja 2004). Hence, the immediate consequences of endothermy are costs, rather than benefits. Therefore, the controversy is not necessarily regarding endothermy itself, but regarding the selective forces that gave rise to it (Hayes & Garland 1995 and references therein).

Evolution of endothermy: current hypotheses

The interest in studying the evolution of endothermy started in the seventies, where at least six hypotheses were proposed (Heinrich 1977; Crompton et al. 1978; McNab 1978; Bennett and Ruben 1979; Pough 1980; Armstrong 1983; Hayes and Garland 1995). Overall, the hypotheses can be broadly assigned to two different categories. The first category includes those models that assume Tb *per se* being the target of selection (i.e., "thermoregulatory" models), and include the thermal niche expansion model (Crompton et al. 1978), the homeothermy and increased biochemical efficiency model (Heinrich 1977) and the endothermy by inertial homeothermy model (McNab 1978). The main assumption of these models is the existence of a genetic correlation between basal metabolic rate (i.e. BMR) and Tb. The second category includes those hypotheses that assume endothermy evolved as a result of selection on other traits: postural changes (Bakker 1971), increased brain size (Armstrong 1983) or higher aerobic capacity (Bennett and Ruben 1979). The latter hypothesis, also known as the aerobic capacity model, is the most popular among evolutionary physiologists. This model is related to the advantages of having higher activity capacities, and assumes a functional link between maximum aerobic capacity (measured as maximum metabolic rate, MMR) with maintenance metabolism (i.e., BMR) (Bennett and Ruben 1979; Ruben 1995). In fact, the aerobic capacity model assumes that activity capacity (or its proxy, MMR), was the target of selection and BMR resulted elevated as a correlated response which in turn caused an elevated Tb. Two key

assumptions should hold according to this model: a functional association in the form of a positive genetic correlation between BMR and MMR, and another genetic correlation between BMR and Tb (Bennett and Ruben 1979; Hayes and Garland 1995; Ruben 1995).
A shared characteristic among all these hypotheses is that they were focused on the benefits of selection on adult organisms. However, two life history models recently proposed involve parental care and thus direct benefits of endothermy to the offspring (Farmer, 2000; Koteja, 2000, 2004). In these models, endothermy evolved as a correlated response of selection acting on the ability to control incubation temperature (Farmer, 2000) and/or to provide food (Farmer, 2000; Koteja, 2000). Even though, both models do not agree in the proximate mechanism by which a higher basal metabolism evolved, they recall the two original propositions: directional selection acted increasing Tb or MMR.

Intriguingly, the great interest in formulating models explaining how the capacity for heat production appeared in birds and mammals, contrast with the absence of ideas proposing how the insulation cover of fur and feathers appeared. In fact, the evidence suggests that the later appeared well separated in time from the former (Ruben and Jones 2000; Seebacher 2003). Moreover, it seems that in birds thermal insulation was present well before the capacity for heat production (Seebacher 2003), although its appearance in mammals occurred after the arising of "mammalian metabolism" (Ruben and Jones 2000).

Possible tests of the models. The main problem with elucidating the timing of evolution of endothermy is related with the fact that contrarily to morphology, physiological traits does not leave fossil evidence. However, almost all groups of living endotherms have some structures associated to endothermy that can be identified in fossils: nasal turbinates. According to Hillenius and Ruben (2004), see also Ruben (1995) the high respiratory frequency of endotherms faces them with the risk of rapid dehydration. However, water loss is limited by these structures that cool the air before exhaling. Fortunately, nasal turbinates leave anatomical records as attached scars in the skull, which have been identified early in the synapsid lineage (proto-mammals) during the Late Permian and Early Triassic periods (250-200 millions of years before present). According to this evidence, it has been suggested that an elevated metabolic rate was already present about 30-40 millions years before the existence of true mammals during the Jurassic (150-200 millions of years ago). Early birds and its immediate ancestors (theropod dinosaurs), however, do not appear to present respiratory turbinates (Ruben 1995). On the contrary, fossilized evidence suggest the rise in metabolic rate of birds appear to occur late in the Cretaceous, in ornuthurine birds (80-100 millions of years ago) (Hillenius and Ruben 2004). In other words, endothermy in birds appears to have evolved after the appearance of flight and far after the evolution of endothermy in mammals.

Evolutionary physiologists have applied their whole battery of experimental procedures to test the assumptions of the proposed models, particularly testing the association between BMR, MMR and Tb in a range of animals (reptiles, mammals and birds) (Crompton et al. 1978; Bennett and Ruben 1979; Bozinovic 1992; Konarzewski and Diamond 1995b; Bennett et al. 2000; Boily 2002; Sadowska et al. 2005; Seebacher et al. 2006; Gebczynski and Konarzewski 2009). However, it is clear that even if a particular evolutionary path is possible in an extant species, its occurrence in the population that gave origin to the endotherms is not guaranteed. Indirect tests are mainly based on determining the particular sign of genetic correlations (i.e. evolutionary paths) and therefore they assume that these would persist over evolutionary time. Unfortunately, the likelihood of such constancy is not yet clear (e.g. Turelli et al. 1988). On the other hand, it is well known that traits that are developmentally, morphologically or physiologically coupled are more likely to show long-term persistence of genetic correlations. Nevertheless, even if studies on extant species provide a partial agreement for the sign of a genetic correlation, this does not necessarily mean that the particular model is supported. In addition, even a complete lack of support (i.e. opposite sign or no genetic correlation) does not mean that the model is incorrect either. In other words, although the aerobic model have received some support because of the existence of a positive genetic correlation between BMR and MMR in modern mammals (Dohm et al. 2001; Gebczynski 2008; Sadowska et al. 2005), these evidences will always have the limitation of not being conclusive because they were obtained either from a single (modern) species.

In order to understand the evolution of endothermy and the putative mechanism that gave rise to it, we believe it is needed a study that combines information from different approaches: (i) phenotypic, to study the overall time-consistency of the physiological traits that define the endotherm's phenotype (see below), (ii) genomics, looking for the signatures of natural selection in the specific genes associated to energetics

and (iii) studying the gene-expression patterns of genes associated to energetic in living representatives of ancient and modern endotherms.

Thermoregulatory abilities of present endotherms.

Living birds and mammals exhibit different degrees of thermoregulatory abilities. This is evident after examining their temporal variation in all physiological traits, but especially in Tb and BMR. Presently, "good endotherms" such as rodents and passerine birds, are able to control Tb at 37° and 41°C, respectively, with a diurnal variation of less than 2 °C (Marsh et al. 1989; Refinetti and Menaker 1992; Refinetti 1999). Also, there is compelling evidence suggesting that their BMR is highly repeatable (see Nespolo and Franco 2007, and references therein). On the other extreme, the thermoregulatory abilities of supposedly "primitive endotherms" are clearly lower in basal representatives of mammals, such as monotremes (Grigg et al. 2004; Nicol and Andersen 2007) and marsupials (Kinnear and Shield 1975), and a similar pattern appears to occur in struthioniform birds (Withers et al. 1987; McNab 1996). For example, the echidna and the basal representative of marsupials, the microbiotherid *Dromiciops gliroides*, exhibit lower normothermic Tbs and BMR than placental mammals, and great within-individual variation in both traits (Augee and Ealey 1968; Grigg et al. 2004; Cortes et al. 2009). In fact, Kinnear and Shield (1975) showed that marsupials exhibit a significant correlation between resting metabolism and Tb, an uncommon situation in placental mammals. It is not known whether ancient birds show such large variations in thermoregulatory abilities, but they appear to exhibit lower Tbs and BMR compared with modern birds. For instance, the kiwi (struthioniformes, the most basal clade of birds, see Appendix. 4) exhibits one of the lowest BMR known for birds, with a considerable (qualitative) variation (McNab 1996). This low BMR is accompanied by a Tb of 38°C, which is much lower compared with the common 41°C in birds. Similarly, the Chilean tinamou (also struthioniformes, see Appendix. 4), controls Tb at 39°C and exhibits a BMR lower than expected for birds (Withers et al. 1987). Hence, the idea that different degrees of sophistication in endothermy occur across the phylogeny of living birds and mammals, and that imperfect endotherms (i.e., showing large within-individual variation in thermoregulatory traits, and lower magnitudes than the rest of them) apparently occur in basal representatives of both groups has some empirical support.

Our proposal:

Exploring the vertebrate tree of life studying physiological diversity

As mentioned before, there is a consensus regarding the fact that natural selection should have been involved during the first steps towards the appearance of endothermy. Classic quantitative genetic theory indicates that in order to respond to selection, a trait should exhibit genetic variation (Arnold 1983; Roff 1997; Nespolo et al. 2005a; Artacho and Nespolo 2009). Quantitative genetic analyses are powerful tools to study the potentials and restrictions for adaptive evolution but they can be performed only under very restricted conditions, and in a single species at a time (Steppan et al. 2002; Roff 2007; Arnold et al. 2008). A good preliminary assessment of genetic variation in a trait is its repeatability. This estimator is defined as the ratio of two variance components: inter-individual variance and intra-individual variance, and should be obtained by repeated-measures of the trait in a sample of individuals. Repeatability studies are common-place in the behavioral and physiological literature because they may give an important insight into the evolutionary potential of a trait (Huey and Dunham 1987; Evans and Rose 1988; Chappell 1993; Chappell et al. 1995; Berteaux et al. 1996; Hayes et al. 1998; Bech et al. 1999; Fournier and Thomas 1999; Custodio 2000; McCarthy 2000; Rhodes et al. 2000; Roman et al. 2000; Singh et al. 2000; Virani and Rees 2000; Wuliji et al. 2000; Dohm 2002; Horak et al. 2002; Marais and Chown 2003; Nespolo et al. 2003c; Labocha et al. 2004; Rezende et al. 2004; Terblanche et al. 2004; Nespolo et al. 2007; Artacho and Nespolo 2008; Boratynski and Koteja 2009; Cortes et al. 2009). In fact, a meta-analysis of more than 40 published estimates of repeatability concluded that repeatability of energy metabolism in animals is significantly different than zero (Nespolo and Franco 2007). Moreover, theoretical considerations suggest that when a trait exhibit genetic variation, it should also exhibit a high and significant repeatability (Lessells and Boag 1987; Roff 1997; Lynch and Walsh 1998), which is generally supported by empirical evidence (Konarzewski et al. 2005; Nespolo and Franco 2007) as long as the measurement protocol is strictly maintained (Dohm 2002). In that sense, we consider that low repeatability in a present species of an ancient lineage would suggest that its ancestors *did* exhibit low genetic variation (and hence the trait did not exhibit potential to respond to selection). Obviously, low genetic variation could also arise because of fixation of all genes

related to the trait after strong and persistent directional selection (i.e. disrupting the mutation–selection balance). But in that case, further descendants of this group (e.g. rodents, in the case of mammals, or passeriforms, in the case of birds) would also exhibit low genetic and inter-individual variation. This prediction is not supported by empirical evidence in energy metabolism and related traits in modern mammals and birds, as they exhibit high repeatability and heritability in physiological traits (Nespolo et al. 2003a; Bacigalupe et al. 2004a; Nespolo et al. 2005b; Sadowska et al. 2005; Ronning et al. 2007; Tieleman et al. 2009). In fact, recently Sadowska, et al. (2009) demonstrated that BMR in rodents can evolve as a correlated response to present-day selective pressures.

Understanding the emergence of innovations from an evolutionary genomic perspective

Molecular changes driven by natural selection represent an exciting topic to evolutionary biologists, because changes at this level (genes and genomes) are ultimately responsible for evolutionary innovations (e.g. endothermy). Natural selection acts as a filter removing deleterious mutations, while fixing changes that produce a difference in fitness. After the advantageous changes became fixed, purifying selection acts preserving them (Goodman 1982).

Evidences of natural selection coming from genomics. Because adaptive molecular evolution occurs in an episodic fashion on a few nucleotide sites and during short periods of time, pairwise comparisons typically fail to reveal positive selection (Yang 2006). During the last decade several methods for testing positive selection have been developed, being an agreement that phylogeny-based tests represent the best alternative to infer evolutionary changes driven by Darwinian positive selection (Yang and Bielawski 2000; Yang and Nielsen 2002; Pond and Muse 2005; Yang et al. 2005; Zhang et al. 2005; Yang 2006). For protein coding sequences the most popular (and effective) approach to infer Darwinian positive selection is comparing the rates at which synonymous and non-synonymous mutations are fixed (Yang and Bielawski 2000; Yang 2006). If selection has not occurred, then non-synonymous mutations will be fixed at the same rate as synonymous mutations, so the ratio between them will be equal to one ($d_N/d_S=\omega=1$). If non-synonymous mutations are deleterious, is expected than purifying selection will reduce their fixation rate, so that $d_N < d_S$ and $\omega < 1$. Finally, if non-synonymous changes are favored by Darwinian positive selection they will be fixed at a higher rate than synonymous mutations, resulting in $d_N > d_S$ and $\omega > 1$. A significant higher non-synonymous rate than synonymous rate is thus evidence for adaptive protein evolution.

Evidences of natural selection coming from functional genomics. The identification of the genetic architecture and genomic basis of adaptive traits are essential to understand how organisms are able to respond to their environment, over both ecological and evolutionary timeframes, and is a major ambition of modern evolutionary biology research (Orr 2005). While knowing the structural changes within the coding regions of candidate genes is important to reconstruct the evolutionary history of endothermy and to detect phylogenetic signatures of positive selection, evidences of adaptive evolution can also be obtained by investigating the genetic changes that alter transcript abundance, an aspect that remains largely unexplored although some efforts have been made in recent times (Whitehead and Crawford 2006a; Cheviron et al. 2008; Lai et al. 2008; Scott et al. 2009). This variation in messenger RNA (mRNA) expression is expected to be the result of genetic and environmental variation. However, the quantification of variance due to the additive effects of genes is important as natural selection acts on this genetic component of variance (Falconer & Mackay 1996). Hence, identifying the existence of functional adaptive divergence among organisms (e.g. endotherms) for those genes showing signatures of positive selection may be critical to understand the biological importance of new genes and traits, because any trait evolving by natural selection must affect fitness (Whitehead and Crawford 2006b). Nevertheless, one needs to be cautious since variation is also expected to be originated and maintained due to random neutral evolution at some extent. If mRNA expression is heritable (i.e. genes control most variation in expression), then closer taxa in the phylogenetic tree should have less variation and fewer significant differences in mRNA expression than among more distant taxa. An investigation into the functional importance of natural variation in mRNA expression will reveal the biological significance of molecular divergence and will help to understand the maintenance of endothermy among mammals and birds.

The genes to be studied. Because the difference in aerobic metabolism between endo- and ectotherms is mainly attributed to energy consuming cellular processes (e.g. ion gradient maintenance, protein synthesis), our study will be focused on the genes participating in the oxidative phosphorylation pathway. This is defined as a metabolic pathway that uses energy released by the oxidation of nutrients to produce the molecule that supplies energy to metabolism (ATP), and emerges as the natural target for Darwinian positive selection to explain (in part) the appearance of endothermy. The electron transport chain is found in the inner membrane of the mitochondria and is composed of five supramolecular complexes, where each complex represents an assembly of nuclear and mitochondrial encoded genes (except complex II; Nelson and Cox 2008). Cases where genes of the electron transport chain have experienced an acceleration in the rate of non-synonymous substitutions (as evidence of Darwinian positive selection), in relation to the emergence of phenotypes that are energy costly, have been reported in the literature, being likely that natural selection have left its signature during the emergence of the endothermy (Adkins et al. 1996; Wu et al. 1997; Andrews et al. 1998; Osada et al. 2002; Wildman et al. 2002; Goldberg et al. 2003; Doan et al. 2004; Grossman et al. 2004; Doan et al. 2005; Schmidt et al. 2005; Uddin et al. 2008).

Objectives

1) To measure repeatability in physiological traits (BMR, MMR, thermal conductance, Tb) representatives of the all major groups of mammals and birds, but also in reptiles and amphibians for comparisons.
2) To test the potential role of Darwinian positive selection in the electron transport chain genes.
3) To study the expression pattern of genes that have shown the signature of positive selection.

Questions to be addressed

(1) Are the repeatabilities of each physiological trait in each species, but especially of: a) the correlation between BMR and MMR (=supporting aerobic models); and b) the correlation of BMR and Tb (=supporting thermoregulatory models) increasing toward modern species in the phylogenies of birds and mammals?
(2) Do these changes correlate with the supposed period of expansion in metabolic rate suggested by the fossil record and nasal turbinates (that is, endothermy evolved later in birds than in mammals)?
(3) Do the repeatabilities between BMR/MMR and BMR/Tb increases simultaneously across species, a) within the phylogeny of mammals, b) within the phylogeny of birds or c) between mammals and birds?
(4) Do the repeatabilities in thermal conductance (TC), change across phylogenies? It resembles what the fossil record suggest (the insulative cover appeared before the rise in metabolism in birds and the contrary occurred in mammals)?
(5) Is the signature of natural selection present in the genes of endothermy?
(6) How the genomic signature of positive selection correlates with the inferences obtained by repeatabilities in BMR/MMR, BMR/Tb and TC?
(7) How is the variation in transcript abundance for those endothermy-genes that exhibited positive selection? is there some correlation between variation of transcript levels and phylogenetic distances?
(8) Do the a) physiological diversity approach, b) genomic approach and c) functional genomic approach coincide all together? How is this concordance with what the fossil record suggests in term of times and period of metabolic expansion in birds and mammals?
(9) Do the synthesis of the three approaches we propose to develop (physiological diversity, genomics and functional genomics), support either the aerobic model or the thermoregulatory model for the evolution of endothermy?

Expected results

We are aware that this is an ambitious proposal. It could be argued that the values of repeatabilities in some species will deviate from the expectations according to they position in the phylogeny because they are too specialized. For instance, it is known that some procellariform birds exhibit hetherothermia as an adaptation for diving, which can produce low repeatability of traits in spite of the fact that they are rooted in a derived position in the bird phylogeny. In placental mammals from seasonal habitats, BMR and MMR exhibit lower consistency in summer than winter, which could underestimate repeatability. We do not expect that these cases would represent the majority of cases, and we do not have reasons to believe that the influence of such cases will be biased toward one or other side. In other words, specializations would contribute to the residual error of the final analyses, which can be minimized by maximizing the total number of species and individuals to be measured, and the diversity of such species in the whole phylogeny.
On the other hand, the number of animals to be measured in the project (nearly 700) might seem ambitious. However, this is a three-years project, and many of us (Nespolo, Bacigalupe, Sabat, Rezende) regularly measures several hundreds of birds, mammals and invertebrates in a single year (see our attached curricula). On the other hand, this proposal includes an important number of collaborators who will assist us in obtaining and measuring the animals.
Expectations. We expect to observe a reduction of the consistency of the metabolic traits (i.e., its repeatability), after "walking" from recent to ancient groups of birds and mammals, with a complete loss of consistency in ectotherms (i.e., inter-individual variation is lower than within individual variation). We would expect that the signature of natural selection estimated with genomics coincides with this reduction, either in the phylogeny of birds or mammals. Also, we expect that the gene expression patterns, measuring the natural activity of the genes of endothermy, increases in the modern species, compared with the ancient ones. These predictions are also depicted in the figure of Appendix 3.4.

Methods

Animals

We will obtain sample 25-30 individuals of the 26 species in Appendix 3, either from commercial suppliers, or wild caught. Even since the project it thought in birds and mammals, we will also repeat the protocol in two species of amphibians and reptiles to known how would be the traits and repeatability in a complete ectotherms.

Chilean species. Many of us (Opazo, Nespolo, Bacigalupe, Sabat) have extensive experience capturing Chilean small mammals. Many times, we have successfully used Sherman traps baited with oat in for capturing the diurnal caviomorph rodent *Octodon degus* (e.g., Nespolo et al. 2001b), the nocturnal murid *Phyllotis darwini* (e.g., Sabat and Bozinovic 2000; Bacigalupe et al. 2004b) and the nocturnal didelphid marsupial *Thlyamys elegans* (e.g., Sabat et al. 1995; Opazo et al. 1999) in central Chile. In the case of the microbiotherid marsupial *Dromiciops gliroides* we have used modified Tomahawk traps baited with bananas, and located in trees 1.5 meters over ground, in South Chile near Valdivia (e.g., Cortes et al. 2009). In all these cases, to obtain a sample of 25-30 individuals represents approximately one month of effort, supposing the availability of about 200 traps. Similarly, one of us (Sabat) is familiar with the methods for capturing Chilean birds (Sabat et al. 1997; Sabat and Martinez del Rio 2002). Diurnal birds (*Zonotrichia capensis*, *Passer domesticus*) can be readily captured with mist nest but the later is also available from commercial suppliers. The hummingbird *Sephanoides sephanoides*, available in central Chile can also be captured by this method, as the Chilean dove (*Zenaida auriculata*), the Californian quail (*Callipepla californica*), and the common dove (*Columba livia*) which can also be captured with special dove traps or obtained from commercial suppliers. Our graduate students, Cristian Suazo and Ronnie Reyes (whose professional services will be asked) have extensive experience capturing marine species, such as the charadriiform *Calidris alba* (mist nest and nest-traps) which is present across all the Chilean coast and the procellariforms (*Procellaria aequinoctialis* and *Puffinus griseus*) in Huafo and Mocha islands (400 km South of Valdivia). Also Dr. Sabat has experience capturing the Chilean quail or tinamous (*Notoprocta perdicaria*), a very important species since it represents paleognathae (Withers et al. 1987). Queltehues (*Vanellus chilensis*) are readily available from central to South Chile in agriculture lands and can be also captured with

mist nests, as well as Taguas (*Fullica armillata*) which can be captured with special nets for aquatic birds. Some of us have also experience capturing and working experimentally with amphibians and reptiles (Naya et al. 2005; Sabat et al. 2005; Castaneda et al. 2006). Specifically, the species *Xenopus laevis* is a plague in Chile and can be easily obtained from commercial suppliers but also the common toad *Bufo spinulosus* is easily found across Chile. The lizard *Microlophus atacamensis* (ca. 50 g) is common in North of Chile and are readily captured in great numbers by tethered sticks in great numbers (Sepulveda et al. 2008).

Foreign species. We already have agreement letters of Drs. Pawel Koteja and Jan Taylor for providing us with their expertise, laboratory and field facilities to capture and measure the laurasiatherians *Erinaceus concolor* and shrews of the genus *Sorex* in Poland. Dr. Barry Lovegrove, similarly signed a similar compromise for capturing and measuring the afrotherian species, the eastern rock elephant shrew (*Elephantulus myurus*) and the tailess tenrec (*Tenrec ecaudatus*). Finally, Dr. Stewart Nicol have provided his support for capturing and measuring monotremes: platypus (*Ornithorhynchus anatinus*) and short-beaked echidnas (*Tachyglossus aculeatus*). All of these colleagues have explained us that in these two species, the measurements should be probably done taking the laboratory to the field and using collared transmitters to locate them. However, this is something that they (and many of us: Sabat, Nespolo, Rezende) have done before.

Physiological measurements

We plan to obtain and measure several physiological traits (see below) in individuals from each species. In order to sample the whole range of vertebrate energetics, we plan to include two amphibian and two reptile species (see Appendix 3.3). This would mean a total of 600-700 individuals that will have to be measured three times (see below). We will be able to capture (or commercially obtain) most of the species in Chile (see previous section, and Appendix 3), but in addition we will count with the collaboration of international colleagues from Australia, Poland and South Africa (see letters of support in Appendix 11), whom will kindly provide laboratory and biotherium facilities in their respective countries, in order to capture, maintain and carry out the energetic measurements.

The experimental protocol will consist in using state-of-the-art respirometric methods for simultaneously measuring the rate of carbon dioxide production (VCO_2) and oxygen consumption (VO_2), for determining metabolic rate under two conditions (Lighton 2008). *First*, we will perform a 2-3 hours trial under resting, thermoneutral (if endotherm: 28-33°, depending on the species and its size) and postabsortive (8-12 hours after the last meal, depending on the species and its specific mean retention time) conditions, at the resting period for each species (e.g., scotophase in diurnal species) in order to estimate BMR. *Second*, each individual will be submitted to a 30-40 min. trial at a temperature below thermoneutrality (18-20°C) at resting conditions, followed by forced exercise induction until exhaustion, in a wheel-like metabolic chamber. Body temperature, taken rectally, will be measured before and after each trial. This protocol permits to estimate BMR, MMR and resting metabolic rate (RMR, below thermoneutrality). We will also compute thermal (TC) conductance as TC = RMR/(Ta-Tb) (McNab 1980), (see examples in Nespolo et al. 2001a; Schleucher and Withers 2001; Klaasen et al. 2002; Nicol and Andersen 2007) and the respiratory quotient (RQ) as the ratio VCO_2/VO_2. In the case of ectotherms (amphibians and reptiles), BMR will be replaced by RMR at their routine preferred temperature (Cossins and Bowler 1987; Willmer et al. 2005). As mentioned before, we will repeat this whole protocol in each species, hopefully three times (but two are enough for computing repeatability, e.g., Chappell et al. 1995; Nespolo et al. 2007) every two weeks, in order to compute the intraclass correlation coefficient (**t**), as **t** = (between individual variance component) / (total variance) from a standard one-way ANOVA procedure and expected mean squares, as in Nespolo et al. (2007).

Such an ambitious project could be only completed by a strong collaborative work, but also replicating equipments and performing parallel experimental procedures. Hence, we plan to purchase four identical Fox Box (Sable Systems) CO_2/O_2 respirometers to be dispatched from the fabricants, directly to our collaborators measurement places (Appendix 10).

General respirometry procedures. All measurements will be performed with a respirometry system consisting of a coupled CO_2 / O_2 analyzer (FoxBox, Sable Systems International, USA). For resting metabolisms, we will use cylindrical metabolic chambers of 200 ml, and a flow rate of 1000 ± 1 ml min^{-1} controlled by a Sierra mass-flow controller (Sierra Instruments, USA), located upstream of the metabolic

chamber and after two columns with H_2O and CO_2 scrubbers (magnesium perclorate and Baralyme, respectively). The metabolic chamber will be located in an incubator, and ambient temperature (Ta) will be set to the temperature corresponding to the needed variable: thermoneutral zone in BMR measurements (28-32°C depending on the species), and 18-20°C for thermal conductance and MMR measurements. This temperature will be continuously recorder within the incubator. After that, the air is injected into the CO_2 analyzer by a subsampler (Intelligent Subsampler, Sable Systems, USA), at a flow rate of 200 ml min^{-1}. Then, the air is passed again through the scrubbers and finally it is injected into the O_2 analyzer. With this system we can record recorded simultaneously, carbon dioxide production (VCO_2) and oxygen consumption (VO_2).

Genomic sequence data

Electron Transport Chain (ETC) genes from birds and mammals will be extracted from public databases. All main group of mammals (eutheria, metatheria and prototheria), and the two available bird species (chicken, *Gallus gallus,* and zebrafinch*, Taeniopygia guttata*), will be sampled. In order to make phylogeny based tests, ETC genes will also be extracted from a reptile (green anole; *Anolis carolinensis*), an amphibian (western clawed frog; *Xenopus tropicalis*), and five fish species (zebra fish, *Danio rerio;* Fugu*, Takifugu rubripes;* spotted green pufferfish*, Tetraodon nigroviridis; three-spined stickleback*, *Gasterosteus aculeatus, and Japanese medaka, Oryzias latipes*). For each species, we will identify ETC genes in the unannotated genomic sequence by using the program Genscan (Burge and Karlin 1997) and by comparing known exon sequences to genomic contigs using the program BLAST2, version 2.2 (Tatusova and Madden 1999) . Sequences alignment will be carried out by using the program MUSCLE (Edgar 2004). Genomic data will be organized in three different ways 1) all ETC genes concatenated, 2) by complex, and 3) by gene.

Determination of transcriptional levels on selected genes by using quantitative PCR (qPCR).

To obtain quantitative results of transcripts abundance (i.e. levels of gene expression) for those oxidative phosphorilation genes showing phylogenetic signatures of positive selection among mammals and birds, qPCR analyses will be performed. Total RNA will be extracted using 100mg of liver from at least 3 unrelated individuals per species. For this, animals in rest will be sacrificed by decapitation (to avoid stress altering gene expression levels), then quickly proceeding to dissect the liver which will be rapidly frozen in liquid nitrogen. Total RNA will be isolated using the RNeasy mini-kit (QIAGEN). Quality and quantity of total RNA will be assessed by gel electrophoresis (in RNase-free conditions) and by Nanodrop spectrophotometer, respectively.cDNA from each mammal and bird species will be synthesized from 1ug of total RNA using the AffinityScript qPCR cDNA kit (Stratagene). Quantitative PCR reactions will be conducted in a Stratagene Mx 3000P thermalcycler, using SYBR green I fluorescence dye (Brillant II SYBR Green QPCR Master Mix, Stratagene) and specific primers (designed using the information available from public databases) for each selected gene.The quantification strategy will be “relative quantification“ (Fleige et al., 2006), which is based on the relative expression of a target gene versus a reference gene. Data analysis will be done using the efficiency corrected Ct mathematical model (Pfaffl, 2001). A normalizer gen will be employed corresponding to β-actin, a housekeeping gene chosen because it has been shown to be consistent in expression profiles in previous studies of liver gene expression (Bartosiewicz et al. 2000).

Statistical analysis

Phylogenetic framework

Thanks to recent advances in molecular systematics we now have a solid phylogenetic framework for reconstructing evolutionary pathways in a diverse group of vertebrates. In this proposal we are planning to test evolutionary hypotheses concerning the evolution of endothermy in a phylogenetic framework based on a consensus of recent studies (Murphy et al. 2001; Cotton and Page 2002; Nilsson et al. 2003; van Rheede et al. 2006; Hallström et al. 2007; Wildman et al. 2007; Hackett et al. 2008)

Variable ω (=dN/dS) rates among lineages

To detect the possible role of positive selection among specific lineages in the phylogeny, we will use the maximum likelihood codon substitution model as implemented in PAML v.4.2 package (Yang 2007). Several models of variable ω (=d_N/d_S) will be implemented using the three data sets previously described. The simplest model will assign the same ω for all branches, while the free ratio model will assumes an independent ω for each branch in the phylogeny. Intermediate models with phylogenetic sense will also be implemented. Each of these models will make different assumptions regarding the ω in the branch of interest. All these tests will be designed taking into account the results from the metabolic measurements. To check for the existence of multiple local optima all models will be run 3 times with different starting ω values. Nested models will be compared using the Likelihood Ratio Test (LRT).
In addition to the branch models mentioned, we will also run branch models as implemented in the DATAMONKEY web server (Pond and Frost 2005). The main difference is the incorporation of variation in the rate of synonymous substitution, which represent an improvement to detect natural selection in a phylogenetic framework (Pond and Muse 2005).

Branch site model
We will use the branch site model A (Yang and Nielsen 2002; Zhang et al. 2005), which allows to detect positive selection on a subset of sites in a specific lineage (branch of the tree). In this test the selected branch is called foreground where positive selection may be allowed, all other branches represent the background branches, where sites are only allowed to evolve under purifying or neutral selection. Like in the previous section, all these tests will be designed taking into account the results from the metabolic measurements. Amino acids under positive selection will be identified using a Bayes Empirical Bayes approach (BEB; Yang et al. 2005). To check for the existence of multiple local optima all these models will be run 3 times with different starting ω values. Models will be compared using the Likelihood Ratio Test (LRT).

Research background, objectives and activities

In this section please provide information related to the state of the art of the research topic(s), state the hypotheses that support the different lines of research and describe the methods that will be used. Indicate also the general and specific objectives of the research project and the program of activities planned to carry them out. Elaborate on the pertinence of the research lines you are proposing within the corresponding scientific-technologic areas or disciplines of study. Also include the relationship between this research and the current work done by the researchers in other projects. Be precise in defining which will be the added value of the development of this (these) line (s) of research within the science domain or any other in case of applicability. Indicate how the participation of several disciplines, if that is the case, will be articulated during the project execution.

State of the art of the research topic

The interest in studying the evolution of endothermy started in the seventies, where at least six hypotheses were proposed (Heinrich 1977; Crompton et al. 1978; McNab 1978; Bennett and Ruben 1979; Pough 1980; Armstrong 1983; Hayes and Garland 1995). Overall, the hypotheses can be broadly assigned to two different categories. The first category includes those models that assume Tb per se being the target of selection (i.e., "thermoregulatory" models), and include the thermal niche expansion model (Crompton et al. 1978), the homeothermy and increased biochemical efficiency model (Heinrich 1977) and the endothermy by inertial homeothermy model (McNab 1978). The main assumption of these models is the existence of a genetic correlation between basal metabolic rate (i.e. BMR) and Tb. The second category includes those hypotheses that assume endothermy evolving as a result of selection on other traits: postural changes (Bakker 1971), increased brain size (Armstrong 1983) or higher aerobic capacity (Bennett and Ruben 1979). The latter hypothesis, also known as the aerobic capacity model, is the most popular among evolutionary physiologists. This model is related to the advantages of having higher activity capacities, and assumes a functional link between maximum aerobic capacity (measured as maximum metabolic rate, MMR) with maintenance metabolism (i.e., BMR) (Bennett and Ruben 1979; Ruben 1995). In fact, the aerobic capacity model assumes that activity capacity (or its proxy, MMR), was the target of selection and BMR resulted elevated as a correlated response which in turn caused an elevated Tb. Two key assumptions should hold according to this model: a functional association in the form of a positive genetic correlation between BMR and MMR, and another genetic correlation between BMR and Tb (Bennett and Ruben 1979; Hayes and Garland 1995; Ruben 1995).

A shared characteristic among all these hypotheses is that they were focused on the benefits of selection on adult organisms. However, two life history models recently proposed involve parental care and thus direct benefits of endothermy to the offspring (Farmer, 2000; Koteja, 2000, 2004). In these models, endothermy evolved as a correlated response of selection acting on the ability to control incubation temperature (Farmer, 2000) and/or to provide food (Farmer, 2000; Koteja, 2000). Even though, both models do not agree in the proximate mechanism by which a higher basal metabolism evolved, they recall the two original proposition: directional selection acted increasing Tb or MMR.

Then in order to understand the evolution of endothermy is very important to know the subjacent causes of thermogenesis. Several of us have been indirectly involved in this kind of research. In fact, our international partner Dr. Stewart Nicol, for instance, published the firsts studies related with thermogenic capacity in marsupials, and the absence of specialized thermogenic tissue (brown fat) in them, an important feature of non-placental mammals that can be associated with an imperfect endothermy (Nicol 1978; Wunder et al. 1996; Nicol et al. 1997). These studies were cited by us in our firsts attempts to understand the consequences of the absence of brown fat in marsupials (Opazo et al. 1999), using the Chilean didelphid *Thylamys elegans*, which is one of the species we included in this proposal. Other of our international partners, Dr. Koteja, proposed one of the two most important hypotheses for the evolution of endothermy (Koteja 2000), and found the adaptive significance of energy metabolism in natural populations of animals, by determining its repeatability and quantitative genetics (Labocha et al. 2004; Sadowska et al. 2009; Sadowska et al. 2005). The other team that was studying the same problem, and started almost at the same time (late nineties) was leadered by some

of us (Nespolo et al. 2003a; Bacigalupe et al. 2004a; Nespolo et al. 2005a). A couple of years later, both, the Polish and the Chilean teams published at the same time the firsts evidences that natural selection acts on energy metabolism in animals, an important assumption for the models for the evolution of endothermy (Artacho and Nespolo 2009; Boratynski and Koteja 2009).

Relationship between this proposal and current work done by main researchers in other projects (refer also to the list of references in each researcher's curricula, in section V).

Dr. Enrico Rezende is a young and productive researcher with a recognized publication record in experimental evolutionary physiology and also in the statistics of comparative methods. He has studied several problems related with how animals respond to artificial selection on bioenergetic traits using rodents as models (Rezende et al. 2005; Rezende et al. 2004b; Rezende et al. 2006), but also he has studied the evolutionary significance of energy metabolism in wild mammals (Chappell et al. 2004; Rezende and Bozinovic 2001; Rezende et al. 2000) and birds (Lopez-Calleja et al. 2000; Rezende et al. 2001; Rezende et al. 2002). He has applied his skills with the comparative methods for problems such as habitat adaptation in bird energetic (Rezende et al. 2004a), renal function in mammals (Diaz et al. 2006) but also for more general questions in other fields such as the relevance of mutualistic networks for the stability of community structure (Rezende et al. 2007a; Rezende et al. 2007b). He has collaborated in the past wth many of us, studying the bioenergetics constraints that explain endotherm's spatial and temporal distribution (Bustamante et al. 2002; Nespolo et al. 2001a; Rezende and Bozinovic 2001).
Dr. Juan C. Opazo is highly recognized by his work related with the analysis of whole genomes of multigenic families, using bioinformatics on public databases and known phylogenies, a powerful approach in identifying signatures of selection and adaptive radiations in the evolution of mammals (Opazo 2005; Opazo et al. 2008; Opazo et al. 2005; Schmidt et al. 2005; Storz et al. 2007). Also, he has contributed to solve classic evolutionary problems of general interest such as the factors behind the diversification of placental mammals (Wildman et al. 2007), or the divergence time in primates phylogenies (Opazo et al. 2006). In the past, he has collaborated with some of us in problems related with the endothermy and its plasticity both in marsupial and placental mammals (Bacigalupe et al. 2004b; Nespolo et al. 2001b; Nespolo et al. 1999; Opazo et al. 1999).
Dr. Leonardo Bacigalupe has developed his career as a functional zoologist (Bacigalupe and Bozinovic 2002; Bacigalupe et al. 2002) and a physiological ecologist first (Bacigalupe et al. 2004b; Bacigalupe et al. 2003), but later he derived into evolutionary questions by studying the quantitative genetics of sustained energy metabolism in mammals , in order to understand the evolution of such traits in the endotherm's energy budget (Bacigalupe et al. 2004a; Bacigalupe et al. 2005). His procedures and approaches permitted him to extend his question into more general evolutionary problems such as the role of maternal effects in life history evolution (Bacigalupe et al. 2007a), and using experimental evolution procedures to study the sexual conflict (Bacigalupe et al. 2007b; Bacigalupe et al. 2008). He has collaborated with some of us in the quantitative genetics of energy metabolism and in general physiological ecology questions both in vertebrates and invertebrates (Bacigalupe et al. 2004b; Nespolo et al. 2002a; Nespolo et al. 2003b; Nespolo et al. 2002b; Nespolo et al. 2005).
Dr. Christian Figueroa has a strong population genetics background and is a specialist in the study of plant-insect relationship using genetic markers (Figueroa et al. 2004; Figueroa et al. 2005; Gaete-Eastman et al. 2004; Wilson et al. 2004), but recently he has applied functional genomics to understand the roles of genetics and environment (both, artificial such as insecticide resistance and natural such as chemical defenses of the plants) in the development of toxic avoidance in insects (Figueroa et al. 2007; Peccoud et al. 2008). He has collaborated with some of us in understanding the role GxE interaction and sexuality on the genetic architecture of insect's life histories (Castañeda et al. 2009; Nespolo et al. 2008; Nespolo et al. 2009). He was also the director of a previous Anillo's team which was successfully evaluated (Appendix 2).

Dr. Pablo Sabat has extensive experience with avian physiological ecology, but also with marsupials and rodents. His studies are related with the role of nutrient ingestion and absortion, the intestinal restrictions in terms of enzyme expressions that different groups of vertebrates posses, and also the

way that animals cope with high concentration of salts. He has collaborated in the past wth many of us by analyzing intestinal morpho-functional capacities and its plasticity, in species at different levels of vertebrate phylogeny (Nespolo et al. 2002; Castañeda et al. 2006; Sabat et al 2004).
Dr. Roberto Nespolo started his career as an animal physiological ecologist (Nespolo et al. 2003c; Nespolo and Rosenmann 2002), changing into evolutionary questions related with the evolutionary significance of vertebrate endothermy (Bacigalupe et al. 2004a; Nespolo et al. 2003b; Nespolo et al. 2005), but then started to use invertebrates as model species for addressing general questions related with adaptive evolution of the physiological phenotype in natural populations (Artacho and Nespolo 2008; Artacho and Nespolo 2009; Cortes et al. 2009; Nespolo et al. 2007a; Nespolo et al. 2007b; Nespolo and Franco 2007). He has collaborated with all of the remainder researchers his career (Castaneda et al. 2006; Castañeda et al. 2009; Nespolo et al. 2005; Nespolo et al. 2008; Nespolo et al. 2009; Opazo et al. 1999; Sabat et al. 2004), and has acquired both research and institutional leadership as the director of Institute of Ecology and Evolution and the head of the PhD program in Systematics and Ecology. He was also the deputy director of a previous successful Anillo's team (Appendix 2).

All of these researchers together, will start a collaborative team to study the causal factor for the evolution of endothermy using genomic, functional genomic and physiological approaches. This effort have never been undertook before and its main objectives are listed both in section II and its expected results and prediction in Appendix 3.4.It comprises laboratory and field experiments, involving postdocs, graduate and undergraduate students, as well as technicians and other colleagues, in Chile and in five other countries. Those activites are listed in sections II and III. The program includes strong outreach activities in order to disseminate the scientific knowledge into non-scientific environments, including a "rapid outreach" strategy (see next sub-section).

Human capital training and formation

Include here detailed information regarding training plans for researchers and students. If this proposal includes the creation or reinforcement of a postgraduate program, please explain the actions leading to this objetive, the resources that will be allocated to it and their specific use.

The researchers in this project are strongly associated with one of the three most important Chilean graduate program of human capital formation in ecological and evolutionary sciences, which is the PhD program in Systematics and Ecology of Universidad Austral de Chile (SISTECOL). Presently, the administrators of the program are three of us (CF, JCO, RN). SISTECOL has about 40 graduate students at different stages of their program, and has produced about 20 Doctors which are engaged in research at different levels of the national research and higher education system. In addition, SISTECOL has been recently funded with two MECESUP grants for about 2.5 million US dollars. The first one (AUS0807, ca. 2 million dollars, whose deputy director is RN, see Appendix 7) is aimed to build a new core facility for functional genomics, bioinformatics and genotyping in our Faculty. The second MECESUP grant (AUS0805, ca. 600.000 dollars, whose director is CF and deputy director is RN; see Appendix 8) is aimed to reinforce our SISTECOL program by hiring three new Faculty professors in the fields of community and population ecology, experimental evolution and plant systematics. In addition, and more important for the present proposal, the AUS0805 includes three postdoc positions to be incorporated into our research team, two of which will be dedicated to the present proposal (see Appendix 5).

These results are posted in:
http://www.mece2.com/portal/content/view/257/23/lang,spanish/

Then, these new MECESUP grants would be in direct benefit to the objetives of our present proposal since they would facilitate tremendously the bioinformatic and functional genomics work that is needed in studying the genes associated to endothermy, including qualified technical assistance by the postdocs.

Additionally, we currently have a MECESUP program in its second year of execution, the AUS0703(see Appendix 6) for about 480.000 US dollars, for financing tuition and maintenance fellowships for SISTECOL students. But more important for this proposal, the AUS0703 is financing *travel* fellowships for students, for short (2-3 months) stays abroad in excellence research centers. Then, this MECESUP grant would be in direct benefit to the objectives of our present proposal since it would assist our student in the travels needed to perform the experiments with echidnas, platypuses, tenrecs and erinaceous in the laboratories of our partners in Poland, South Africa, Australia and Spain. At the same time, we would be offering them training and advanced formation in vertebrate evolution, genomics and evolutionary physiology, in the form of their PhD theses, and in an exciting research project with an important international component.

On the other hand, our Faculty has two undergraduate programs to offer theses in our grant: Licentiature in Biochemistry and Licentiature in Biological Sciences, especially in genomics, transciptomics and evolutionary physiology. We plan to recruit students of those careers to perform their theses in the different aspects of our proposal.
Finally, we plan to hire technicians and to educate them in the standard genomic techniques, physiology, and molecular biology. The idea is not just to hire people to work into our project but also to offer them a formal training that would finish with a certificate as a laboratory technician, risk management, or animal husbandry.

Use the necessary space within the limits for this section

International Cooperation

Indicate and describe the activities programmed (laboratory or enterprise visits, invited researchers, students exchange, etc.) to establish significant and permanent links with foreign researchers, institutions abroad or international centers in shared areas of interest.

As is detailed in the project and in the attached commitment letters,this proposal has a strong international component. In fact, in addition with Enrico Rezende in Spain, we will extend our formal international cooperative network to Pawel Koteja and Janek Taylor in Poland, Stewart Nicol in Australia and Barry Lovegrove in South Africa. Our staff of postdocs, students and technicians will travel to the laboratories of our international partners to perform their theses, research stays and experiments, along with field work and seminars.

Interestingly, our international partners are important proponents of some of the most important hypotheses for the evolution of endothermy. Dr. Stewart Nicol, for instance, published the firsts studies related with thermogenic capacity in marsupials, and the absence of specialized thermogenic tissue (brown fat) in them, an important feature of non-placental mammals that can be associated with an imperfect endothermy (Nicol 1978; Wunder et al. 1996; Nicol et al. 1997). These studies were cited by us in our firsts attempts to understand the consequences of the absence of brown fat in marsupials (Opazo et al. 1999), using the Chilean didelphid *Thylamys elegans*, which is one of the species we propose to include in this proposal. Also, Dr. Nicol is one of the few researchers that have studied the physiology of one of the most primitive living mammal, the echidna (Nicol and Andersen 2007) which confirmed previous laboratory studies indicating that it exhibits an imperfect endothermy (Augee and Ealey 1968; Grigg et al. 2004), supporting the hypotheses that we plan to test in this proposal.

Dr. Koteja, who proposed one of the two most important hypotheses for the evolution of endothermy (Koteja 2000), was the leader of the team that started the “scientific race” to find the adaptive significance of energy metabolism in natural populations of animals, by determining its repeatability and quantitative genetics (Labocha et al. 2004; Sadowska et al. 2009; Sadowska et al. 2005). The other team that was studying the same problem, and started at the same time (late nineties) was leadered by some of us (Nespolo et al. 2003b; Bacigalupe et al. 2004a; Nespolo et al. 2005a). It is hard to say who won this “race”, but is clear that evolutionary physiology was benefited by the results of both research teams as these papers have been highly cited. In fact, this was an exciting and fair competition since during that time, we voluntarily interchanged manuscripts and ideas, we met in scientific meetings and also we cross-reviewed the last published papers almost at the same time (Artacho and Nespolo 2009; Boratynski and Koteja 2009). By the way, those were the first published evidence showing natural selection acting on energy metabolism.

Now we have the opportunity to collaborate in the same research, which would necessarily will produce a good result.

Dr. Lovegrove was one of the few researchers that have experience working on the physiological ecology of afroterians such as tenrecs and elephant shrews (Mzilikazi and Lovegrove 2005, 2006; Lovegrove and Genin 2008). In addition, Dr. Lovegrove is a known expert in evolutionary physiology studies of mammals, and have proposed one of the most important hypothesis about the adaptive forces that shaped basal metabolic rate in mammals (Lovegrove 2000), and also how energetic constraint have determined the evolution of extravagant phenotypic characteristics in mammals, such as armoured bodies (Lovegrove, 2001).

As indicated in the budget and in the Gantt chart, we plan to perform four travelling missions of three months each, with a student and a postdoc to each of the international destinations in order to capture and measure the animals. We expect that will be a valuable experience for our staff, including gathering data for the theses of our students and also for involving them with our international colleagues.

Use the necessary space within the limits for this section

Dissemination of results and knowledge transfer to non-academic environments.

Describe the activities that will ensure the dissemination and communication of the project results and advances, thus projecting such information to other domains and transmitting and validating the progress in science and technology contributed by this project.

Impacts: education and clinical applications

The Chilean scientific community is rather small, but very productive in comparative terms following standard indexes (Macilwain 1999). However, while certain areas are relatively well developed (*e.g.* physiology and cellular biology), others are insufficiently developed (*e.g.* palaeontology). Evolutionary biology in Chile suffers from the same type of asymmetric development: whereas evolutionary studies are scanty (Bacigalupe et al. 2004a; Nespolo et al. 2008; Artacho and Nespolo 2009), comparative studies and evolutionary genomics are almost absent. Elsewhere, the theory and practice of these methodologies are commonly applied and included in undergraduate and graduate courses on evolution (e.g., Ridley 1996; Futuyma 1998; Maynard Smith 1998); unfortunately, this is not the case in Chile.

This project is meant to represent, in the long term, a platform for further development of new scientific programs related to the evolution of vertebrates, and especially functional (physiological) genomics and evolutionary physiology. Since we are intended to identify and track several genes related with aerobic metabolism at different levels in the vertebrate phylogeny, several potential application for human diseases are possible. For instance, the recent identification of brown fat in adult humans (Cypess et al. 2009; Lichtenbelt et al. 2009), a tissue related with controlling energy metabolism and so far known to be present only in small placental mammals (Himms-Hagen 1990), has opened new possibilities treatment for the obesity epidemic (Farmer 2009). On the other hand, knowing the diversity of the same group of genes across the vertebrate tree will obviously generate clues into the most probable genes related with a range of metabolic diseases both in humans and in domestic animals.

Despite the fact that evolution has been recognized as the foundation for all biological disciplines (Dobzhansky 1973), there are still some people fighting to incorporate evolutionary thinking in their formal education and/or practice. In the particular case of medicine, scientists have realized that the incorporation of evolution in their education represents a significant step forward to understand ultimate explanations to medical questions (Nesse et. al. 2006, MacCallum 2007). In the literature there are many examples where an evolutionary approach has been crucial to unravel biomedical questions. The case of the insulin second binding site is one of them, in which it was demonstrated that an evolutionary analysis in a diverse array of species, can shed light into the identification of functional relevant sites with biomedical implications for disease treatment (Opazo et al. 2005).

In this proposal we believe that by capturing the genetic variation of the electron transport chain genes available in the genomic databases we will be able to contribute to the understanding of the metabolic disorders associated with these genes (www.mitomap.org) by identifying genes and/or sites within genes that were more relevant in the emergence of this complex phenotype called endothermy.

Impact on society: world "evolutionary crisis" and our "rapid outreach" strategy.

Evolution is one of the most controversial scientific disciplines at the public level. At present, the teaching of organic evolution at public schools has been criticised in several states of USA (Antolin and Herbers 2001; Alters and Nelson 2002; Holden and Bhattacharjee 2005; Holden 2006), and even forbidden in Italy (Science 304: 809, 2004). In fact, during the last years there has been a historical triumph of creationists in their fight against organic evolution through the publication, for the first time, of a scientific paper advocating "intelligent design" in a peer reviewed scientific journal (Meyer 2004, see comments in Nature 431: 114, 2004).

This is a complex problem related with historical and sociological factors that are also present in Chile, mostly related with a lack of appropriate connexions between scientists and the public. This problem lies in the education at public schools, but also with the lack of connection between the specialized publications and the day-to-day knowledge managed by the mass media. This project will contribute to

solve this problem by explicitly transferring our results, the *fact* and methods of the evolutionary science (focused on vertebrate evolution), by using what we call "*rapid outreach*".
Rapid outreach consists in periodically impacting the society immediately after the publication of a paper in a scientific journal. We usually do this by taking advantage of strategic contacts with specialized media such as the EFE news agency for Latin America, or the London-BBC. The following examples are the results of such initiatives:

i. A report in the BBC website featuring a result published by one of our PhD student, Paulina Artacho, in *Evolution*, (Artacho and Nespolo 2009) demonstrating natural selection acting on reducing energy costs of living in animals
(see http://news.bbc.co.uk/earth/hi/earth_news/newsid_8043000/8043689.stm).
As a consequence of this news, the next day there were several columns featuring this finding in many Chilean newspapers and in other websites across the world. Even a radio in Canada telephoned us for an live-interview.

ii. A related strategy was followed a number of times in our department, the Institute of Ecology and Evolution, aimed to "outreach" our research grants into the local community in Valdivia, outlining our basic and applied research in a single e-mail sent to journalists of "Diario Austral de Valdivia" during the last years. As a result, several full-reports were published in the central pages of the newspaper including photos, laboratories and working people. The consequences of this "rapid outreach" were that many people started to learn what is being done in our department, but more importantly school teachers and students asked for advice into their specific science matters and also the local authorities of the city asked our opinion for specific problems regarding sustainable development (e.g., pollution, national reserves, conservation, species management).

iii. A similar phenomenon, was induced after the publication of the results of the undergraduate thesis of Pablo Cortés, who used the relict marsupial *Dromiciops gliroides* as a model to study the evolution of endothermy (Cortes et al. 2009), which is the rationale behind our present proposal. After emailing a short outline of the paper to a journalist at the EFE news agency for Latin America, the report appeared in their website
(see http://www.20minutos.es/noticia/475482/0/fosil/evolucion/mamiferos/), and the next day in many national newspapers, examples:
http://www.lanacion.cl/prontus_noticias_v2/site/artic/20090623/pags/20090623194643.html
http://diario.elmercurio.cl/2009/06/24/ciencia_y_tecnologia/mas/noticias/38dd3a58-bcb6-461c-8b82-a2ae7b1486f9.htm).

The efficiency of such strategies in transferring specialized knowledge to the general public was astounding. Immediate discussions about ecology and the facts of evolution appeared in forums, blogs and letters. In the last example, common people appeared asking what is the endothermy and how such an ancient mammal (a "living fossil") could be still living, and can be used for asking evolutionary questions. The names of our students were rapidly associated with their research by school teachers and students, other graduate and undergraduate students and faculty professors and authorities. Our financing agencies, such as Conicyt and Fondecyt, contacted us asking details of how we managed to put such technical result in terms of common language to the public and decided to create an "outreach" link in the institutional website to inform to the public how their money from taxes is invested in scientific knowledge (see http://www.fondecyt.cl/578/article-32486.html).
Not only the specific knowledge was transferred but also the methods of science. In the reports, we specified that scientific results are published in peer review journals devoted to a specific discipline, and published by a given scientific society. In fact, the name and the specific issue of the journal was mentioned.
Use the necessary space within the limits for this section

REFERENCES

ADKINS, R.M., R. L. HONEYCUTT, AND T. R. DISOTELL. 1996. EVOLUTION OF EUTHERIAN CYTOCHROME C OXIDASE SUBUNIT II: HETEROGENEOUS RATES OF PROTEIN EVOLUTION AND ALTERED INTERACTION WITH CYTOCHROME C. MOL. BIOL. EVOL. 13:1393-1404.

ALTERS, B. J., AND C. E. NELSON. 2002. TEACHING EVOLUTION IN HIGHER EDUCATION. EVOLUTION 56:1891-1901.

ANDREWS, T.D., L. S. JERMIIN, AND S. EASTEAL. 1998. ACCELERATED EVOLUTION OF CYTOCHROME B IN SIMIAN PRIMATES: ADAPTIVE EVOLUTION IN CONCERT WITH OTHER MITOCHONDRIAL PROTEINS?. J. MOL. EVOL. 47:249-257.

ANTOLIN, M. F., AND J. M. HERBERS. 2001. EVOLUTION'S STRUGGLE FOR EXISTENCE IN AMERICA'S PUBLIC SCHOOLS. EVOLUTION 55 2379-2388.

ARMSTRONG, E. 1983. RELATIVE BRAIN SIZE AND METABOLISM IN MAMMALS. SCIENCE 220:1302-1304.

ARNOLD, S. J. 1983. MORPHOLOGY, PERFORMANCE, AND FITNESS. THE AMERICAN ZOOLOGIST 23:347-361.

ARNOLD, S. J., R. BURGER, P. A. HOHENLOHE, B. C. AJIE, AND A. G. JONES. 2008. UNDERSTANDING THE EVOLUTION AND STABILITY OF THE G-MATRIX. EVOLUTION 62:2451-2461.

ARTACHO, J. P., AND R. F. NESPOLO. 2008. INTRAPOPULATION VARIATION IN THE STANDARD METABOLISM OF A TERRESTRIAL MOLLUSC: REPEATABILITY OF THE CO2 PRODUCTION IN THE LAND SNAIL HELIX ASPERSA. PHYSIOLOGICAL AND BIOCHEMICAL ZOOLOGY IN PRESS.

ARTACHO, P., AND R. F. NESPOLO. 2009. NATURAL SELECTION REDUCES ENERGY METABOLISM IN THE GARDEN SNAIL, HELIX ASPERSA (CORNU ASPERSUM). EVOLUTION 63:1044-1050.

AUGEE, M. L., AND H. M. EALEY. 1968. TORPOR IN THE ECHIDNA, TACHYGLOSSUS ACULEATUS. JOURNAL OF MAMMALOGY 49:446-454.

BACIGALUPE LD, BOZINOVIC F. 2002. DESIGN, LIMITATIONS AND SUSTAINED METABOLIC RATE: LESSONS FROM SMALL MAMMALS. JOURNAL OF EXPERIMENTAL BIOLOGY 205:2963-2970

BACIGALUPE LD, IRIARTE-DIAZ J, BOZINOVIC F. 2002. FUNCTIONAL MORPHOLOGY AND GEOGRAPHIC VARIATIONS IN THE DIGGING APPARATUS OF CURUROS (OCTODONTIDAE: SPALACOPUS CYANUS). JOURNAL OF MAMMALOGY 83 145-152

BACIGALUPE LD, REZENDE EL, KENAGY GJ, BOZINOVIC F. 2003. ACTIVITY AND SPACE USE BY DEGUS: A TRADE-OFF BETWEEN THERMAL CONDITIONS AND FOOD AVAILABILITY? JOURNAL OF MAMMALOGY 84 311-318

BACIGALUPE LD, NESPOLO RF, BUSTAMANTE DM, BOZINOVIC F. 2004A. THE QUANTITATIVE GENETICS OF SUSTAINED ENERGY BUDGET IN A WILD MOUSE. EVOLUTION 58:421-429

BACIGALUPE LD, NESPOLO RF, OPAZO JC, BOZINOVIC F. 2004B. PHENOTYPIC FLEXIBILITY IN A NOVEL THERMAL ENVIRONMENT: PHYLOGENETIC INERTIA IN THERMOGENIC CAPACITY AND EVOLUTIONARY ADAPTATION IN ORGAN SIZE. PHYSIOLOGICAL AND BIOCHEMICAL ZOOLOGY 77:805-815

BACIGALUPE LD, NESPOLO RF, BUSTAMANTE DM, BOZINOVIC F. 2005. IS THERE A TRADE-OFF BETWEEN ENERGETICS AND SPLEEN MASS? A QUANTITATIVE GENETIC STUDY IN THE LEAF-EARED MOUSE. EVOLUTIONARY ECOLOGY RESEARCH 7:497-503

BACIGALUPE LD, ARAYA NM, CARTER MJ, CATALANA TP, LARDIES MA, BOZINOVIC F. 2007A. MATERNAL EFFECTS, MATERNAL BODY SIZE AND OFFSPRING ENERGETICS: A STUDY IN THE COMMON WOODLOUISE PORCELLIO LAEVIS. COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY A-MOLECULAR & INTEGRATIVE PHYSIOLOGY 147:349-354

BACIGALUPE LD, CRUDGINGTON HS, HUNTER F, MOORE AJ, SNOOK RR . 2007B. SEXUAL CONFLICT DOES NOT DRIVE REPRODUCTIVE ISOLATION IN EXPERIMENTAL POPULATIONS

OF DROSOPHILA PSEUDOOBSCURA. JOURNAL OF EVOLUTIONARY BIOLOGY 20:1763-1771
BACIGALUPE LD, CRUDGINGTON HS, SLATE J, MOORE AJ, SNOOK RR. 2008. SEXUAL SELECTION AND INTERACTING PHENOTYPES IN EXPERIMENTAL EVOLUTION: A STUDY OF DROSOPHILA PSEUDOSCURA MATING BEHAVIOR. EVOLUTION IN PRESS
BAKKER, R. T. 1971. DINOSAUR PHYSIOLOGY AND THE ORIGIN OF MAMMALS. EVOLUTION 25:636-658.
BARTOSIEWICZ, M., TROUNSTINE, M., BARKER, D., JOHNSTON, R. AND BUCKPITT, A. 2000. DEVELOPMENT OF A TOXICOLOGICAL GENE ARRAY AND QUANTITATIVE ASSESSMENT OF THIS TECHNOLOGY. ARCH. BIOCH. BIOPHYS. 376:66–73.
BECH, C., I. LANGSETH, AND G. W. GABRIELSEN. 1999. REPEATABILITY OF BASAL METABOLISM IN BREEDING FEMALE KITTIWAKES. PROCEEDINGS OF THE ROYAL SOCIETY OF LONDON B 266:2161-2167.
BENNETT, A. F., AND J. A. RUBEN. 1979. ENDOTHERMY AND ACTIVITY IN VERTEBRATES. SCIENCE 206:649-653.
BENNETT, A. F., J. W. HICKS, AND A. J. CULLUM. 2000. AN EXPERIMENTAL TEST OF THE THERMOREGULATORY HYPOTHESIS FOR THE EVOLUTION OF ENDOTHERMY. EVOLUTION 54:1768-1773.
BERTEAUX, D., D. W. THOMAS, J. M. BERGERON, AND H. LAPIERRE. 1996. REPEATABILITY OF DAILY FIELD METABOLIC RATE IN FEMALE MEADOW VOLES (MICROTUS PENNSILVANICUS). FUNCT. ECOL. 10:751-759.
BISHOP, J. A., AND W. S. ARMBRUSTER. 1999. THERMOREGULATORY ABILITIES OF ALASKAN BEES: EFFECT OF SIZE, PHYLOGENY AND ECOLOGY. FUNCT. ECOL. 13:711-724.
BLOCK, B. A., J. R. FINNERTY, A. F. R. STEWART, AND J. KIDD. 1993. EVOLUTION OF ENDOTHERMY IN FISH: MAPPING PHYSIOLOGICAL TRAITS ON A MOLECULAR PHYLOGENY. EVOLUTION 260:210-215.
BOILY, P. 2002. INDIVIDUAL VARIATION IN METABOLIC TRAITS OF WILD NINE-BANDED ARMADILLOS (DASYPUS NOVEMCINCTUS), AND THE AEROBIC CAPACITY MODEL FOR THE EVOLUTION OF ENDOTHERMY. J. EXP. BIOL. 205:3207-3214.
BORATYNSKI, Z., AND P. KOTEJA. 2009. THE ASSOCIATION BETWEEN BODY MASS, METABOLIC RATES AND SURVIVAL OF BANK VOLES. FUNCT. ECOL. 23:330-339.
BOZINOVIC, F. 1992. SCALING OF BASAL AND MAXIMUM METABOLIC RATE IN RODENTS AND THE AEROBIC CAPACITY MODEL FOR THE EVOLUTION OF ENDOTHERMY. PHYSIOL. ZOOL. 65:921-931.
BURGE, C., AND S. KARLIN. 1997. PREDICTION OF COMPLETE GENE STRUCTURES IN HUMAN GENOMIC DNA. J. MOL. BIOL. 268:78-94.
BUSTAMANTE DM, NESPOLO RF, REZENDE EL, BOZINOVIC F. 2002. DYNAMIC THERMAL BALANCE IN SMALL MAMMALS: THE INTERPLAY AMONG AMBIENT TEMPERATURE, BODY SIZE AND BEHAVIOR. PHYSIOLOGICAL AND BIOCHEMICAL ZOOLOGY 75
CASTANEDA, L. E., P. SABAT, S. P. GONZALEZ, AND R. F. NESPOLO. 2006. DIGESTIVE PLASTICITY IN TADPOLES OF THE CHILEAN GIANT FROG (CAUDIVERBERA CAUDIVERBERA): FACTORIAL EFFECTS OF DIET AND TEMPERATURE. PHYSIOLOGICAL AND BIOCHEMICAL ZOOLOGY 79:919-926.
CASTAÑEDA LE, FIGUEROA CC, FUENTES E, NIEMEYER H, NESPOLO RF. 2009. ENERGY COSTS OF DETOXIFICATION SYSTEMS IN APHIDS FEEDING ON CHEMICALLY DEFENDED HOST-PLANTS: A CORRELATIONAL STUDY IN THE GRAIN APHID, SITOBION AVENAE. JOURNAL OF EXPERIMENTAL BIOLOGY 212:1185-1190
CHAPPELL, M. A. 1993. AEROBIC PERFORMANCE IN GROUND SQUIRRELS: FITNESS CORRELATES AND REPEATABILITY. PROYECTO NSF:1-29.
CHAPPELL, M. A., G. C. BACHMAN, AND J. P. ODELL. 1995. REPEATABILITY OF MAXIMAL AEROBIC PERFORMANCE IN BELDING'S GROUND SQUIRRELS, SPERMOPHILUS BELDINGI. FUNCT. ECOL. 9:498-504.
CHAPPELL MA, GARLAND T, REZENDE EL, GOMES FR. 2004. VOLUNTARY RUNNING IN DEER MICE: SPEED, DISTANCE, ENERGY COSTS AND TEMPERATURE EFFECTS. JOURNAL OF EXPERIMENTAL BIOLOGY 207 3839-3854.

CHEVIRON, Z.A., WHITEHEAD, A. AND BRUMFIELD, R.T. 2008. TRANSCRIPTOMIC VARIATION AND PLASTICITY IN RUFOUS-COLLARED SPARROWS (ZONOTRICHIA CAPENSIS) ALONG AN ALTITUDINAL GRADIENT. MOL. ECOL. 17:4556–4569.
CORTES, P., S. A. QUIJANO, AND R. F. NESPOLO. 2009. BIOENERGETICS AND INTER-INDIVIDUAL VARIATION IN PHYSIOLOGICAL CAPACITIES IN A RELICT MAMMAL - THE MONITO DEL MONTE (DROMICIOPS GLIROIDES). J. EXP. BIOL. 212:297-304.
COSSINS, A. R., AND K. BOWLER. 1987. TEMPERATURE BIOLOGY OF ANIMALS. CHAPMAN & HALL, LONDON.
COTTON, J.A., AND R. D. M. PAGE. 2002. GOING NUCLEAR: GENE FAMILY EVOLUTION AND VERTEBRATE PHYLOGENY RECONCILED. PROC. BIOL. SCI. 269:1555-1561.
CROMPTON, A. W., C. R. TAYLOR, AND J. A. JAGGER. 1978. EVOLUTION OF HOMEOTHERMY IN MAMMALS. NATURE 272:333-336.
CUSTODIO, R. W. S. 2000. REPEATABILITY AND HERITABILITY ESTIMETES FOR EGG AND CHICK PRODUCTION, WITH HIERARCHICAL MATINGS, IN MEAT-TYPE CHICKENS. PESQUISA AGROPECUARIA BRASILEIRA 35:967-974.
CYPESS, A. M., S. LEHMAN, G. WILLIAMS, I. TAL, D. RODMAN, A. B. GOLDFINE, F. C. KUO, E. L. PALMER, Y. TSENG, A. DORIA, G. M. KOLODNY, AND C. R. KAHN. 2009. IDENTIFICATION AND IMPORTANCE OF BROWN ADIPOSE TISSUE IN ADULT HUMANS. N. ENGL. J. MED. 360:1509-1517.
DIAZ GB, OJEDA RA, REZENDE EL. 2006. RENAL MORPHOLOGY, PHYLOGENETIC HISTORY AND DESERT ADAPTATION OF SOUTH AMERICAN HYSTRICOGNATH RODENTS. FUNCTIONAL ECOLOGY 20:609-620
DOAN, J.W., T. R. SCHMIDT, D. E. WILDMAN, M. GOODMAN, M. L. WEISS, AND L. I. GROSSMAN. 2005. RAPID NONSYNONYMOUS EVOLUTION OF THE IRON-SULFUR PROTEIN IN ANTHROPOID PRIMATES. J. BIOENERG. BIOMEMBR. 37:35-41..
DOAN, J.W., T. R. SCHMIDT, D. E. WILDMAN, M. UDDIN, A. GOLDBERG, M. HÜTTEMANN, M. GOODMAN, M. L. WEISS. 2004. COADAPTIVE EVOLUTION IN CYTOCHROME C OXIDASE: 9 OF 13 SUBUNITS SHOW ACCELERATED RATES OF NONSYNONYMOUS SUBSTITUTION IN ANTHROPOID PRIMATES. MOL. PHYLOGENET. EVOL. 33:944-950.
DOBZHANSKY, T. 1973. NOTHING IN BIOLOGY MAKE SENSE EXCEPT IN THE LIGHT OF EVOLUTION. AM. BIOL. TEACH. 35: 125-129.
DOHM MR, HAYES JP, GARLAND T (2001) THE QUANTITATIVE GENETICS OF MAXIMAL AND BASAL RATES OF OXYGEN CONSUMPTION IN MICE. GENETICS 159:267-277
DOHM, M. R. 2002. REPEATABILITY ESTIMATES DO NOT ALWAYS SET AN UPPER LIMIT TO HERITABILITY. FUNCT. ECOL. 16:273-280.
EDGAR, R.C. 2004. MUSCLE: MULTIPLE SEQUENCE ALIGNMENT WITH HIGH ACCURACY AND HIGH THROUGHPUT. NUCLEIC ACIDS RES. 32:1792-1797.
ELSE, P. L., N. TURNER, AND A. J. HULBERT. 2004. THE EVOLUTION OF ENDOTHERMY: ROLE FOR MEMBRANES AND MOLECULAR ACTIVITY. PHYSIOLOGICAL AND BIOCHEMICAL ZOOLOGY 77:950-958.
EVANS, D. L., AND R. J. ROSE. 1988. DETERMINATION AND REPEATABILITY OF MAXIMUM OXYGEN UPTAKE AND OTHER CARDIORESPIRATORY MEASUREMENTS IN THE EXERCICING HORSE. EQUINE VETERINARIAN JOURNAL 20:94-98.
FALCONER, D.S., MACKAY, T.F.C. 1996. INTRODUCTION TO QUANTITATIVE GENETICS, 4TH EDN. PEARSON EDUCATION LIMITED, HARLOW, UK.
FARMER, S. R. 2009. OBESITY BE COOL, LOSE WEIGHT. NATURE 458:839-840.
FIGUEROA CC ET AL. (2004) EFFECT OF HOST DEFENSE CHEMICALS ON CLONAL DISTRIBUTION AND PERFORMANCE OF DIFFERENT GENOTYPES OF THE CEREAL APHID SITOBION AVENAE. JOURNAL OF CHEMICAL ECOLOGY 30:2515-2525
FIGUEROA CC ET AL. (2005) GENETIC STRUCTURE AND CLONAL DIVERSITY OF AN INTRODUCED PEST IN CHILE, THE CEREAL APHID SITOBION AVENAE HEREDITY 95:24-33
FIGUEROA, C.C, PRUNIER-LETERME, N, RISPE, C., SEPÚLVEDA, F., FUENTES-CONTRERAS, E., SABATER-MUÑOZ, B., SIMON, J.-C., TAGU, D. 2007. ANNOTATED EXPRESSED SEQUENCE TAGS AND XENOBIOTIC DETOXIFICATION IN THE APHID MYZUS PERSICAE (SULZER). INSECT SCIENCE 14:29-45

FLEIGE, S., WOLF. V., HUCH. S., PRGOMET, C., SEHM, J., PFAFFL, M. W. 2006. COMPARISON OF RELATIVE MRNA QUANTIFICATION MODELS AND THE IMPACT OF RNA INTEGRITY IN QUANTITATIVE REAL-TIME RT-PCR. BIOTECH. LETTS. 28:1601-1613.
FOURNIER, F., AND D. THOMAS. 1999. THERMOREGULATION AND REPEATABILITY OF OXYGEN-CONSUMPTION MEASUREMENTS IN WINTER-ACCLIMATIZED NORTH AMERICAN PORCUPINES (ERETHIZON DORSATUM) CANADIAN JOURNAL OF ZOOLOGY 77:194-202.
FUTUYMA, D. J. 1998. EVOLUTIONARY BIOLOGY. SINAUER, SUNDERLAND.
GAETE-EASTMAN C, FIGUEROA CC, OLIVARES-DONOSO R, NIEMEYER HM, RAMIREZ CC. 2004. DIET BREADTH AND ITS RELATIONSHIP WITH GENETIC DIVERSITY AND DIFFERENTIATION: THE CASE OF SOUTHERN BEECH APHIDS (HEMIPTERA : APHIDIDAE). BULLETIN OF ENTOMOLOGICAL RESEARCH 94:219-227.
GEBCZYNSKI AK (2008) NONSHIVERING THERMOGENESIS CAPACITY VERSUS BASAL METABOLIC RATE IN LABORATORY MICE. JOURNAL OF THERMAL BIOLOGY 33:250-254.
GEBCZYNSKI, A. K., AND M. KONARZEWSKI. 2009. LOCOMOTOR ACTIVITY OF MICE DIVERGENTLY SELECTED FOR BASAL METABOLIC RATE: A TEST OF HYPOTHESES ON THE EVOLUTION OF ENDOTHERMY. JOURNAL OF EVOLUTIONARY BIOLOGY 22:1212-1220.
GOLDBERG, A., D. E. WILDMAN, T. R. SCHMIDT, M. HUTTEMANN, M. GOODMAN, M. L. WEISS, AND L. I. GROSSMAN. 2003. ADAPTIVE EVOLUTION OF CYTOCHROME C OXIDASE SUBUNIT VIII IN ANTHROPOID PRIMATES. PROC. NATL. ACAD. SCI. U.S.A. 100:5873-5878.
GOODMAN, M. 1982. POSITIVE SELECTION CAUSES PURIFYING SELECTION. NATURE 295:630.
GRIGG, G. C., L. A. BEARD, AND M. L. AUGEE. 2004. THE EVOLUTION OF ENDOTHERMY AND ITS DIVERSITY IN MAMMALS AND BIRDS. PHYSIOLOGICAL AND BIOCHEMICAL ZOOLOGY 77:982-997.
GROSSMAN, L.I., D. E. WILDMAN, T. R. SCHMIDT, AND M. GOODMAN. 2004. ACCELERATED EVOLUTION OF THE ELECTRON TRANSPORT CHAIN IN ANTHROPOID PRIMATES. TRENDS GENET. 20:578-585.
HACKETT, S.J., R. T. KIMBALL, S. REDDY, R. C. K. BOWIE, E. L. BRAUN, M. J. BRAUN, J. L. CHOJNOWSKI, W.A. COX, K. HAN, J. HARSHMAN, C. J. HUDDLESTON, B. D. MARKS, K. J. MIGLIA, W. S. MOORE, F. H. SHELDON, D. W. STEADMAN, C. C. WITT, AND T. YURI. 2008. A PHYLOGENOMIC STUDY OF BIRDS REVEALS THEIR EVOLUTIONARY HISTORY. SCIENCE 320:1763-1768.
HALLSTRÖM, B.M., M. KULLBERG, M. A. NILSSON, AND A. JANKE. 2007. PHYLOGENOMIC DATA ANALYSES PROVIDE EVIDENCE THAT XENARTHRA AND AFROTHERIA ARE SISTER GROUPS. MOL. BIOL. EVOL. 24:2059-2068.
HAYES, J. P., AND T. GARLAND. 1995. THE EVOLUTION OF ENDOTHERMY: TESTING THE AEROBIC CAPACITY MODEL. EVOLUTION 49:836-847.
HAYES, J. P., C. A. BIBLE, AND J. D. BOONE. 1998. REPEATABILITY OF MAMMALIAN PHYSIOLOGY: EVAPORATIVE WATER LOSS AND OXYGEN CONSUMPTION OF DIPODOMYS MERRIAMI. JOURNAL OF MAMMALOGY 79:475-485.
HEINRICH, B. 1977. WHY HAVE SOME ANIMALS EVOLVED TO REGULATE A HIGH BODY TEMPERATURE? THE AMERICAN NATURALIST 111:623-640.
HILLENIUS, W. J., AND J. A. RUBEN. 2004. THE EVOLUTION OF ENDOTHERMY IN TERRESTRIAL VERTEBRATES: WHO? WHEN? WHY? PHYSIOLOGICAL AND BIOCHEMICAL ZOOLOGY 77:1019-1042.
HIMMS-HAGEN, J. 1990. BROWN ADIPOSE TISSUE THERMOGENESIS: INTERDISCIPLINARY STUDIES. FASEB 4:2890-2891.
HOLDEN, C. 2006. TEACHING EVOLUTION - COURT REVIVES GEORGIA STICKER CASE. SCIENCE 312:1292-1292.
HOLDEN, C., AND Y. BHATTACHARJEE. 2005. TEACHING EVOLUTION - ANTIEVOLUTIONISTS WIN ONE IN KANSAS, LOSE EIGHT SEATS IN DOVER. SCIENCE 310:1105-1105.
HORAK, P., L. SAKS, I. OTS, AND H. KOLLIST. 2002. REPEATABILITY OF CONDITION INDICES IN CAPTIVE GREENFINCHES (CARDUELIS CHLORIS). CANADIAN JOURNAL OF ZOOLOGY 80 636-643.

HUEY, R. B., AND A. E. DUNHAM. 1987. REPEATABILITY OF LOCOMOTOR PERFORMANCE IN NATURAL POPULATIONS OF THE LIZARD SCELOPORUS MERRIAMI. EVOLUTION 41:1116-1120.
HULBERT, A. J. 1990. THE CELLULAR BASIS OF ENDOTHERMIC METABOLISM: A ROLE FOR "LEAKY" MEMBRANES. NEWS PHYSIOL. SCI. 5:25-28.
HULBERT, A. J., AND P. L. ELSE. 1989. COMPARISON OF THE "MAMMAL MACHINE" AND THE "REPTILE MACHINE": ENERGY USE AND TYROID PRODUCTION. AMERICAN JOURNAL OF PHYSIOLOGY 241:R350-R356.
HULBERT, A. J., AND P. L. ELSE. 2004. BASAL METABOLIC RATE: HISTORY, COMPOSITION, REGULATION AND USEFULNESS. PHYSIOLOGICAL AND BIOCHEMICAL ZOOLOGY 77:869-876.
KEMP, T. S. 2006. THE ORIGIN OF MAMMALIAN ENDOTHERMY: A PARADIGM FOR THE EVOLUTION OF COMPLEX BIOLOGICAL STRUCTURE. ZOOL. J. LINN. SOC. 147:473-488.
KINNEAR, A., AND J. W. SHIELD. 1975. METABOLISM AND TEMPERATURE REGULATION IN MARSUPIALS. COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY A 52A:235-245.
KLAASEN, M., J. AGRELL, AND A. LINDSTROM. 2002. METABOLIC RATE AND THERMAL CONDUCTANCE OF LEMMINGS FROM HIGH-ARCTIC CANADA AND SIBERIA. JOURNAL OF COMPARATIVE PHYSIOLOGY B 172:371-378.
KONARZEWSKI, M., A. KSIAZEK, AND I. B. LAPO. 2005. ARTIFICIAL SELECTION ON METABOLIC RATES AND RELATED TRAITS IN RODENTS. INTEGRATIVE AND COMPARATIVE BIOLOGY 45:416-425.
KONARZEWSKI, M., AND J. DIAMOND. 1995A. EVOLUTION OF BASAL METABOLIC RATE AND ORGAN MASSES IN LABORATORY MICE. EVOLUTION 49:1239-1248.
KONARZEWSKI, M., AND J. DIAMOND. 1995B. EVOLUTION OF BASAL METABOLIC RATE AND ORGAN MASSES IN LABORATORY MICE. EVOLUTION 49:1239-2148.
KOTEJA, P. 2000. ENERGY ASSIMILATION, PARENTAL CARE, AND EVOLUTION OF ENDOTHERMY. PROCEEDINGS OF THE ROYAL SOCIETY OF LONDON B 267:479-484.
KOTEJA, P. 2004. THE EVOLUTION OF CONCEPTS ON THE EVOLUTION OF ENDOTHERMY IN BIRDS AND MAMMALS. PHYSIOLOGICAL AND BIOCHEMICAL ZOOLOGY 77:1043-1050.
LABOCHA, M. K., E. T. SADOWSKA, K. BALIGA, A. K. SEMER, AND P. KOTEJA. 2004. INDIVIDUAL VARIATION AND REPEATABILITY OF BASAL METABOLISM IN THE BANK VOLE, CLETHRIONOMYS GLAREOLUS PROCEEDINGS OF THE ROYAL SOCIETY OF LONDON B 271:367-372.
LAI, Z., KANE, N.C., ZOU, Y. AND RIESEBERG, L.H. 2008. NATURAL VARIATION IN GENE EXPRESSION BETWEEN WILD AND WEEDY POPULATIONS OF HELIANTHUS ANNUUS. GENETICS 179:1881-90.
LESSELLS, C. M., AND P. T. BOAG. 1987. UNREPEATABLE REPEATABILITIES: A COMMON MISTAKE. THE AUK 104:116-121.
LICHTENBELT, W. D. V., J. W. VANHOMMERIG, N. M. SMULDERS, J. DROSSAERTS, G. J. KEMERINK, N. D. BOUVY, P. SCHRAUWEN, AND G. J. J. TEULE. 2009. COLD-ACTIVATED BROWN ADIPOSE TISSUE IN HEALTHY MEN (VOL 360, PG 1500, 2009). N. ENGL. J. MED. 360:1917-1917.
LIGHTON, J. R. B. 2008. MEASURING METABOLIC RATES. OXFORD UNIVERSITY PRESS, NEW YORK.
LOPEZ-CALLEJA MV, SOTO-GAMBOA M, REZENDE EL. 2000. THE ROLE OF GASTROLITES ON FEEDING BEHAVIOR AND DIGESTIVE EFFICIENCY IN THE RUFOUS-COLLARED SPARROW. CONDOR 102:465-469
LOVEGROVE, B. G. 2000. THE ZOOGEOGRAPHY OF MAMMALIAN BASAL METABOLIC RATE. THE AMERICAN NATURALIST 156:201-219.
LOVEGROVE, B. G. 2001. THE EVOLUTION OF BODY ARMOR IN MAMMALS: PLANTIGRADE CONSTRAINTS OF LARGE BODY SIZE. EVOLUTION 55:1464-1473
LOVEGROVE, B. G., AND F. GENIN. 2008. TORPOR AND HIBERNATION IN A BASAL PLACENTAL MAMMAL, THE LESSER HEDGEHOG TENREC ECHINOPS TELFAIRI. JOURNAL OF COMPARATIVE PHYSIOLOGY B-BIOCHEMICAL SYSTEMIC AND ENVIRONMENTAL PHYSIOLOGY 178:691-698.

LUNA-JORQUERA, G., R. P. WILSON, AND B. CULIK. 1997. OBSERVATIONS ON THE THERMAL CONDUCTANCE OF ADELIE (PYGOSCELIS ADELIAE) AND HUMBOLDT (SPHENISCUS HUMBOLDTI) PENGUINS. POLAR BIOLOGY 17:74-80.
LYNCH, M., AND B. WALSH. 1998. GENETICS AND ANALYSIS OF QUANTITATIVE TRAITS. SINAUER, SUNDERLAND.
MACCALLUM, C.J. 2007. DOES MEDICINE WITHOUT EVOLUTION MAKE SENSE? PLOS BIOLOGY 5:E112.
MACILWAIN, C. 1999. CHILE TRIES TO BRIDGE GAP IN SCIENTIFIC STANDARDS. NATURE 398:11-12.
MADSEN, T., AND R. SHINE. 1999. LIFE HISTORY CONSEQUENCES OF NEST-SITE VARIATIONS IN TROPICAL PYTHONS (LIASIS FUSCUS). ECOLOGY 80:989-997.
MARAIS, E., AND S. L. CHOWN. 2003. REPEATABILITY OF STANDARD METABOLIC RATE AND GAS EXCHANGE CHARACTERISTICS IN A HIGHLY VARIABLE COCKROACH, PERISPHAERIA SP. . J. EXP. BIOL. 206 4565-4574.
MARSH, R. L., W. R. DAWSON, AND L. C. H. WANG. 1989. AVIAN ADJUSTMENTS TO COLD. PP. 205-253. ADVANCES IN COMPARATIVE AND ENVIRONMENTAL PHYSIOLOGY. SPRINGER VERLAG, BERLIN.
MAYNARD SMITH, J. 1998. EVOLUTIONARY GENETICS. OXFORD UNIVERSITY PRESS, OXFORD.
MCCARTHY, I. D. 2000. TEMPORAL REPEATABILITY OF RELATIVE STANDARD METABOLIC RATE IN JUVENILE ATLANTIC SALMON AND ITS RELATION WITH LIFE HISTORY VARIATION. JOURNAL OF FISH BIOLOGY 57 224-238.
MCNAB, B. K. 1978. THE EVOLUTION OF HOMEOTHERMY IN THE PHYLOGENY OF MAMMALS. THE AMERICAN NATURALIST 112:1-21.
MCNAB, B. K. 1980. ON ESTIMATING THERMAL CONDUCTANCE IN ENDOTERMS. PHYSIOL. ZOOL. 53:145-156.
MCNAB. 1996. METABOLISM AND TEMPERATURE REGULATION OF KIWIS (APTERYGIDAE). THE AUKL 113:687-692.
MURPHY, W.J., E. EIZIRIK, S. J. O'BRIEN, O. MADSEN, M. SCALLY, C. J. DOUADY, E. TEELING, O. A. RYDER, M. J. STANHOPE, W. W. DE JONG, AND M. S. SPRINGER. 2001. RESOLUTION OF THE EARLY PLACENTAL MAMMAL RADIATION USING BAYESIAN PHYLOGENETICS. SCIENCE 294:2348-2351.
MZILIKAZI, N., AND B. G. LOVEGROVE. 2005. DAILY TORPOR DURING THE ACTIVE PHASE IN FREE-RANGING ROCK ELEPHANT SHREWS (ELEPHANTUS MYURUS). JOURNAL OF ZOOLOGY OF LONDON 267 103-111.
MZILIKAZI, N., AND B. G. LOVEGROVE. 2006. NORADRENALIN INDUCES THERMOGENESIS IN A PHYLOGENETICALLY ANCIENT EUTHERIAN MAMMAL, THE ROCK ELEPHANT SHREW, ELEPHANTYLUS MYURUS. JOURNAL OF COMPARATIVE PHYSIOLOGY B-BIOCHEMICAL SYSTEMIC AND ENVIRONMENTAL PHYSIOLOGY 176:75-84.
NAYA, D. E., G. FARFAN, P. SABAT, M. A. MENDEZ, AND F. BOZINOVIC. 2005. DIGESTIVE MORPHOLOGY AND ENZYME ACTIVITY IN THE ANDEAN TOAD, BUFO SPINULOSUS: HARD-WIRED OR FLEXIBLE PHYSIOLOGY? COMP. BIOCHEM. PHYSIOL. A-MOL. INTEGR. PHYSIOL. 140:165-170.
NELSON, D.L., AND M. M. COX. 2008. LEHNINGER PRINCIPLES OF BIOCHEMISTRY. W. H. FREEMAN.
NESPOLO RF, OPAZO JC, ROSENMANN M, BOZINOVIC F.1999. THERMAL ACCLIMATION, MAXIMUM METABOLIC RATE AND NONSHIVERING THERMOGENESIS IN PHYLLOTIS XANTHOPYGUS (RODENTIA) INHABITING THE ANDEAN RANGE. JOURNAL OF MAMMALOGY 80:742-748
NESPOLO, R. F., L. D. BACIGALUPE, E. L. REZENDE, AND F. BOZINOVIC. 2001A. WHEN NONSHIVERING THERMOGENESIS EQUALS MAXIMUM METABOLIC RATE: THERMAL ACCLIMATION AND PHENOTYPIC PLASTICITY OF FOSSORIAL SPALACOPUS CYANUS (RODENTIA). PHYSIOLOGICAL AND BIOCHEMICAL ZOOLOGY 74:325-332
NESPOLO, R. F., J. C. OPAZO, AND F. BOZINOVIC. 2001B. THERMAL ACCLIMATION AND NON-SHIVERING THERMOGENESIS IN THREE SPECIES OF SOUTH AMERICAN RODENTS: A

COMPARISON BETWEEN ARID AND MESIC HABITATS. JOURNAL OF ARID ENVIRONMENTS 48:581-590.
NESPOLO RF, ROSENMANN M. 2002. INTRASPECIFIC ALLOMETRY OF HAEMATOLOGICAL PARAMETERS IN *BASILICHTHYS AUSTRALIS*. JOURNAL OF FISH BIOLOGY 60:1358-1362.
NESPOLO RF, BACIGALUPE LD, BOZINOVIC F. 2002A. THE INFLUENCE OF HEAT INCREMENT OF FEEDING ON BASAL METABOLIC RATE IN PHYLLOTIS DARWINI (MURIDAE). COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY A IN PRESS
NESPOLO RF, BACIGALUPE LD, SABAT PA, BOZINOVIC F. 2002B. INTERPLAY AMONG ENERGY METABOLISM, ORGAN MASSES AND DIGESTIVE ENZYME ACTIVITY IN THE MOUSE OPPOSUM, THYLAMYS ELEGANS: THE ROLE OF THERMAL ACCLIMATION. JOURNAL OF EXPERIMENTAL BIOLOGY 205:2697-2703
NESPOLO, R. F., L. D. BACIGALUPE, AND F. BOZINOVIC. 2003A. HERITABILITY OF ENERGETICS IN A WILD MAMMAL, THE LEAF-EARED MOUSE (PHYLLOTIS DARWINI). EVOLUTION 57 1679-1688..
NESPOLO RF, ARIM M, BOZINOVIC F. 2003B. BODY SIZE AS A LATENT VARIABLE IN A STRUCTURAL EQUATION MODEL: THERMAL ACCLIMATION AND ENERGETICS OF THE LEAF-EARED MOUSE. JOURNAL OF EXPERIMENTAL BIOLOGY 206 2145-2157
NESPOLO, R. F., M. A. LARDIES, AND F. BOZINOVIC. 2003C. INTRAPOPULATIONAL VARIATION IN THE STANDARD METABOLIC RATE OF INSECTS: REPEATABILITY, THERMAL DEPENDENCE AND SENSITIVITY (Q10) OF OXYGEN CONSUMPTION IN A CRICKET. J. EXP. BIOL. 206:4309-4315.
NESPOLO, R. F., D. M. BUSTAMANTE, L. D. BACIGALUPE, AND F. BOZINOVIC. 2005 QUANTITATIVE GENETICS OF BIOENERGETICS AND GROWTH-RELATED TRAITS IN THE WILD MAMMAL, PHYLLOTIS DARWINI. EVOLUTION 59:1829-1837.
NESPOLO, R. F., P. ARTACHO, AND L. E. CASTAÑEDA. 2007. CYCLIC GAS-EXCHANGE IN THE CHILEAN RED CRICKET: INTER-INDIVIDUAL VARIATION AND THERMAL DEPENDENCE. J. EXP. BIOL. 210:668-675.
NESPOLO, R. F., AND M. FRANCO. 2007. WHOLE-ANIMAL METABOLIC RATE IS A REPEATABLE TRAIT: A META ANALYSIS. J. EXP. BIOL. 210:2000-2005.
NESPOLO RF, ARTACHO P, CASTAÑEDA LE. 2007A. CYCLIC GAS-EXCHANGE IN THE CHILEAN RED CRICKET: INTER-INDIVIDUAL VARIATION AND THERMAL DEPENDENCE. JOURNAL OF EXPERIMENTAL BIOLOGY 210:668-675
NESPOLO RF, CASTANEDA LE, ROFF DA. 2007B. QUANTITATIVE GENETIC VARIATION OF METABOLISM IN THE NYMPHS OF THE SAND CRICKET, GRYLLUS FIRMUS, INFERRED FROM AN ANALYSIS OF INBRED-LINES. BIOLOGICAL RESEARCH 40:5-12
NESPOLO, R. F., C. C. FIGUEROA, M. PLANTEGENEST, AND J. C. SIMON. 2008. SHORT-TERM POPULATION DIFFERENCES IN THE GENETIC ARCHITECTURE OF LIFE HISTORY TRAITS RELATED TO SEXUALITY IN AN APHID SPECIES. HEREDITY 100:374-381.
NESPOLO RF, HALKETT F, FIGUEROA CC, PLANTEGENEST M, SIMON JC. 2009. EVOLUTION OF TRADE-OFFS BETWEEN SEXUAL AND ASEXUAL PHASES AND THE ROLE OF PHENOTYPIC PLASTICITY IN THE GENETIC ARCHITECTURE OF APHID LIFE HISTORIES. EVOLUTION 63:IN PRESS.
NESSE, R.M., S.C. STEARNS, AND G.S. OMENN. 2006. MEDICINE NEEDS EVOLUTION. SCIENCE 311: 1071.
NICOL, S. C. 1978. NON-SHIVERING THERMOGENESIS IN THE POTOROO, POTORUS TRIDACTYLUS (KERR). COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY A 59C:33-37.
NICOL, S. C., AND N. A. ANDERSEN. 2007. COOLING RATES AND BODY TEMPERATURE REGULATION OF HIBERNATING ECHIDNAS (TACHYGLOSSUS ACULEATUS). J. EXP. BIOL. 210:586-592.
NICOL, S. C., D. PAVLIDES, AND N. A. ANDERSEN. 1997. NONSHIVERING THERMOGENESIS IN MARSUPIALS: ABSENCE OF THERMOGENIC RESPONSE TO B3-ADRENERGIC AGONISTS. COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY A 117A:399-405.
NILSSON, M.A., A. GULLBERG, A. E. SPOTORNO, U. ARNASON, AND A. JANKE. 2003. RADIATION OF EXTANT MARSUPIALS AFTER THE K/T BOUNDARY: EVIDENCE FROM COMPLETE MITOCHONDRIAL GENOMES. J. MOL. EVOL. 57 SUPPL 1:S3-12.

NOVOA, F. F., F. BOZINOVIC, AND M. ROSENMANN. 1994. SEASONAL CHANGES OF THERMAL CONDUCTANCE IN ZONOTRICHIA CAPENSIS (EMBEREZIDAE), FROM CENTRAL CHILE: THE ROLE OF PLUMAGE. COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY A 107A:297-300.
OPAZO JC, NESPOLO RF, BOZINOVIC F. 1999. AROUSAL FROM TORPOR IN THE CHILEAN MOUSE-OPPOSUM (THYLAMYS ELEGANS): DOES NON-SHIVERING THERMOGENESIS PLAY A ROLE? COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY A 123:393-397
OPAZO JC, PALMA RE, MELO F, LESSA EP. 2005. ADAPTIVE EVOLUTION OF THE INSULIN GENE IN CAVIOMORPH RODENTS. MOLECULAR BIOLOGY AND EVOLUTION 22:1290-1298
OPAZO JC. 2005. A MOLECULAR TIMESCALE FOR CAVIOMORPH RODENTS (MAMMALIA, HYSTRICOGNATHI). MOLECULAR PHYLOGENETICS AND EVOLUTION 37:932-937
OPAZO JC, WILDMAN DE, PRYCHITKO T, JOHNSON RM, GOODMAN M. 2006. PHYLOGENETIC RELATIONSHIPS AND DIVERGENCE TIMES AMONG NEW WORLD MONKEYS (PLATYRRHINI, PRIMATES). MOLECULAR PHYLOGENETICS AND EVOLUTION 40:274-280
OPAZO JC, HOFFMANN FG, STORZ JF. 2008. GENOMIC EVIDENCE FOR INDEPENDENT ORIGINS OF BETA-LIKE GLOBIN GENES IN MONOTREMES AND THERIAN MAMMALS. PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA 105:1590-1595
ORR, H.A. 2005. THE GENETIC THEORY OF ADAPTATION: A BRIEF HISTORY. NATURE REV. GENET. 6:119–127.
OSADA, N., J. KUSUDA, M. HIRATA, R. TANUMA, M. HIDA, S. SUGANO, M. HIRAI, AND K. HASHIMOTO. 2002. SEARCH FOR GENES POSITIVELY SELECTED DURING PRIMATE EVOLUTION BY 5'-END-SEQUENCE SCREENING OF CYNOMOLGUS MONKEY CDNAS. GENOMICS 79:657-662.
PECCOUD J., FIGUEROA C.C., SILVA-BÁEZ A., RAMIREZ C.C., MIEUZET L., BONHOMME J., STOECKEL S., PLANTEGENEST M. & SIMON J.-C. 2008. HOST RANGE EXPANSION OF AN INTRODUCED INSECT PEST THROUGH MULTIPLE COLONIZATIONS OF SPECIALIZED CLONES. MOLECULAR ECOLOGY 17:4608-4618.
PATIÏO, S., J. GRACE, AND H. B"NZINGER. 2000. ENDOTHERMY BY FLOWERS OF RHIZANTHES LOWII (RAFFLESIACEAE). OECOLOGIA (BERLIN) 124:149-155.
PFAFFL, M.W. 2001. A NEW MATHEMATICAL MODEL FOR RELATIVE QUANTIFICATION IN REAL-TIME RT-PCR. NUCL. ACIDS RES. 29:2002-2007.
POND, S.K., AND S. V. MUSE. 2005. SITE-TO-SITE VARIATION OF SYNONYMOUS SUBSTITUTION RATES. MOL. BIOL. EVOL. 22:2375-2385.
POND, S.L.K., AND S. D. W. FROST. 2005. DATAMONKEY: RAPID DETECTION OF SELECTIVE PRESSURE ON INDIVIDUAL SITES OF CODON ALIGNMENTS. BIOINFORMATICS 21:2531-2533.
POUGH, F. H. 1980. THE ADVANTAGES OF ECTOTHERMY FOR TETRAPODS. THE AMERICAN NATURALIST 115:92-112.
REFINETTI, R. 1999. RELATIONSHIPS BETWEEN THE DAILY RHYTHMS OF LOCOMOTOR ACTIVITY AND BODY TEMPERATURE IN EIGHT MAMMALIAN SPECIES. AMERICAN JOURNAL OF PHYSIOLOGY 277:R1493-R1500.
REFINETTI, R., AND M. MENAKER. 1992. THE CIRCADIAN RHYTHM OF BODY TEMPERATURE. PHYSIOLOGY AND BEHAVIOR 51:613-637.
REZENDE EL, SILVA-DURAN I, NOVOA FF, ROSENMANN M. 2000. DOES THERMAL HISTORY AFFECT METABOLIC PLASTICITY?: A STUDY IN THREE SPECIES ALONG AN ALTITUDINAL GRADIENT. JOURNAL OF THERMAL BIOLOGY.
REZENDE EL, BOZINOVIC F. 2001. PATTERNS OF DAILY ACTIVITY IN THE LEAF-EARED MOUSE (PHYLLOTIS DARWINI). JOURNAL OF ARID ENVIRONMENTS 47:95-100
REZENDE EL, LOPEZ-CALLEJA MV, BOZINOVIC F. 2001. STANDARD AND COMPARATIVE ENERGETICS OF A SMALL AVIAN HERBIVORE (PHYTOTOMA RARA). AUK 118:781-785
REZENDE EL, SWANSON DL, NOVOA FF, BOZINOVIC F. 2002. PASSERINES VERSUS NONPASSERINES: SO FAR, NO STATISTICAL DIFFERENCES IN THE SCALING OF AVIAN ENERGETICS. JOURNAL OF EXPERIMENTAL BIOLOGY 205:101-107
SABAT P, NESPOLO RF, BOZINOVIC F. 2004. WATER ECONOMY OF THREE CINCLODES (FURNARIIDAE) SPECIES INHABITING MARINE AND FRESHWATER ECOSYSTEMS. REVISTA CHILENA DE HISTORIA NATURAL 77:219-225

REZENDE EL, BOZINOVIC F, GARLAND T. 2004A. CLIMATIC ADAPTATION AND THE EVOLUTION OF BASAL AND MAXIMUM RATES OF METABOLISM IN RODENTS. EVOLUTION 58:1361-1374
REZENDE EL, CHAPPELL MA, HAMMOND KA .2004B. COLD-ACCLIMATION IN PEROMYSCUS: TEMPORAL EFFECTS AND INDIVIDUAL VARIATION IN MAXIMUM METABOLISM AND VENTILATORY TRAITS. JOURNAL OF EXPERIMENTAL BIOLOGY 207:295-305
REZENDE EL, CHAPPELL MA, GOMES FR, MALISCH JL, GARLAND T. 2005. MAXIMAL METABOLIC RATES DURING VOLUNTARY EXCERCISE, FORCED EXERCISE, AND COLD EXPOSURE IN HOUSE MICE SELECTIVELY BRED FOR HIGH WHEEL-RUNNING. JOURNAL OF EXPERIMENTAL BIOLOGY 208 2447-2458
REZENDE EL, GOMES FR, MALISCH JL, CHAPPELL MA, GARLAND T. 2006. MAXIMAL OXYGEN CONSUMPTION IN RELATION TO SUBORDINATE TRAITS IN LINES OF HOUSE MICE SELECTIVELY BRED FOR HIGH VOLUNTARY WHEEL RUNNING JOURNAL OF APPLIED PHYSIOLOGY 101
REZENDE EL, JORDANO P, BASCOMPTE J. 2007A. EFFECTS OF PHENOTYPIC COMPLEMENTARITY AND PHYLOGENY ON THE NESTED STRUCTURE OF MUTUALISTIC NETWORKS. . OIKOS 116:1919-1929
REZENDE EL, LAVABRE JE, GUIMARAES PR, JORDANO P, BASCOMPTE J. 2007B. NON-RANDOM COEXTINCTIONS IN PHYLOGENETICALLY STRUCTURED MUTUALISTIC NETWORKS. NATURE 448:925-928
RHODES, J. S., P. KOTEJA, J. G. SWALLOW, P. A. CARTER, AND T. GARLAND. 2000. BODY TEMPERATURES OF HOUSE MICE ARTIFICIALLY SELECTED FOR HIGH VOLUNTARY WHEEL-RUNNING BEHAVIOR: REPEATABILITY AND EFFECT OF GENETIC SELECTION. J. THERM. BIOL. 25:391-400.
RIDLEY, M. 1996. EVOLUTION. BLACKWELL, USA.
ROFF, D. A. 1997. EVOLUTIONARY QUANTITATIVE GENETICS. CHAPMAN & HALL, MONTREAL.
ROFF, D. A. 2007. A CENTENNIAL CELEBRATION FOR QUANTITATIVE GENETICS. EVOLUTION 61:1017-1032.
ROMAN, R. M., C. J. WILCOX, AND F. G. MARTIN. 2000. ESTIMATES OF REPEATABILITY AND HERITABILITY OF PRODUCTIVE AND REPRODUCTIVE TRAITS IN A HERD OF JERSEY CATTLE. GENETICS AND MOLECULAR BIOLOGY 23:113-119.
RONNING, B., H. JENSEN, B. MOE, AND C. BECH. 2007. BASAL METABOLIC RATE: HERITABILITY AND GENETIC CORRELATIONS WITH MORPHOLOGICAL TRAITS IN THE ZEBRA FINCH. JOURNAL OF EVOLUTIONARY BIOLOGY 20:1815-1822.
RUBEN, J. A. 1995. THE EVOLUTION OF ENDOTHERMY IN MAMMALS AND BIRDS:FROM PHYSIOLOGY TO FOSSILS. ANNUAL REVIEWS OF PHYSIOLOGY 57:69-76.
RUBEN, J. A., AND T. D. JONES. 2000. SELECTIVE FACTORS ASSOCIATED WITH THE ORIGIN OF FUR AND FEATHERS. AMERICAN ZOOLOGIST 40:585-596.
SABAT, P., F. BOZINOVIC, AND F. ZAMBRANO. 1995. ROLE OF DIETARY SUBSTRATES ON INTESTINAL DISACCHARIDASES, DIGESTIBILITY, AND ENERGETICS IN THE INSECTIVOROUS MOUSE-OPPOSUM (THYLAMYS ELEGANS). JOURNAL OF MAMMALOGY 76:603-611.
SABAT, P., F. NOVOA, F. BOZINOVIC, AND C. MARTINEZ DEL RIO. 1997. DIETARY PLASTICITY AND INTESTINAL LABILITY IN BIRDS: A FIELD AND LABORATORY STUDY. PHYSIOL. ZOOL.
SABAT, P., AND F. BOZINOVIC. 2000. DIGESTIVE PLASTICITY AND THE COST OF ACCLIMATION TO DIETARY CHEMISTRY IN THE OMNIVOROUS LEAF-EARED PHYLLOTIS DARWINI. JOURNAL OF COMPARATIVE PHYSIOLOGY B 170.
SABAT, P., AND C. MARTINEZ DEL RIO. 2002. INTER- AND INTRASPECIFIC VARIATION IN THE USE OF MARINE FOOD RESOURCES BY THREE CINCLODES (FURNARIIDAE, AVES) SPECIES: CARBON ISOTOPES AND OSMOREGULATORY PHYSIOLOGY. ZOOLOGY 105.
SABAT, P., J. M. RIVEROS, AND C. LOPEZ-PINTO. 2005. PHENOTYPIC FLEXIBILITY IN THE INTESTINAL ENZYMES OF THE AFRICAN CLAWED FROG XENOPUS LAEVIS COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY A 140:135-139.
SADOWSKA ET ET AL. (2005) GENETIC CORRELATIONS BETWEEN BASAL AND MAXIMUM METABOLIC RATES IN A WILD RODENT: CONSEQUENCES FOR EVOLUTION OF ENDOTHERMY. EVOLUTION 59 672-681

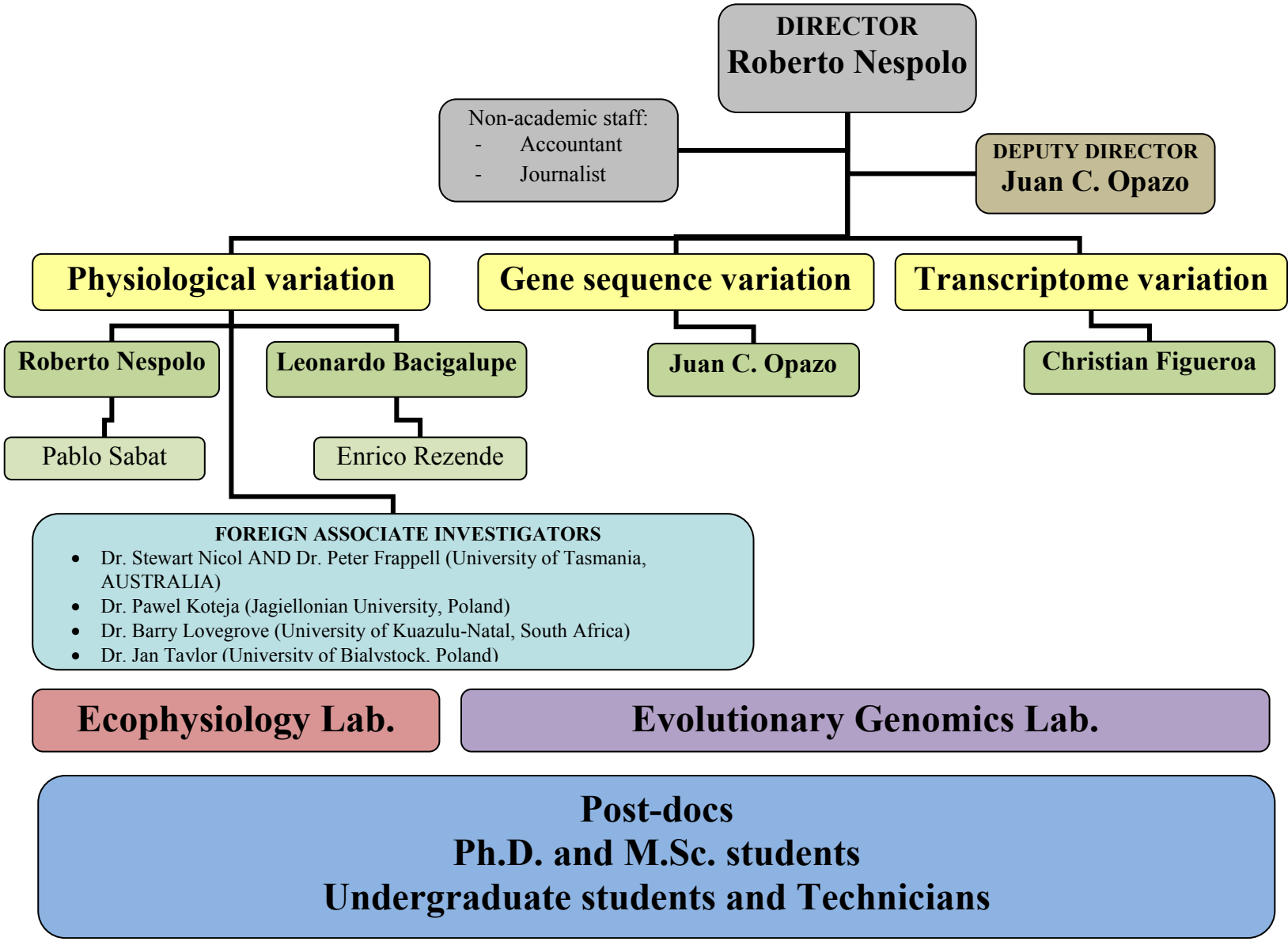
SADOWSKA ET, BALIGA-KLIMCZYK K, LABOCHA MK, KOTEJA P (2009) GENETIC CORRELATIONS IN A WILD RODENT: GRASS-EATERS AND FAST-GROWERS EVOLVE HIGH BASAL METABOLIC RATES. EVOLUTION 63:1530-1539
SCHLEUCHER, E., AND P. C. WITHERS. 2001. RE-EVALUATION OF THE ALLOMETRY OF WET THERMAL CONDUCTANCE FOR BIRDS. COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY A 129:821-827.
SCHMIDT, T.R., D. E. WILDMAN, M. UDDIN, J. C. OPAZO, M. GOODMAN, AND L. I. GROSSMAN. 2005. RAPID ELECTROSTATIC EVOLUTION AT THE BINDING SITE FOR CYTOCHROME C ON CYTOCHROME C OXIDASE IN ANTHROPOID PRIMATES. PROC. NATL. ACAD. SCI. U.S.A. 102:6379-6384.
SCHOLANDER, P. 1955. EVOLUTION OF CLIMATIC ADAPTATIONS IN HOMEOTHERMS. EVOLUTION 9:15-26.
SCOTT, C.P., WILLIAMS, D.A. AND CRAWFORD, D.L. 2009. THE EFFECT OF GENETIC AND ENVIRONMENTAL VARIATION ON METABOLIC GENE EXPRESSION. MOL. ECOL. 18:2832–2843.
SEEBACHER, F. 2003. DINOSAUR BODY TEMPERATURES: THE OCCURRENCE OF ENDOTHERMY AND ECTOTHERMY. PALEOBIOLOGY 29:105-122.
SEEBACHER, F., T. S. SCHWARTZ, AND M. B. THOMPSON. 2006. TRANSITION FROM ECTOTHERMY TO ENDOTHERMY: THE DEVELOPMENT OF METABOLIC CAPACITY IN A BIRD (GALLUS GALLUS). PROC. R. SOC. B-BIOL. SCI. 273:565-570.
SEPULVEDA, M., M. A. VIDAL, J. M. FARINA, AND P. SABAT. 2008. SEASONAL AND GEOGRAPHIC VARIATION IN THERMAL BIOLOGY OF THE LIZARD MICROLOPHUS ATACAMENSIS (SQUAMATA : TROPIDURIDAE). J. THERM. BIOL. 33:141-148.
SINGH, M., N. S. SIDHU, AND G. S. BISHT. 2000. ESTIMATES OF HERITABILITY AND REPEATABILITY FOR IMPORTANT PRODUCTIVE AND REPRODUCTIVE TRAITS IN SAHIWAL CATTLE. INDIAN JOURNAL OF ANIMAL SCIENCES 70:744-746.
STEPPAN, S. J., P. C. PHILLIPS, AND D. HOULE. 2002. COMPARATIVE QUANTITATIVE GENETICS: EVOLUTION OF THE G MATRIX. TRENDS IN ECOLOGY AND EVOLUTION 17 320-327.
STORZ JF, BAZE M, WAITE JL, HOFFMANN FG, OPAZO JC, HAYES JP. 2007. COMPLEX SIGNATURES OF SELECTION AND GENE CONVERSION IN THE DUPLICATED GLOBIN GENES OF HOUSE MICE. GENETICS 177:481-500
TATUSOVA, T.A., AND T. L. MADDEN. 1999. BLAST 2 SEQUENCES, A NEW TOOL FOR COMPARING PROTEIN AND NUCLEOTIDE SEQUENCES. FEMS MICROBIOL. LETT. 174:247-250.
TERBLANCHE, J. S., C. J. KLOK, AND S. L. CHOWN. 2004. METABOLIC RATE VARIATION IN GLOSSINA PALLIDIPES (DIPTERA: GLOSSINIDAE): GENDER, AGEING AND REPEATABILITY. JOURNAL OF INSECT PHYSIOLOGY 50
TIELEMAN, B. I., M. A. VERSTEEGH, A. FRIES, B. HELM, N. J. DINGEMANSE, H. L. GIBBS, AND J. B. WILLIAMS. 2009. GENETIC MODULATION OF ENERGY METABOLISM IN BIRDS THROUGH MITOCHONDRIAL FUNCTION. PROC. R. SOC. B-BIOL. SCI. 276:1685-1693.
TURELLI, M., J. H. GILLESPIE, AND R. LANDE. 1988. RATE TESTS FOR SELECTION ON QUANTITATIVE CHARACTERS DURING MACROEVOLUTION AND MICROEVOLUTION. EVOLUTION 42:1085-1089.
UDDIN, M., J. C. OPAZO, D. E. WILDMAN, C. C. SHERWOOD, P. R. HOF, M. GOODMAN, AND L. I. GROSSMAN. 2008. MOLECULAR EVOLUTION OF THE CYTOCHROME C OXIDASE SUBUNIT 5A GENE IN PRIMATES. BMC EVOL. BIOL. 8:8.
VAN RHEEDE, T., T. BASTIAANS, D. N. BOONE, S. B. HEDGES, W. W. DE JONG, AND O. MADSEN. 2006. THE PLATYPUS IS IN ITS PLACE: NUCLEAR GENES AND INDELS CONFIRM THE SISTER GROUP RELATION OF MONOTREMES AND THERIANS. MOL. BIOL. EVOL. 23:587-597.
VIRANI, N. A., AND B. B. REES. 2000. OXYGEN CONSUMPTION, BLOOD LACTATE AND INTER-INDIVIDUAL VARIATION IN THE GULF KILLIFISH, FUNDULUS GRANDIS , DURING HYPOXIA AND RECOVERY. COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY A 126 397-405.

WARREN WC ET AL. (2008) GENOME ANALYSIS OF THE PLATYPUS REVEALS UNIQUE SIGNATURES OF EVOLUTION. NATURE 453:175-U171.
WHITEHEAD, A., CRAWFORD, D.L. 2006A. VARIATION WITHIN AND AMONG SPECIES IN GENE EXPRESSION: RAW MATERIAL FOR EVOLUTION. MOL. ECOL. 15:1197–1211.
WHITEHEAD, A., AND CRAWFORD, D.L. 2006B. NEUTRAL AND ADAPTIVE VARIATION IN GENE EXPRESSION. PROC. NATL. ACAD. SCI. U.S.A. 103:5425–5430.
WILDMAN, D.E., W. WU, M. GOODMAN, AND L. I. GROSSMAN. 2002. EPISODIC POSITIVE SELECTION IN APE CYTOCHROME C OXIDASE SUBUNIT IV. MOL. BIOL. EVOL. 19:1812-1815.
WILDMAN, D.E., M. UDDIN, J. C. OPAZO, G. LIU, V. LEFORT, S. GUINDON, O. GASCUEL, L. I. GROSSMAN, R. ROMERO, AND M. GOODMAN. 2007. GENOMICS, BIOGEOGRAPHY, AND THE DIVERSIFICATION OF PLACENTAL MAMMALS. PROC. NATL. ACAD. SCI. U.S.A. 104:14395-14400.
WILLMER, P., G. STONE, AND I. A. JOHNSTON. 2005. ENVIRONMENTAL PHYSIOLOGY OF ANIMALS. BLACKWELL, MALDEN.
WILSON, A.C.C., MASSONNET, B., SIMON, J-C., PRUNIER-LETERME, N., DOLATTI, L., LLEWELLYN, K.S., FIGUEROA, C.C., RAMIREZ, C.C., BLACKMAN, R.L., ESTOUP, A., AND SUNNUCKS, P. 2004. CROSS-SPECIES AMPLIFICATION OF MICROSATELLITE LOCI IN APHIDS: ASSESSMENT AND APPLICATION. MOLECULAR ECOLOGY NOTES 4, 104-109.
WITHERS, P. C., R. B. FORBES, AND M. S. HEDRICK. 1987. METABOLIC, WATER AND THERMAL RELATIONS OF THE CHILEAN TINAMOU. THE CONDOR 89:424-426.
WU, W., M. GOODMAN, M. I. LOMAX, AND L. I. GROSSMAN. 1997. MOLECULAR EVOLUTION OF CYTOCHROME C OXIDASE SUBUNIT IV: EVIDENCE FOR POSITIVE SELECTION IN SIMIAN PRIMATES. J. MOL. EVOL. 44:477-491.
WULIJI, T., G. H. DAVIS, K. G. DODDS, P. R. TURNER, AND R. N. ANDREWS. 2000. PRODUCTION PERFORMANCE, REPEATABILITY AND HERITABILITY ESTIMATES FOR LIVE WEIGHT, FLEECE WEIGHT AND FIBER CHARACTERISTICS OF IN NEW ZEALAND. SMALL RUMINANT RESEARCH 37:189-201.
WUNDER, B. A., R. D. GETTINGER, F. GEISER, A. J. HULBERT, AND S. C. NICOL. 1996. EFFECTS OF BODY MASS AND TEMPERATURE ACCLIMATION ON THE NONSHIVERING THERMOGENIC RESPONSE OF SMALL MAMMALS. PP. 131-139. ADAPTATIONS TO THE COLD: TENTH INTERNATIONAL HIBERNATION SYMPOSIUM. UNIVERSITY OF NEW ENGLAND PRESS, ARMIDALE.
YANG, Z., AND J. BIELAWSKI. 2000. STATISTICAL METHODS FOR DETECTING MOLECULAR ADAPTATION. TRENDS ECOL. EVOL. (AMST.) 15:496-503..
YANG, Z., AND R. NIELSEN. 2002. CODON-SUBSTITUTION MODELS FOR DETECTING MOLECULAR ADAPTATION AT INDIVIDUAL SITES ALONG SPECIFIC LINEAGES. MOL. BIOL. EVOL. 19:908-917.
YANG, Z., W. S. W. WONG, AND R. NIELSEN. 2005. BAYES EMPIRICAL BAYES INFERENCE OF AMINO ACID SITES UNDER POSITIVE SELECTION. MOL. BIOL. EVOL. 22:1107-1118.
YANG, Z.. 2006. COMPUTATIONAL MOLECULAR EVOLUTION. OXFORD UNIVERSITY PRESS.
YANG, Z. 2007. PAML 4: PHYLOGENETIC ANALYSIS BY MAXIMUM LIKELIHOOD. MOL. BIOL. EVOL. 24:1586-1591
ZHANG, J., R. NIELSEN, AND Z. YANG. 2005. EVALUATION OF AN IMPROVED BRANCH-SITE LIKELIHOOD METHOD FOR DETECTING POSITIVE SELECTION AT THE MOLECULAR LEVEL. MOL. BIOL. EVOL. 22:2472-2479.

III. WORKING PLAN

General aims and activities	2010										2011												2012											
	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jau	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jau	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Setting-up: equipments, climatization biotherium, photoperiod, metabolic chambers.	■	■	■	■	■																													
1. Repetibility of physiological traits																																		
Chile: Field, acclimation and measurements						■	■	■	■	■	■	■	■	■	■	■	■																	
Poland: Field, acclimation and measurements					■	■	■																											
Australia: Field, acclimation and measurements								■	■																									
South Africa: Field, acclimation and measurements										■	■	■																						
2. Genomic and natural selection																																		
Identification of the genes of the electron transport chain from public databases	■	■	■	■	■	■	■	■	■	■	■	■																						
Selection análysis: dN/dS													■	■	■	■	■	■	■	■	■	■												
3. Gen expression																																		
Analysis of transcript levels							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■											
4. Manuscript redaction.																																		
											■	■	■	■	■	■	■	■	■	■			■	■	■	■	■	■	■	■	■	■	■	■
5. Outreach																																		
																					■	■										■	■

IV. RESEARCH TEAM ORGANIZATION.



V. RESEARCH TEAM (Must be filled in by main and associated researchers).

1. Personal data

Name Roberto Fernando Nespolo Rossi

Institution (Department, Faculty or other) Instituto de Ecología y Evolución, Universidad Asutral de Chile		
Current position (Si es independiente indicarlo aquí) Associate Professor, Head of the Department		
Working address Casilla 567		City Valdivia
Home address (main researchers only for legal purposes) Mehuin 1486, Los Notros		City Valdivia
Contact phones +56 63 221704	Fax +56 63 221344	E-Mail robertonespolorossi@gmail.com

2. Curricular data

Title or Deegre (s)	Institution where it was obtained	Obtained date
PhD	P. Universidad Católica de Chile	2001
BSc	Universidad de Chile	1995

Indicate any other training relative to the researcher´s discipline and expertise.

- **Postdoc** training at Center for Advanced Studies in Ecology and Biodiversity, P. Universidad Católica de Chile, 2002.
- Several **scientific visits** to University of California, Riverside (2003,2004); Oxford University (2004); Institut National de la Recherche Agronomique (INRA) at Rennes, France (2005, 2006).

Enclose CV following this records. CV must include:

- Publications of the latest 5 years. (Include ISI and non-ISI publications, books, book chapters, etc.).
- Updated number of citations for each publication,
- National and international congresses where the researcher presented results (either oral or poster).
- Training and formation os researchers and students. Indicate theses tutor and co-tutorships, tutorial seminars, collective courses and others.
- Participation in science & development projects indicating source(s) of funds, period of funding and category within the project.
- Consulting provided to public or private institutions, enterprises and/or individuals only related to the project topic or discipline.
- Any other information that you consider relevant for the functions and compromises taken within this project.

In all previous activities done in collaboration with other people please include all other persons involved and highlight your collaborator(s) last name(s). Please asterisk those activities that had inter or multidisciplinary aspects.

Publications (2004-present)

ISI publications
(Total number of publications = 54; Sum of the Times Cited = 320; *h*-index = 11)

1. **Nespolo R.F.** & Bacigalupe L.D. (2009) Viability selection on early body mass and the effect of female body size on fecundity: a study on the leaf-eared mouse *Phyllotis darwini*. Ecological Research. In press.

2. **Nespolo, R.F.,** Halkett, F. Figueroa, C.C., Plantegenest, M. and Simon, J.-C. (2009). Evolutionary conflicts between sexual and asexual phases and the role of reproductive plasticity in the genetic architecture of aphid life history traits. Evolution: in press.

3. Castañeda, L.E., Figueroa, C.C., Fuentes-Contreras, E., Niemeyer, H.M., and **Nespolo, R.F.** Metabolic costs of feeding on chemically defended host-plants in the grain aphid *Sitobion avenae*.(2009). Journal of Experimental Biology 212, 1185-1190. **Total citations = 0**

4. **Nespolo, R.F.,** Figueroa, C.C., Plantegenest, M., Simon, J.C. (2008) Drastic population differences in the genetic architecture of life history traits related to sexuality in an aphid species. Heredity 100, 374-381. **Total citations = 0**

5. Artacho, P. & **Nespolo R.F**. (2009) Natural Selection on Reducing Energy Metabolism in the Garden Snail (*Helix aspersa*). Evolution 63: 1044-1050. **Total citations = 0**

6. Cortes P., Quijano S.A. & **Nespolo R.F.** (2009) Bioenergetics and inter-individual variation in physiological capacities in a relict mammal, the monito del monte (*Dromiciops gliroides*). Journal of Experimental Biology 212: 297-207. **Total citations = 0**

7. **Nespolo R.F.**, Figueroa, C.C., Plantegenest, M. & Simon, J.C. (2008) Short-term population differences in the genetic architecture of life history traits related to sexuality in an aphid species. Heredity 100: 374-381. **Total citations = 0**

8. **Nespolo R.F.,** Artacho P., Castañeda L.E., Verdugo C. (2008) Short-term thermoregulatory adjustments in a South American anseriform, the black-necked swan (*Cygnus melanocoryphus*). Comparative Biochemistry and Physiology A 150: 366-368. **Total citations = 0**

9. **Nespolo R.F.**, Fairbairn D. & Roff D.A. (2008). Energetic trade-off between maintenance costs and dispersion capacity in the sand cricket (*Gryllus firmus*). Functional Ecology 22: 624-632. **Total citations = 0**

10. Artacho P., Castañeda L.E., Soto-Gamboa M., Verdugo C. & **Nespolo R.F.** (2007). Blood biochemistry in a population of black–necked swans (*Cygnus melanocoryphus*) in a conservation priority area. Comparative Biochemistry and Physiology A146: 283-290. **Total citations = 6**

11. **Nespolo R.F.**, Castañeda L.E. & Roff D.A. (2007). Quantitative genetic variation of metabolism in the nymphs of the sand cricket, *Gryllus firmus*, inferred from an analysis of inbred-lines. Biological Research 40: 5-12. **Total citations = 0**

12. **Nespolo R.F.** (2007) A complex population dynamic explained by a single-locus Mendelian model for litter size. Heredity 98: 63-64. **Total citations = 0**

13. **Nespolo R.F.,** Artacho P. & Castañeda L.E. (2007) Cyclic gas-exchange in the Chilean red cricket: inter-individual variation and thermal dependence. Journal of Experimental Biology 210: 668-675. **Total citations = 2**

14. Alcapan A.C., **Nespolo R.F.** & Toro J. (2007) Heritability of body size in the Chilean blue mussel (*Mytilus chilensis* Hupé 1854): effects of environment and aging. Aquaculture Research 38: 313-320. **Total citations = 1**

15. **Nespolo R.F.** & Franco M. (2007) Metabolic rate is a repeatable trait: a meta analysis. Journal of Experimental Biology 210: 2000-2005. **Total citations = 12**

16. Artacho P., Castañeda L.E., Soto-Gamboa M., Verdugo C. & N**espolo R.F.** (2007) Using haematological parameters to assess the health and nutritional status of an endangered Black-Necked swan population. Comparative Biochemistry and Physiology A147: 1060-1066. **Total citations = 5**

17. Castañeda L.E., Sabat P. Gonzales S.P. & **Nespolo R.F.** (2006). Digestive plasticity in tadpoles of the Chilean giant frog (*Caudiverbera caudiverbera*): factorial effects of diet and temperature. Physiological and Biochemical Zoology 79: 919-926. **Total citations = 1**

18. **Nespolo R.F.**, Castañeda L.E. & Roff D.A. (2005). The effect of fasting on activity and resting metabolism in the sand cricket, *Gryllus firmus*: a multivariate approach. Journal of Insect Physiology 51: 61-66. **Total citations = 7**

19. Bacigalupe L.D., **Nespolo R.F.**, Bustamante D. & Bozinovic F. (2005). Is there a trade-off betweeen energetics and spleen mass? A quantitative genetic study in the leaf-eared mouse. Evolutionary Ecology Research 7: 1-7. **Total citations = 0**

20. Artacho P., Castañeda L.E. & **Nespolo** R.F. (2005). The role of quantitative genetic studies in animal physiological ecology. Revista Chilena de Historia Natural 78: 161-167. **Total citations = 2**

21. **Nespolo R.F.** & Artacho P. (2005). How general are current comparative physiology studies? A quantitative review. Revista Chilena de Historia Natural 78: 313-321. **Total citations = 0**

22. **Nespolo R.F.** (2005). New invariants and dimensionless numbers: futile renaissance of old fallacies? Biological Research 38: 27-29. **Total citations = 1**

23. **Nespolo R.F.,** Bacigalupe L.D., Bustamante D. & Bozinovic F. (2005). Quantitative genetics of bioenergetics and growth-related traits in the wild mammal, *Phyllotis darwini*. Evolution 59: 1829-1837. **Total citations = 15**

24. **Nespolo R.F.**, Castañeda L.D. & Roff D.A. (2005). Dissecting the variance-covariance structure in insect physiology: the multivariate association between metabolism and morphology in the nymphs of the sand cricket (*Gryllus firmus*). Journal of Insect Physiology 51: 913-921. **Total citations = 1**

25. Bacigalupe L.D., **Nespolo R.F.**, Bustamante D. & Bozinovic F. (2004). The quantitative genetics of sustained energy budget in a wild mouse. Evolution 58: 421-429. **Total citations = 18**

26. Carter M..J, Lardies M.A., **Nespolo R.F.** & Bozinovic F. (2004). Heritability of progeny size in a terrestrial isopod: transgenerational environmental effects on a life history trait. Heredity 93: 455 – 459. **Total citations = 5**

27. Sabat P., **Nespolo** R.F. & Bozinovic F. (2004). Water economy of three *Cinclodes* (Furnariidae) species inhabiting marine and freshwater ecosystems. Revista Chilena de Historia Natural 77: 219 – 225.

28. Bacigalupe L.D., **Nespolo R.F.**, Opazo J. & Bozinovic F. (2004). The role of thermal history on phenotypic plasticity in thermogenic capacity and organ size in the leaf-eared mouse *Phyllotis darwini*. Physiological and Biochemical Zoology 77: 805-815. **Total citations = 3**

Presentations at National/International Congresses

Selected international meetings

1. **Nespolo R.F.,** Castañeda L.E. & Roff D.A. (2004). Quantitative genetic variation of metabolism in the nymphs of the sand cricket, *Gryllus firmus*, inferred from an analysis of inbred-lines. Annual Meeting of the British Ecological Society, Lancaster, UK, September 7 -9, 2004.

2. **Nespolo R.F,** Bacigalupe L.D., Bustamante, D.M & Bozinovic F. (2005) Quantitative genetics of bioenergetics and growth-related traits in a wild mammal, the leaf-eared mouse (*Phyllotis darwini*). Annual Meeting of the European Society for Evolutionary Biology, Cracovia, Poland.

3. Castaneda L.E., **Nespolo R.F.**, Roff D.A (2006). Dissecting the variance-covariance structure in insect physiology: The multivariate association between metabolism and morphology in the nymphs of the sand cricket (Gryllus firmus). INTEGRATIVE AND COMPARATIVE BIOLOGY 45 (6): 1116.
4. Castañeda L.E & **Nespolo R.F** (2006). Quantitative genetics on metabolism in insects: a study in the colonizing species *Drosophila subobscura* Proceedings of the Annual Meeting of the American Society for the Study of Evolution, New York, pp 48.

5. **Nespolo R.F.**, Figueroa C.C., Plantegenest M & Simon J.C. (2006). Sexuality and temperature modify the genetic architecture of life histories traits in the cyclic parthenogenetic aphid

Rhoalosiphum padi. Proceedings of the Annual Meeting of the American Society for the Study of Evolution, New York, pp 64.

6. **Nespolo R.F,** Bacigalupe L.D, Bustamante D.M. & Bozinovic F. (2006). Revisitando las hipótesis de limitación central/periférica en mamíferos: ¿son los roedores atletas olímpicos o boy scouts? XLIX Reunión Anual de la Sociedad de Biología de Chile, Pucón, 22 de Noviembre de 2006.

7. Artacho P., Guiller A., **Nespolo R.F,** Véliz D. & Poulin E. (2006) From North Africa to Chile: origin, and genetic diversity of the introduced land snail, *Helix aspersa*. Encuentro de Ecología del Mediterráneo (Reencontres Méditerranéennes d'Ecologie), Béjaïa, Algerie.

8. **Nespolo R.F.** (2007) Quantitative genetic approaches in mammalian physiological evolution. Symposium "Evolutionary Physiology" in the Annual Meeting of the American Society of Mammalogists, Albuquerque, USA. June 2-6.

9. **Nespolo R.F.** (2007) Heritability of physiological traits: the case of metabolic rate. Symposium "Key issues in evolutionary physiology: repeatability, heritability and fitness". Salvador de Bahia, Brazil. August 14-17.

Selected national meetings

1. **Nespolo R.F**, Alcapán A., Toro J. (2005) Heredabilidad del tamaño corporal en el chorito *Mytilus chilensis* (Hupé, 1854): efectos de la ontogenia y el ambiente. XXV Congreso de la Sociedad Latinoamericana de Ciencias del Mar, Viña del Mar, Mayo, 2005.

2. **Nespolo R.F.,** Castañeda L.E. & Roff D.A. (2005). Variación genético cuantitativa en el metabolismo del grillo de las dunas, *Gryllus firmus*, inferido por análisis de líneas endogámicas. Reunión Anual de la Sociedad de Biología de Chile, Pucón.

3. Artacho P., Castaneda L.E., Soto-gamboa M., Verdugo C. & **Nespolo R.F.** (2006). Haematological parameters as tools for evaluate physiological status in an endangered blacknecked swan population. Integrative and Comparative Biology (6): 1106.

4. **Nespolo R.F.** (2006) Estudios microevolutivos funcionales en poblaciones naturales: integrando genética, ecología y evolución en tiempo real. Simposio de la Sociedad de Ecología de Chile presentado en la XLIX Reunión Anual de la Sociedad de Biología de Chile, Pucón, 22 de Noviembre de 2006.

5. Artacho P. & **Nespolo R.F.** (2007). Metabolismo energético y sobrevivencia: evidencia de selección direccional sobre la tasa metabólica estándar de *Helix aspersa*. L Reunión Anual de la Sociedad de Biología de Chile. I Reunión Anual de la Sociedad de Biología Evolutiva de Chile, Pucón, Chile.

6. **Nespolo R.F.** (2007) Evolución en Chile: una disciplina emergente? L Reunión Anual de la Sociedad de Biología de Chile. I Reunión Anual de la Sociedad de Biología Evolutiva de Chile, Pucón, Chile.

7. Castañeda L.E., Fuentes-Contreras E., Niemeyer H. & **Nespolo R.F.** (2007). Evaluando la interacción genotipo-ambiente de rasgos fisiológicos en *Sitobion avenae*. L Reunión Anual de la Sociedad de Biología de Chile. I Reunión Anual de la Sociedad de Biología Evolutiva de Chile, Pucón, Chile.

8. Cortés P. **& Nespolo R.F.** (2007) Bioenergética del último representante de la familia microbioteridae: el monito del monte y caracterización del sopor. L Reunión Anual de la Sociedad de Biología de Chile. I Reunión Anual de la Sociedad de Biología Evolutiva de Chile, Pucón, Chile

Human Capital Training

Postdoctoral trainees

2009-present	Castañeda, L.E: FONDECYT postdoctoral grant at UACh

Theses supervision

2003-2007	Artacho, J.P: Ph.D. in Systematic and Ecology at UACh
2004-2008	Castañeda, L.E.: Ph.D. in Systematic and Ecology at UACh
2008-present	Gaitán, J.D.: Ph.D. studies in Systematic and Ecology at UACh
2006-present	Scheihing,R.: Ph.D. studies in Systematic and Ecology at UACh
2006-present	Montecinos, M.: Ph.D. studies in Systematic and Ecology at UACh (co-supervised with Dr. Miguel Pardo)
2006-present	Franco, M.: Ph.D. studies in Systematic and Ecology at UACh (co-supervised with Dr. Mauricio Soto)
2006-2007	Cortés, P.: Licentiate in Biological Sciences at UACh
2003-2004	Vidal, O.: Licentiate in Biological Sciences at UACh (co-supervised with Dr. Carlos Ramirez)
2003-2004	González,C.: Licentiate in Marine Biology at UACh (co-supervised with Dr. Carlos Jara)
2002-2003	Cespedes, P.: Licentiate in Marine Biology at UACh (co-supervised with Dr. Roberto Schlatter)
2002-2003	Díaz, A.: Licentiate in Biological Sciences at UACh (co-supervised with Dr. Carlos Ramirez)

Teaching

2003-2008	Graduate course: Advanced Biostatistics, UACh
2003-2008	Graduate course: Population and quantitative genetics, UACh (collaborator)
2003-2008	Graduate course: Evolutionary Physiological Ecology, UACh (collaborator)
2003-2008	Undergraduate course: Biometry, UACh.
2003-2008	Undergraduate course: Evolution, UACh (collaborator).
2003-2008	Undergraduate course: Genetics, UACh (collaborator).

Organization of international graduate courses

2003	Evolution of Life histories, by Dr. Derek Roff (7 lecturers, 15 students)

Participation in research projects since 2005

2009-2012	Principal Investigator FONDECYT grant 1090423 entitled "Natural selection, quantitative genetics and evolutionary physiology: lessons from a cosmopolitan species, *Helix aspersa*"(U$ 300.000).
2008-2011	Co-investigator FONDECYT grant 1080085 entitled "Biological invasions: adaptive evolution, history and management of an exotic plague" "(U$ 250.000).
2007-2011	Responsible researcher PBCT grant PSD89 (funds for attracting new faculties in specific fields) entitled "Reinforcing evolutionary ecology in Universidad Austral de Chile" (U$ 250.000, three new professors).
2008-2011	Director, MECESUP grant AUS0703 (funds for reinforcement of the graduate program, for fellowships and travel for students) (U$ 450.000).
2009-2010	Sponsor Investigator FONDECYT postdoctoral grant 3090056 entitled " Effects of geographic divergence and environmental ethanol on the G-matrix of morphological and life-history traits in Drosophila suboscura" to Luis Castañeda entitled (U$ 80.000).
2007-2009	Collaborator in CONICYT-PBCT-REDES R-01 grant between Anillos and Núcleos entitled "Evolutionary genomics of the plant-insect interaction: molecular mechanisms in the peach-aphid model" (U$ 200.000).
2009-2011	Principal Investigator ECOS-CONICYT (collaborative program between France and Chile) grant entitled "The evolution of genetic architecture in an aphid species" (U$ 60.000).
2005-2008	Main researcher, Project Anillos de Investigación en Ciencias y Tecnología-PBCT (finished) ACT38 grant entitled "Scientific ring in microevolution of phytophagous insects: an ecological, physiological and genomic approach" (U$ 900.000).

Advisory / consulting services

2007-2010	Member of the studying board "Biología 1" CONICYT-FONDECYT
2007-2010	Member of the studying board "Biología 1" CONICYT-ADVANCED HUMAN RESOURCES COMMITTEE" (PhD and Master fellowships evaluating comitee).
2005-present	Referee for CONICYT-FONDECYT projects
2000-present	Referee for the following ISI journals: • Evolution • Heredity • Journal of Experimental Biology • Functional Ecology • Comparative Biochemistry and Physiology A • Biological Research

- Evolutionary Ecology Research
- Behavior and Physiology
- Fish Biochemistry and Physiology
- Journal of Insect Physiology
- Journal of Comparative Physiology
- Revista Chilena de Historia Natural

Memberships

2007-present	Chair of the academic committee of PhD program in Systematic and Ecology, Universidad Austral de Chile
2006-present	Full member and Vice-President of the Chilean Evolutionary Biology Society
2001-present	Full member of the Chilean Ecological Society
2001-present	Full member of the Chilean Biology Society
2004-present	Member of the academic committee of Genetics Master in Science program, Universidad Austral de Chile

Linkage / cooperation with other national and foreign investigators outside UACh

	Collaborator	Affiliation	Type of cooperation (years)
National collaboration	Marco Lardies	USanto Tomás	Research, (10 years)
	Pablo Sabat	UChile	Research (8 years)
	Pedro Labarca	CECS	Research (1 year)
	Elie Poulin	UChile	Research (4 years)
International collaborators	Jean-Christophe Simon	INRA-Rennes, France	Research, Co-inv. Anillo (13 years)
	Manuel Plantegenest	INRA-Rennes, France	Research, ECOS-CONICYT (5 years)
	Derek Roff	University of California, Riverside (6 years)	
	Mark Chappell	University of California, Riverside (2 years)	

Dissemination and Transfer

2009 Featured article: "*Bioenergetics and inter-individual variation in physiological capacities in a relict mammal - the Monito del Monte (*Dromiciops gliroides*).*" (J. Exp. Biol. 212:297-304): "Science

and Technology" sections of "El Mercurio", "La Tercera" and "La Nación" newspapers, June 24; see also: http://www.20minutos.es/noticia/475482/0/fosil/evolucion/mamiferos/

2009 Featured article: "*Natural selection reduces energy metabolism in the garden snail* Helix aspersa" (Evolution 63:1044-1050): (1) "Science and Technology" section of "El Mercurio" newspaper, Wednesday, March 2009; (2) BBC-London website http://news.bbc.co.uk/earth/hi/earth_news/newsid_8043000/8043689.stm.

2009 Explora-Conicyt experience with two high school students performing the research "Using a living fossil to study the origin of endothermy".

2008 "Diario Austral" (main newspaper in Valdivia) full report describing the research and outreach of our department, the Institute of Ecology and Evolution. http://www.universia.cl/portada/actualidad/noticia_actualidad.jsp?noticia=137109.

2008 "Founder of modern evolutionary theory visits Universidad Austral de Chile". News: Niles Eldredge visits our Department, the Institute of Ecology and Evolution and meets with our graduate students. Full news in: (http://www.universia.cl/portada/actualidad/noticia_actualidad.jsp?noticia=139066)

2005-2006 Rio Cruces Wetland crisis: several interviews, seminars to the community (fishermens, children and teachers in the school of Contulmo, people of Valdivia) and divulgation articles regarding the ecosystem effects of industrial activity in the Rio Cruces wetland, Examples:
http://www.australvaldivia.cl/prontus4_nots/antialone.html?page=http://www.australvaldivia.cl/prontus4_nots/site/artic/20060609/pags/20060609235132.html

http://www.fipasur.cl/archivos/ppv/ppv10_200601-05.pdf

V. RESEARCH TEAM (Must be filled in by main and associated researchers).

1. Personal data

Name Juan Cristóbal Opazo Carvallo		
Institution (Department, Faculty or other) Instituto de Ecología y Evolución		
Current position (Si es independiente indicarlo aquí) Assistant professor		
Working address Instituto de Ecología y Evolución, Casilla 567, UACh	City Valdivia	
Home address (main researchers only for legal purposes) Nebuco 497	City Valdivia	
Contact phones 56-63-221674	Fax 56-63-221344	E-Mail jopazo@gmail.com

2. Curricular data

Title or Deegre (s)	Institution where it was obtained	Date it was obtained
Bachelor degree (Biology)	Pontificia Universidad Católica de Chile	1997
PhD Biological Sciencies	Pontificia Universidad Católica de Chile	2003

Training:

- Postdoctoral fellow, School of Biological Sciences, University of Nebraska, Lincoln, NE 68588 (2/2007- 4/2008).
- Postdoctoral fellow, Molecular Evolution Group, Center for Molecular Medicine & Genetics, School of Medicine, Wayne State University, Michigan, USA (1/2004 – 1/2007).
- C++ course. Computer Science Department, Wayne State University (2006).
- A field guide to GenBank and NCBI molecular biology resources. National Center for Biotechnology Information (NCBI) (2005).

- Workshop on Molecular Evolution. Marine Biological Laboratory, Woods Hole, Massachusetts (2002).

Enclose CV following this records. CV must include:

- Publications of the latest 5 years. (Include ISI and non-ISI publications, books, book chapters, etc.).
- Updated number of citations for each publication,
- National and international congresses where the researcher presented results (either oral or poster).
- Training and formation os researchers and students. Indicate theses tutor and co-tutorships, tutorial seminars, collective courses and others.
- Participation in science & development projects indicating source(s) of funds, period of funding and category within the project.
- Consulting provided to public or private institutions, enterprises and/or individuals only related to the project topic or discipline.
- Any other information that you consider relevant for the functions and compromises taken within this project.

In all previous activities done in collaboration with other people please include all other persons involved and highlight your collaborator(s) last name(s). Please asterisk those activities that had inter or multidisciplinary aspects.

Publications (2004-present):

ISI publications

(Total Nº of publications = 23, Sum of the Times Cited = 155; *h*-index = 7)

1. Opazo J.C., Soto-Gamboa M. & Bozinovic F. (2004) Blood glucose concentration in caviomorph rodents. Comparative Biochemistry and Physiology, 137A: 57-64. **Times cited: 5**

2. Bacigalupe L.D., Nespolo R.F., Opazo J.C. & Bozinovic F. Phenotypic flexibility in a novel thermal environment: Phylogenetic inertia in thermogenic capacity and evolutionary adaptation in organ size. (2004) Physiological and Biochemical Zoology, 77: 805-815. **Times cited: 3**

3. Opazo, J.C., Palma, R.E., Melo, F. & Lessa, E.P. (2005) Adaptive evolution of the insulin gene in caviomorph rodents. Molecular Biology and Evolution, 22: 1290-1298. **Times cited: 7**

4. Schmidt, T.R., Wildman, D.E., Uddin, M., Opazo, J.C., Goodman, M. & Grossman, L.I. (2005) Rapid electrostatic evolution at the binding site for cytochrome *c* on cytochrome *c* oxidase in anthropoid primates. Proceedings of the National Academy of Sciences USA, 102: 6379-6384. **Times cited: 17**

5. Opazo, J.C. (2005) A Molecular timescale for caviomorph rodents (Mammalia, Hystricognathi). Molecular Phylogenetics and Evolution. 37: 932-937. **Times cited: 13**

6. Opazo, J.C., Soto-Gamboa, M. & Fernández, M.J. (2005) Cell size and basal metabolic rate in hummingbirds. Revista Chilena de Historia Natural, 78: 261-265. **Times cited: 0**

7. Opazo, J.C., Wildman, D.E., Prychitko, T., Johnson, R.M. & Goodman, M. (2006) Phylogenetic relationships and divergence times among New World Monkeys (Platyrrhini, Primates). Molecular Phylogenetics and Evolution, 40: 274-280**. Times cited: 15**

8. Wildman, D.E., Uddin, M., Opazo, J.C., Liu, G., Lefort, V., Gascuel, O., Grossman, L.I., Romero, R. & Goodman, M. (2007) Genomics, biogeography, and the diversification of placental mammals. Proceedings of the National Academy of Sciences USA, 104: 14395-14400. **Times cited: 29**

9. Storz, J.F., Baze, M., Waite, J.L., Hoffmann, F.G., Opazo, J.C. & Hayes, J.P. (2007) Complex signatures of selection and gene conversion in the duplicated globin genes of house mice. Genetics, 177: 481-500. **Times cited: 6**

10. Uddin*, M., Opazo*, J.C., Wildman, D.E., Sherwood, C.C., Hof, P.R., Goodman, M. & Grossman, L.I. (2008) Molecular evolution of the cytochrome c oxidase subunit VA gene in primates. BMC Evolutionary Biology, 2008. 8:8. * Contributed equally. **Times cited: 3**

11. Opazo, J.C., Hoffmann, F.G., Storz, J.F. (2008) Genomic evidence for independent origins of beta like globin genes in monotremes and therian mammals. Proceedings of the National Academy of Sciences USA. 105: 1590-1595, **Times cited: 5**

12. Uddin, M., Goodman, M., Erez, O., Romero, R., Liu, G., Islam, M., Opazo, J.C., Sherwood, C.C., Grossman, L.I., Wildman, D.E. (2008) Distinct genomic signatures of adaptation in pre- and post-natal environments during human evolution. Proceedings of the National Academy of Sciences USA, 105: 3215-3220. **Times cited: 6**

13. Hoffmann, F.G., Opazo, J.C., Storz, J.F. (2008) Rapid rates of lineage-specific gene duplications and deletion in the α-globin gene family. Molecular Biology and Evolution, 25: 591-602. **Times cited: 3**

14. Chen, C., Opazo, J.C., Erez, O., Uddin, M., Santolaya-Forgas, J., Goodman, M., Grossman, L.I., Romero, R., Wildman, D.E. (2008) The human progesterone receptor shows evidence of adaptive evolution associated with its ability to act as a transcription factor. Molecular Phylogenetics and Evolution, 47: 637-649. **Times cited: 2**

15. Storz, J.F., Hoffmann, F.G., Opazo, J.C. & Moriyama, H. (2008) Adaptive functional divergence among triplicated alpha-globin genes in rodents. Genetics, 178: 1623-1638. **Times cited: 4**

16. Opazo, J.C., Bugueño, M., Carter, M.J., Palma, R.E. & Bozinovic, F. (2008) Genetic structure and biogeography of the subterranean rodent *Spalacopus cyanus*. Journal of Mammalogy, 89: 837-844. **Times cited: 0**

17. Opazo, J.C., Hoffmann, F.G., Storz, J.F. (2008) Differential loss of embryonic globin genes during the radiation of placental mammals. Proceedings of the National Academy of Sciences USA, 105: 12950-12955. **Times cited: 2**

18. Hoffmann, F.G., Opazo, J.C., Storz, J.F. (2008) New Genes Originated via Multiple Pathways in the β-Globin Gene Family of Rodents. Molecular Biology and Evolution, 25: 2589-2600**. Times cited: 0**

19. Gering, E.J., Opazo, J.C., Storz, J.F. (2008) Molecular evolution of cytochrome b in high- and low-altitude deer mice (genus *Peromyscus*). Heredity, 102: 226-235. **Times cited: 0**

20. Opazo, J.C., Sloan, A.M., Campbell, K.L., Storz, J.F. (2009) Origin and Ascendancy of a Chimeric Fusion Gene: the β/δ-Globin Gene of Paenungulate Mammals. Molecular Biology and Evolution, 26: 1469-1478. **Times cited: 0**

Book chapters:

1. Opazo J.C. (2003) Genómica funcional: Efecto nucleotípico en endotermos. En: Fisiología Ecológica & Evolutiva de animales: conceptos y casos de estudio. F. Bozinovic Editor, 45-57.

Meeting presentations (last five years):

1. Phylogenetic relationships and divergence times among New World Monkeys (Platyrrhini, Primates). **Opazo, J.C.**, Wildman, D.E., Prychitko, T., Johnson, R.M. & Goodman, M. (2005). Internacional Conference on Primates Genomics, Seattle, USA.

2. Phylogenetic relationships and divergence times among primates. **Opazo, J.C.**, Wildman, D.E., Uddin, M., Grossman, L.I. & Goodman, M. (2006). Annual Meeting of the Society for Molecular Biology and Evolution. Genomes, Evolution, and Bioinformatics. Tempe, USA.

3. Phylogenetic relationships and divergence times among New World monkeys, old problems, new approaches. **Opazo, J.C**., Scheer, J., Yi, S. & Wildman, D.E. (2006). Annual Meeting of the Society for the Study of Evolution. New York, USA.

4. Phylogenetic relationships and divergence times among hystricomorph rodents. **Opazo, J.C.** (2006). Annual Meeting of the Society for the Study of Evolution. New York, USA.

5. Genomic approach to study of the beta gene family in mammals. **Opazo, J.C.**, Hoffmann, F.G. & Storz, J.F. (2007) Annual meeting of the American Society of Mammalogists. Albuquerque, USA.

6. Genomic approach to study of the alpha gene family in mammals. Hoffmann, F.G., **Opazo, J.C.** & Storz, J.F. (2007) Annual meeting of the American Society of Mammalogists. Albuquerque, USA.

7. Adaptation to high-altitude hypoxia: the role of allelic and non-allelic variation in triplicated alpha globin genes. Storz, J.F., Runck, A., Hoffmann, F.G., **Opazo, J.C**., Moriyama, H. (2007) Annual meeting of the Society for Molecular Biology and Evolution. Halifax, Canada.

8. Neutrally evolving intergenic, non-coding DNA markers provide a resolved genus level phylogeny of neotropical primates (Platyrrhini). Wildman, D.E., **Opazo, J.C.,** Yi, S.V. (2008). 77th Annual Meeitng of the American Association of Physical Anthropologists. Ohio, USA.

9. Rapid gene turnover and functional differentiation in the alpha-globin gene family. Storz, J.F., Hoffmann, F.G., **Opazo, J.C.**, Moriyama, H. (2008). Gordon Conference in Molecular Evolution.

Human Capital Training
Undergraduate theses:

2002-2003	Manuel Bugueño, "Phylography of the subterranean rodent *Spalacopus cyanus"* (Co-advised Dr. Francisco Bozinovic)
2009-present	José Ignacio Arroyo "Evolution of the insulin gene family in mammals"
2009-present	Dimar González "Evolution of the guinea pig genome"

Master thesis:

2009-present	Natalia Rego, "Evolution of the insulin and insulin growth factor receptors in New World mammals" To be ended December 2009. Co-advised with Enrique Lessa and Hugo Naya (both from Uruguay).

Participation in research projects

2002-2003	CONICYT "Evolución del gen de la insulina en roedores histricomorfos". Principal investigator.

2004-2007	NSF “Evolution of aerobic energy metabolism in primates”. Postdoctoral fellow.
2007-2008	NSF “A test of adaptive divergence across altitudinal gradients: population genomics of deer mice”. Postdoctoral fellow.
2008-2011	FONDECYT “Evolution of the insulin gene family: a genomic approach. Principal investigator.
2009-2012	FONDECYT “Natural selection, quantitative genetics and evolutionary physiology: lessons from a cosmopolitan species, the land snail *Helix aspersa*. Co-investigator investigator.

Advisory/consulting services

2008-present Member of the Advanced human resources board “Biología 1” (FONDECYT)
2004-present Referee for ECOS-CONICYT
2004-present Referee for CONICYT-FONDECYT

2004-present Referee for the following journals

- Comparative Biochemistry and Physiology
- Heredity
- Gene
- Journal of Heredity
- Journal of Molecular Evolution
- Mechanism of Aging and Development
- Molecular Phylogenetics and Evolution
- PLoS Computational Biology
- Proceedings of the National Academy of Sciences USA
- Revista Chilena de Historia Natural

Memberships:

1999-present	Sociedad de Biología de Chile.
2006-present	Sociedad de Biologia Evolutiva de Chile (miembro fundador).
1999-present	Sociedad de Ecología de Chile.
1998-present	Society for Molecular Biology and Evolution.

Fellowships:

- CONICYT (Consejo Nacional de Investigación Científica y Tecnológica) (3/1999 – 2/2003).
- CONICYT (Consejo Nacional de Investigación Científica y Tecnológica) (3/2003 – 10/2003).
- CONICYT (Consejo Nacional de Investigación Científica y Tecnológica) (2002).
- MECESUP (Mejoramiento de la Calidad y Equidad de la Educación Superior), Chilean goverment (2002).
- DIPUC (Dirección de Investigación y Postgrado), Pontificia Universidad Católica de Chile (1999-2003).
- Oliver Pearson Award, by the American Society of Mammalogists (2008).

V. RESEARCH TEAM (Must be filled in by main and associated researchers).

1. Personal data

Name Christian Figueroa Caro		
Institution (Department, Faculty or other) Instituto de Ecología y Evolución, Universidad Austral de Chile		
Current position (Si es independiente indicarlo aquí) Associate Professor		
Working address Casilla 567	City Valdivia	
Home address (main researchers only for legal purposes) Basauri 53	City Valdivia	
Contact phones +56 63 221449	Fax +56 63 221344	E-Mail christianfigueroa@uach.cl

2. Curricular data

Title or Deegre (s)	Institution where it was obtained	Date it was obtained
PhD	Universidad de Chile	2001
BSc	P. Universidad Católica de Chile	1994

Indicate any other training relative to the researcher´s discipline and expertise.

- **Postdoc** training at Universidad de Talca, Chile, 2002
- Several **scientific visits** to Institut National de la Recherche Agronomique (INRA) at Rennes, France, 1996-2003. Training on molecular markers to study population genetics, and on transcriptomic tools to study gene expression

Enclose CV following this records. CV must include:

- Publications of the latest 5 years. (Include ISI and non-ISI publications, books, book chapters, etc.).
- Updated number of citations for each publication,
- National and international congresses where the researcher presented results (either oral or poster).
- Training and formation os researchers and students. Indicate theses tutor and co-tutorships, tutorial seminars, collective courses and others.

- Participation in science & development projects indicating source(s) of funds, period of funding and category within the project.
- Consulting provided to public or private institutions, enterprises and/or individuals only related to the project topic or discipline.
- Any other information that you consider relevant for the functions and compromises taken within this project.

In all previous activities done in collaboration with other people please include all other persons involved and highlight your collaborator(s) last name(s). Please asterisk those activities that had inter or multidisciplinary aspects.

Publications (2004-present)

ISI publications
(Total Nº of publications = 18, Sum of the Times Cited = 154; *h*-index = 8)

1. Nespolo, R.F., Halkett, F. Figueroa, C.C., Plantegenest, M. and Simon, J.-C. (2009). Evolutionary conflicts between sexual and asexual phases and the role of reproductive plasticity in the genetic architecture of aphid life history traits. Evolution: in press. **Total citations = 0**

2. Castañeda, L.E., Figueroa, C.C., Fuentes-Contreras, E., Niemeyer, H.M., and Nespolo, R.F. Metabolic costs of feeding on chemically defended host-plants in the grain aphid *Sitobion avenae*.(2009). Journal of Experimental Biology 212, 1185-1190. **Total citations = 0**

3. Lavandero, B., Figueroa, C.C., Ramirez, C.C., Caligari, P.D.S. & Fuentes-Contreras, E. (2009) Isolation and characterization of microsatellite loci from the woolly apple aphid *Eriosoma lanigerum* (Hemiptera: Aphididae: Eriosomatinae). Molecular Ecology Resources 9, 302–304. **Total citations = 0**

4. Peccoud J., Figueroa C.C., Silva-Báez A., Ramirez C.C., Mieuzet L., Bonhomme J., Stoeckel S., Plantegenest M. & Simon J.-C. (2008) Host range expansion of an introduced insect pest in Chile through multiple colonisations of specialized clones. Molecular Ecology 17, 4608-4618. **Total citations = 2**

5. Nespolo, R.F., Figueroa, C.C., Plantegenest, M., Simon, J.C. (2008) Drastic population differences in the genetic architecture of life history traits related to sexuality in an aphid species. Heredity 100, 374-381. **Total citations = 0**

6. Figueroa, C.C., Prunier-Leterme, N., Rispe, C., Sepúlveda, F., Fuentes-Contreras, E., Sabater-Muñoz, B., Simon, J.-C. & Tagu, D. (2007) Annotated expressed sequence tags and xenobiotic detoxification in the aphid *Myzus persicae* (Sulzer). Insect Science 14, 29-45. **Total citations = 6**

7. Figueroa, C.C., Simon, J-C., Le Gallic, J-F., Prunier-Leterme, N., Briones, L.M., Dedryver, C-A., and Niemeyer, H.M. (2005) Genetic structure and clonal diversity of an introduced pest in Chile, the cereal aphid *Sitobion avenae*. Heredity 95, 24-33. **Total citations = 8**

8. Figueroa, C.C., Simon, J-C., Le Gallic, J-F., Prunier-Leterme, N., Briones, L.M., Dedryver, C-A., and Niemeyer, H.M. (2004) Effect of host defense chemicals on clonal distribution and performance of different genotypes of the cereal aphid *Sitobion avenae* (Hemiptera: Aphididae). Journal of Chemical Ecology 30, 2515-2525. **Total citations = 3**

9. Gaete-Eastman, C., Figueroa, C.C., Olivares-Donoso, R., Niemeyer, H.M., and Ramírez, C.C. (2004) Diet breadth and genetic differentiation in phytophagous insects: the case of Southern beech aphids (Hemiptera, Aphididae, Neuquenaphidinae). Bulletin of Entomological Research 94, 219-227. **Total citations = 3**

10. Wilson, A.C.C., Massonnet, B., Simon, J-C., Prunier-Leterme, N., Dolatti, L., Llewellyn, K.S., Figueroa, C.C., Ramirez, C.C., Blackman, R.L., Estoup, A., and Sunnucks, P. (2004) Cross-species amplification of microsatellite loci in aphids: assessment and application. Molecular Ecology Notes 4, 104-109. **Total citations = 36**

11. Fuentes-Contreras, E., Figueroa, C.C., Reyes, M., Briones, L.M., and Niemeyer, H.M. (2004) Clonal diversity and insecticide resistance of *Myzus persicae* (Hemiptera: Aphididae) populations from tobacco in Chile: evidence for the existence of a single predominant clone. Bulletin of Entomological Research 94, 11-18. **Total citations = 15**

Book chpaters

1. **Figueroa, C.C.**, Simon, J.-C., Dedryver C.-A. & Niemeyer, H.M. (2004). Genetic variability of the recently introduced aphid Sitobion avenae in Chile. En: Simon, J.-C., Dedryver, C.-A., Rispe, C. & Hullé, M. (eds.) Aphids in a New Millennium, INRA Editions, Versailles. pp. 219-225.
2. Gaete-Eastman, C., Olivares-Donoso, R., **Figueroa, C.C.**, Ramírez C.C. & Niemeyer, H.M. (2004) Genetic and morphological variation in Neuquenaphis aphids on southern beeches (Nothofagus spp.). En: Simon, J.-C., Dedryver, C.-A., Rispe, C. & Hullé, M. (eds.) Aphids in a New Millennium, INRA Editions, Versailles. pp. 227-232.
3. Loayza-Muro, R., **Figueroa, C.C.** & Niemeyer, H.M. (2004) Host chemistry and genotypic variation of aphid populations. En: Simon, J.-C., Dedryver, C.-A., Rispe, C. & Hullé, M. (eds.) Aphids in a New Millennium, INRA Editions, Versailles. pp. 239-244.
4. Daza-Bustamante, P., Rodríguez, L.C., **Figueroa, C.C.**, Fuentes-Contreras, E. & Niemeyer H.M. (2004) Attraction toward alfalfa and wheat aphid-host plant complexes explains the absence of genetic population structure of the parasitoid Aphidius ervi (Hymenoptera: Braconidae) in Chile. En: Simon, J.-C., Dedryver, C.-A., Rispe, C. & Hullé, M. (eds.) Aphids in a New Millennium, INRA Editions, Versailles. pp. 281-286.

Publication in public databases

1. **Figueroa, C.C.**, Prunier-Leterme, N., Rispe, C., Sepúlveda, F., Fuentes-Contreras, E., Sabater-Muñoz, B., Simon, J.-C. & Tagu, D. (2007) ESTs sequences isolated from the aphid *Myzus persicae*. NCBI. DW361650-DW362608.

Presentations at National/International Congresses

Selected international meetings

M. Cabrera-Brandt, A.X. Silva, E. Fuentes-Contreras, G. Le Trionnaire, D. Tagú & **C.C. Figueroa.** (2009). Response in the aphid *Myzus persicae* to insecticide pressures: searching for genetic targets of selection. 8th International Symposium on Aphids, June 8-12, Catania, Italy.

Castañeda, L.E., Filún, M., Fuentes-Contreras, E., Niemeyer, H.M., **Figueroa, C.C.** & Nespolo, R.F. (2008). Life-history and physiological strategies of the grain aphid and its invasion to Chile. SICB Annual Meeting, January 2-6, 2008, San Antonio, TX, USA.

Peccoud, J., **Figueroa, C.C.**, Silva, A., Ramirez, C.C., Mieuzet, L., Plantegenest, M. & Simon, J.C. (2007). Genetic diversity and host specialisation in invasive populations of the pea aphid in Chile. 11th Congress of the European Society for Evolutionary Biology, 20-25 Agosto de 2007, Uppsala University, Sweden.

Peccoud J., **Figueroa C.**, Silva A., Ramirez C., Mieuzet L., Plantegenest M. & Simon J.-C. (2007). Diversité génétique et spécialisation sur l'hôte de populations invasives du puceron du pois au Chili. Invasions biologiques et traits d'histoire de vie Deuxièmes rencontres francophones. Rennes, France - 14 au 16 novembre 2007.

Figueroa, C.C., H.M. Niemeyer & E. Fuentes-Contreras (2005). Genetic diversity and insecticide resistance of *Myzus persicae* (Hemiptera: Aphididae) populations from tobacco in Chile: evidence for the existence of a single predominant clone. 7th International Symposium on Aphids, 2-7 de octubre de 2005, Fremantle, Australia.

Figueroa, C.C., R.N. Nespolo, H.M. Niemeyer, E. Fuentes-Contreras, C.C. Ramírez, D. Tagu, & J.-C. Simon (2005). Chemical ecological and genomic approaches to the defense of *Sitobion avenae* against phytochemicals: an aphid genomic project in Chile. 7th International Symposium on Aphids, 2-7 de octubre de 2005, Fremantle, Australia.

Figueroa, C.C., B. Sabater-Muñoz, C. Rispe, N. Prunier-Leterme, E. Fuentes-Contreras, J.-C. Simon & D. Tagu (2005). Annotated expressed sequence tags from the aphid *Myzus persicae*: a utility for studies on insect-plant relationships and insecticide resistance. 7th International Symposium on Aphids, 2-7 de octubre de 2005, Fremantle, Australia.

Figueroa, C.C. (2005). Aphid-cereal interactions: a chemical ecological, population and genomic journey. MISTRA/IFS international workshop. Semiochemical research in Latin America: a multidisciplinary endeavour requiring collaborating scientists. 5-9 de septiembre de 2005, Santiago, Chile (invited).

Figueroa, C.C., Simon, J.C., Briones, L.M., Fuentes-Contreras, E, y Niemeyer, H.M. (2004). Diversidad y estructura genética en poblaciones de áfidos introducidos en Chile. XXXIII Congreso Argentino de Genética, Septiembre 26-29, Malargüe, Provincia de Mendoza, Argentina.

Figueroa, C.C., Briones, L.M., Niemeyer, H.M., Fuentes-Contreras, E. (2004). Genetic and biochemical differences in host-plant use by the aphid *Myzus persicae* (Sulzer). XXII International Congress of Entomology. 15-21 de Agosto, Brisbane, Australia.

Figueroa, C.C., Briones, L.M., Niemeyer, H.M., Fuentes-Contreras, E. (2004). Genetic and biochemical mechanisms involved in the use of host plants by phytophagous insects: genomic studies with *Myzus persicae* Sulzer (Hemiptera: Aphididae). Twelfth Symposium of Insect Plant Relationships. 7-12 de Agosto, Berlin, Alemania.

Selected national meetings

Luna-Rudloff., M., Silva. A.X., Filún., M.A., & **Figueroa, C.C.** (2008). Pérdida de la reproducción sexual en el pulgón introducido *Sitobion avenae* en Chile. Reunión Anual de la Sociedad de Biología de Chile, 26-29 de noviembre, 2008, Pucón, Chile. (by Manuela Luna-Rudloff).

Cabrera-Brandt, M., Verdugo, J., Fuentes-Contreras, E., Ramírez, C.C., Sauge, M-H., Lacroze, J-P., & **Figueroa, C.C.** (2008). Respuestas adaptativas del áfido *Myzus persicae* (Sulzer) alimentados sobre plantas con diferentes niveles de defensas: evidencias de co-evolución? Reunión Anual de la Sociedad de Biología de Chile, 26-29 de noviembre, 2008, Pucón, Chile. (by Marco Cabrera-Brandt).

Cabrera-Brandt, M.A., Fuentes-Contreras E. y **Figueroa, C.C.** (2006). Aspectos genéticos y metabólicos de la especialización de *Myzus persicae* sobre tabaco. XXXIX Reunión Anual de la Sociedad de Genética de Chile, November 1-3, 2006, Viña del Mar, Chile.

Gajardo, C., Santana, P., Sepúlveda, F. Vera, C. & **Figueroa, C.C.** (2006). Genómica evolutiva: una síntesis entre genética, ecología y genómica funcional. XXXIX Reunión Anual de la Sociedad de Genética de Chile, November 1-3, 2006, Viña del Mar, Chile.

Zepeda, F., Briones, L.M & **Figueroa, C.C.** (2006). Diversidad genética del áfido del tabaco en América. XXXIX Reunión Anual de la Sociedad de Genética de Chile, November 1-3, 2006, Viña del Mar, Chile.

Cabrera, M.A., Fuentes-Contreras, E., Briones, L.M. y **Figueroa, C.C.** (2005). Diversidad genética de *Myzus persicae* en Chile. XXXVLII Reunión Anual Sociedad de Genética de Chile, 23-25 de noviembre de 2005, Puerto Varas, Chile.

Sepúlveda, F., Tagu, D., Rispe, C., Fuentes-Contreras, E., **Figueroa, C.C.** (2005). Una biblioteca de ESTs para estudiar mecanismos de resistencia a insecticidas en el áfido *Myzus persicae* (Sulzer). XXVII Congreso Nacional de Entomología, 23-25 de noviembre de 2005, Valdivia, Chile.

Cabrera, M.A., Fuentes-Contreras E. y **Figueroa, C.C.** (2005). Rol del metabolismo detoxificador en la especializacion de *Myzus persicae* sobre tabaco. XXVII Congreso Nacional de Entomología, 23-25 de noviembre de 2005, Valdivia, Chile.

Figueroa, C.C. (2005). Interacciones áfido-cereal: Un estudio químico-ecológico, poblacional y genómico. XXVII Congreso Nacional de Entomología, 23-25 de noviembre de 2005, Valdivia, Chile (invited).

Human Capital Training

Postdoctoral trainees

2008-present	Oyarzún, M.P: FONDECYT postdoctoral grant at UACh
2008-present	Artacho, P.: FONDECYT postdoctoral grant at UACh

Theses supervision

2008-present	Silva, A.X.: Ph.D. studies in Systematic and Ecology at UACh
2008-present	Cabrera-Brandt, M.: Ph.D. studies in Systematic and Ecology at UACh
2008-present	Torres, J.P.: Ph.D. studies in Systematic and Ecology at UACh
2008-present	Luna-Rudloff, M.: Licentiate in Biological Sciences at UACh
2007-present	Troncoso, A.: Ph.D. studies in Ecology and Evolutionary Biology at UChile (co-supervised with Dr. Hermann Niemeyer)
2006-2008	Castañeda, L.: Ph.D. in Systematic and Ecology at UACh (co-supervised with Dr. Roberto Nespolo)
2006-2008	Oyarzún, M.P., Ph.D. in Natural Resources at UFRO (co-supervised with Dr. Andrés Quiroz)
2006-2007	Zepeda, F.: Licentiate in Biological Sciences at UACh

2006-2007	Sepúlveda, F.: Licentiate in Biochemistry at UACh
2005-2006	Cabrera, M.: Licentiate in Biochemistry at UACh

Teaching

2005-2008	Graduate course: Advanced Genetics, UACh (coordinator)
2005-2008	Graduate course: Population and quantitative genetics, UACh (coordinator)
2004-2008	Graduate course: Molecular Ecology, UACh (coordinator)
2003-2008	Undergraduate: Research seminar in Genetics, UACh (coordinator)
2002-2008	Undergraduate course: Genetics, UACh (coordinator)

Organization of international graduate courses

2005	Evolution of herbivore insects (7 lecturers, 21 students)
2006	Genomic tools for studying evolution (4 lecturers, 25 students)

Participation in research projects

2009-2012	Principle Investigator FONDECYT grant 1090378 entitled "Temporal and spatial dynamics of insecticide resistance in populations of the aphid *Myzus persicae* (Sulzer) in Chile"
2009-2010	Sponsor Investigator FONDECYT postdoctoral grant 3090032 to María Paz Oyarzún entitled "Molecular characterization of insecticide resistance in horn fly (Haematobia irritans) populations in Chile, and its utility for designing pest management strategies"
2008-2009	Sponsor Investigator FONDECYT postdoctoral grant 3080051 to Paulina Artcaho entitled "Consequences of the reproductiction mode on microevolutionary potential in a clonal organism"
2007-2009	Principle Investigator CONICYT-PBCT-REDES R-01 grant between Anillos and Núcleos entitled "Evolutionary genomics of the plant-insect interaction: molecular mechanisms in the peach-aphid model"
2005-2008	Director, Project Anillos de Investigación en Ciencias y Tecnología-PBCT ACT38 grant entitled "Scientific ring in microevolution of phytophagous insects: an ecological, physiological and genomic approach"
2005-2007	Principle Investigator ECOS-CONICYT C04B01 grant entitled "Genetic and ecological determinants of the invasive capacity in introduced aphid populations in Chile".
2005-2006	Principle Investigator FONDECYT 1050644 grant entitled "Patterns of gene expression in insecticide resistant and susceptible phenotypes of the aphid *Myzus persicae*: a genomic approach"
2002-2005	Principle Investigator postdoctoral FONDECYT 3020051 grant entitled "Biochemical and genetic patterns involved in host plant use in *Myzus persicae*"
2002-2004	Co-investigator National Geographic Society NGS 7637-02 grant to Hermann M. Niemeyer entitled "Selection of *Nothofagus* host trees by *Neuquenaphis* aphids"

Advisory / consulting services

2006-2009 Member of the studying board "Biología 1" CONICYT-FONDECYT

2006-present Referee for CONICYT-PBCT projects

2006-present Referee for CONICYT-EXPLORA projects

2005-present Referee for CONICYT-FONDECYT projects

2002-present Referee for the following ISI journals:

- Molecular Ecology
- Heredity
- Oecologia
- Journal of Heredity
- Bulletin of Entomological Research
- Insect Science
- Journal of Applied Entomology
- Revista Chilena de Historia Natural

Memberships

2007-present Member of the academic committee of PhD program in Systematic and Ecology, Universidad Austral de Chile

2006-present Full member of the Chilean Evolutionary Biology Society

2004-present Member of the academic committee of Genetics Master in Science program, Universidad Austral de Chile

2003-present Member of "The International Aphid Genomics Consortium (IAGC)"

2000-present Full member of the Chilean Genetic Society

Linkage / cooperation with other national and foreign investigators

	Collaborator	Affiliation	Type of cooperation (years)
National collaboration	Hermann Niemeyer	UChile	Research, Co-inv. Anillo (14 years)
	Lee Meisel	UNAB	Research, Co-inv. REDES (3 years)
	Herman Silva	UNAB	Research, Co-inv. REDES (3 years)
	Eduardo Fuentes	UTalca	Research, Co-inv. Anillo (14 years)
	Claudio Ramírez	UTalca	Research, Co-inv. Anillo (14 years)
	Andrés Quiroz	UFRO	Thesis co-tutored (14 years)
	Blas Lavandero	UTalca	Research (5 years)

	Gonzalo Gajardo	ULagos	Postgraduate courses (4 years)
	Mauricio Soto-Gamboa	UACh, Fac. Cs.	Research (3 years)
International collaborators	Jean-Christophe Simon	INRA-Rennes, France	Research, Co-inv. Anillo (13 years)
	Denis Tagu	INRA-Rennes, France	Research, Co-inv. Anillo (6 years)
	Alex Wilson	Univ. Miami, USA	Research (6 years)
	Beatriz Sabater	IVIA, Valencia, Spain	Research (6 years)
	Manuel Plantegenest	INRA-Rennes, France	Research, ECOS-CONICYT (5 years)
	Paul Sunnucks	Monash University, Australia	Research, postgraduate courses (5 years)
	Marie-Helene Sauge	INRA-Avignon, France	Research, Co-inv. REDES PBCT (3 years)
	Frederic Francis	Universite de Gemblaux, Belgium	Research, Co-inv. REDES-PBCT (3 years)
	Yannick Outreman	INRA-Rennes, France	Research, ECOS-CONICYT (4 years)

Dissemination and Transfer

2009 Interview: "Qué se investiga en el Sur de Chile". Ediciones especiales El Mercurio, Domingo 29 de marzo de 2009

2008 Interview: "Hacia el fin de las plagas". Revista Actualidad, UACh, abril de 2008.

2007 Interview: "Interacciones Insecto-planta: una carrera armamentista en la naturaleza". Diario Austral de Valdivia, 24 de junio de 2007.

2005 Conference to agrochemical companies: "Population genetics and pest insect management", November 4, 2005, Santiago.

2005 Interview: "Un proyecto Anillos en Valdivia". Diario Austral de Valdivia, 11 de julio de 2005.

V. RESEARCH TEAM (Must be filled in by main and associated researchers).

1. Personal data

Name Leonardo Daniel Bacigalupe		
Institution (Department, Faculty or other) Instituto de Ecología y Evolución, Facultad de Ciencias, Universidad Austral de Chile (Chile)		
Current position (Si es independiente indicarlo aquí) Assistant Professor		
Working address Instituto de Ecología y Evolución, Casilla 567, UACh	City Valdivia	
Home address (main researchers only for legal purposes) Av. Principal 85, Casa 10, Lonco Oriente, Chiguayante	City Concepcion	
Contact phones Office: +56 (41) 272 6581 Mobile: + 56 9-78788983	Fax	E-Mail lbacigal@gmail.com

2. Curricular data

Title or Deegre (s)	Institution where it was obtained	Date it was obtained
PhD. Biology (Mention: Ecology)	Pontificia Universidad Catolica de Chile (Chile)	2003
BSc Biology	Universidad de la Republica (Uruguay)	1996

Indicate any other training relative to the researcher´s discipline and expertise.

Postdoctoral training:

- Center for Advanced Studies in Ecology & Biodiversity, P. Universidad Catolica de Chile, Chile (2003 – 2004)
- Department of Animal and Plants Sciences, University of Sheffield, UK (2005 -2007).

Enclose CV following this records. CV must include:

- Publications of the latest 5 years. (Include ISI and non-ISI publications, books, book chapters, etc.).
- Updated number of citations for each publication,
- National and international congresses where the researcher presented results (either oral or poster).

- Training and formation os researchers and students. Indicate theses tutor and co-tutorships, tutorial seminars, collective courses and others.
- Participation in science & development projects indicating source(s) of funds, period of funding and category within the project.
- Consulting provided to public or private institutions, enterprises and/or individuals only related to the project topic or discipline.
- Any other information that you consider relevant for the functions and compromises taken within this project.
  In all previous activities done in collaboration with other people please include all other persons involved and highlight your collaborator(s) last name(s). Please asterisk those activities that had inter or multidisciplinary aspects.

Publications (2004-present)

ISI publications
(Total Nº of publications = 22, Sum of the Times Cited = 267; *h*-index = 10)

1. Bacigalupe, L.D. Biological invasions and phenotypic evolution: A quantitative genetic perspective. Biological Invasions. In press [doi: 10.1007/s10530-008-9411-2].
   Total citations = 0

2. Nespolo, R.F. & Bacigalupe, L.D. Viability selection on early body mass and the effect of female body size on fecundity: a study on the leaf-eared mouse *Phyllotis darwini*. Ecological Research. In press [doi: 10.1007/s11284-008-0570-5].
   Total citations = 0

3. Bacigalupe, L.D., Crudgington, H.S., Slate, J., Moore, A.J. and Snook, R.R. (2008) Sexual selection and interacting phenotypes in experimental evolution: a study of *Drosophila pseudoobscura* mating behavior. Evolution 62: 1804-1812.
   Total citations = 1

4. Bacigalupe, L.D., Crudgington, H.S., Hunter, F., Moore, A.J. and Snook, R.R. (2007) Sexual conflict does not drive reproductive isolation in experimentally populations of *Drosophila pseudoobscura*. Journal of Evolutionary Biology 20: 1763-1771.
   Total citations = 1

5. Bacigalupe, L.D., Araya, N.M., Carter, M.J., Catalán, T.P., Lardies, M.A., and Bozinovic, F. (2007) Maternal effects, maternal body size and offspring energetics: a study in the common woodlouse *Porcellio laevis*. Comparative Biochemistry and Physiology A 147: 349 – 354.
   Total citations = 1

6. Bacigalupe, L.D., Nespolo, R.F., Bustamante, D.M., and Bozinovic, F. (2005) Is there a trade- off between energetics and spleen mass? A quantitative genetic study in the leaf-eared mouse. Evolutionary Ecology Research 7: 497-507.
   Total citations = 0

7. Naya, D.E., Bacigalupe, L.D., Bustamante, D.M. and Bozinovic, F. (2005) Dynamic digestive

strategies in response to increased energy demands: a study in the leaf-eared mouse (*Phyllotis darwini*). Journal of Comparative Physiology B 175: 31-36.
Total citations = 9

8. Nespolo, R.F., Bustamante, D.M., Bacigalupe, L.D., and Bozinovic, F. (2005) Quantitative genetics of energetics and growth-related traits in the wild mammal, *Phyllotis darwini*. Evolution 59: 1829-1837.
Total citations = 15

9. Bacigalupe, L.D., Nespolo, R.F., Bustamante, D.M., and Bozinovic, F. (2004) The quantitative genetics of sustained energy budget in a wild mouse. Evolution 58: 421-429.
Total citations = 18

10. Bacigalupe, L.D., Nespolo, R.F., Opazo, J.C., and Bozinovic, F. (2004) Phenotypic flexibility in a novel thermal environment: phylogenetic inertia in thermogenic capacity and evolutionary adaptation in organ size. Physiological and Biochemical Zoology 77: 805-815.
Total citations = 3

11. Bozinovic, F., Bacigalupe, L.D., Vasquez, R., Veloso, C., and Kenagy, G.J. (2004) Cost of living in free-ranging degus (*Octodon degus*): seasonal dynamics of energy expenditure. Comparative Biochemistry and Physiology A 137: 597-604.
Total citations = 11

12. Lardies, M.A., Bacigalupe, L.D., and Bozinovic, F. (2004) Testing the metabolic cold adaptation hypothesis: an intraespecific latitudinal comparison in the common woodlouse. Evolutionary Ecology Research 6: 567-578.
Total citations = 8

13. Weibel, E.R., Bacigalupe, L.D., Schmitt, B., and Hoppeler, H. (2004) Allometric scaling of maximal metabolic rate in mammals: Muscle aerobic capacity as determinant factor. Respiratory Physiology and Neurobiology 140: 115-132.
Total citations = 53

<u>Book chapters</u>

5. Naya, D.E. and Bacigalupe, L.D. (2009) Metabolic constraints to resource allocation. In: Resource allocation theory applied to farm animal, Rauw WR (editor), CAB Publishing.

6. Bozinovic, F., Lima, M., Bacigalupe, L.D., Gutierrez, J.R., Rosenmann, M., and Cortés, A. (2005) Essays in honor of Oliver Pearson. El Niño-related long-term physiological responses in water balance of rodents from semi-arid Chile. *In*: University of California Publications in Zoology Series, California, USA.

Presentations at National/International Congresses (2004 – present)

1. Bacigalupe, L.D., Crudgington, H.S., Moore, A.J. and Snook, R.R. (2007) Sexual selection and female-male coevolution. 11th Congress European Society for Evolutionary Biology, Uppsala, Sweden.

2. Bacigalupe, L.D., Crudgington, H.S., Moore, A.J. and Snook, R.R. (2007) Sexual selection and female-male coevolution. 9th Meeting Biology of Spermatozoa, Derbyshire Peak District National Park, UK.

3. Nespolo, R.F., Bustamante, D.M., Bacigalupe, L.D., and Bozinovic, F. (2005) Quantitative genetics of energetics and growth-related traits in the wild mammal, *Phyllotis darwini*. 10th Congress European Society for Evolutionary Biology, Krakow, Poland.

4. Araya, N.M., Bacigalupe, L.D., Carter, M.J., Catalán, T.P., Lardies, M.A., and Bozinovic, F. (2004) Potencial microevolutivo bajo en rasgos de historia de vida: Un apoyo empírico para el teorema fundamental de la selección natural. II Reunión Binacional de Ecología, Mendoza, Argentina. [In Spanish]

5. Bacigalupe, L.D., Lardies, M.A., and Bozinovic, F. (2004) Puesta a prueba de la hipótesis de adaptación metabólica al frío: una comparación latitudinal en un isópodo terrestre. II Reunión Binacional de Ecología, Mendoza, Argentina. [In Spanish]

6. Bacigalupe L.D., Nespolo, R.F., Bustamante, D.M., and Bozinovic, F. (2004). The quantitative genetics of sustained energy budget in a wild mouse, III International Conference of Comparative Physiology & Biochemistry in Africa, Ithala Game Reserve, South Africa.

Human Capital Training

Thesis supervision

2008-present	Myriam Iturra. Master's thesis. Universidad de Concepción, Chile
2008	Jorge Avaria. BSc's thesis. Universidad de Concepción, Chile

Undergraduate courses

2009	Animal Physiology. Universidad de Concepcion, Chile
2008	Animal Physiology. Universidad de Concepcion, Chile
2008	Evolutionary Ecology. Universidad de Concepcion, Chile

Graduate courses

2008	Guest lecturer in "Evolutionary quantitative genetics" in Course Evolutionary Biology Universidad de Concepción, Chile. Dr. N. Gouin.
2003 -2004	Guest lecturer in "Evolutionary quantitative genetics" in Course Advanced topics in organismal biology. P. Universidad Catolica de Chile. Dr. F. Bozinovic

Participation in research projects

2009 – 2012: Natural selection, quantitative genetics and evolutionary physiology: Lessons from a cosmopolitan species, the land snail Helix aspersa. Co-Principal Investigator. Funded by FONDECYT (Fondo Nacional de Ciencia y Tecnología) (Chile).

2008 – 2011: Biological Invasions: adaptive evolution, history and management of an exotic pest. Principal Investigator. Funded by FONDECYT (Fondo Nacional de Ciencia y Tecnología) (Chile).

2005 – 2007: Consequences of mating system structure on genetic architecture and reproductive isolation. Principal Investigator Rhonda Snook (University of Sheffield). Postdoctoral Research Associate. Funded by NERC (National Environment Research Council) (UK)

2002 – 2004: The individual basis of biodiversity: patterns, process and mechanisms in time and space. Principal Investigator Francisco Bozinovic (P. Universidad Católica de Chile). Doctoral (2002) and Postdoctoral Associate (2003 - 2004). Funded by FONDECYT (Fondo Nacional de Ciencia y Tecnología) (Chile).

2000 – 2001: Plasticity and trade-offs in behavioral ecology: using information, time and energy in changing environments. Principal Investigators: Rodrigo Vásquez (U. de Chile) and Francisco Bozinovic (P. Universidad Católica de Chile). Assistant researcher. Funded by FONDECYT (Fondo Nacional de Ciencia y Tecnologia) (Chile).

1996 – 1998: Burrow structure, behavior and digging morphological specializations in Ctenomys (Rodentia, Octodontidae) from Uruguay. Principal Investigator Carlos Altuna (U. de la República). Assistant researcher. Funded by CSIC (Comision Sectorial de Investigación Cientifica) (Uruguay)

1995 – 1996: Nutritional ecology of a fosorial rodent: behavior and digestion on diet selection. Principal Investigator Bettina Tassino (U. de la República). Assistant researcher. Funded by CSIC (Comision Sectorial de Investigación Cientifica) (Uruguay)

1994 – 1996: Evolutionary biology of genus Ctenomys. Principal Investigator Carlos Altuna (U. de la República). Assistant researcher. Funded by CSIC (Comision Sectorial de Investigación Cientifica) (Uruguay)

Advisory / consulting services

2008-2011 Editorial board Journal Evolutionary Biology

2005-present Referee for CONICYT-FONDECYT projects (Chile)

2008-present Referee for CONICYT-ECOS projects (Chile)

2008-present Referee for DINACYT projects (Uruguay)

2008-present Member of the board Programa Capital Humano CONICYT

2002-present Referee for the following ISI journals:

1. Acta Theriologica
2. Comparative Biochemistry and Physiology
3. Evolution
4. Evolutionary Ecology Research
5. Journal of Arid Environments
6. Journal of Experimental Biology
7. Journal of Evolutionary Biology
8. Functional Ecology
9. Mammalian Biology
10. Revista Chilena de Historia Natural

Memberships

2008-present European Society for Evolutionary Biology

2008-present Society for the Study of Evolution

Linkage / cooperation with other national and foreign investigators

	Collaborator	Affiliation	Type of cooperation (years)
National collaboration	Roberto Nespolo	UACh (Chile)	Research (10 years)
	Francisco Bozinovic	PUC (Chile)	Research (10 years)
	Marco Lardies	UST (Chile)	Research (10 years)
	Enrico Rezende	UAB (Spain)	Research (10 years)
International collaborators	Allen Moore	U of Exeter (UK)	Research (4 years)
	Rhonda Snook	U of Sheffield (UK)	Research (4 years)

Dissemination and Transfer

Invited seminars

Departamento de Zoología, Universidad de Concepción, Chile (2008)
Centre d'Ecologie Fonctionnelle et Evolutive, CNRS, Montpellier, France (2006)
Department of Animal and Plant Sciences, University of Sheffield, UK (2006)
Departamento de Ecologia. P. Universidad Católica de Chile, Chile (2004)
Universidad de la República, Uruguay (2003)
Instituto de Ecologia y Evolucion, Universidad Austral de Chile, Chile (2003)
Anatomy Department, University of Bern, Switzerland (2002)

V. RESEARCH TEAM (Must be filled in by main and associated researchers).

1. Personal data

Name Alejandro Pablo Sabat Kirkwood		
Institution (Department, Faculty or other) Departmento de Ciencias Ecologicas, Facultad de Ciencias,Universidad de Chile		
Current position (Si es independiente indicarlo aquí) Associate Professor		
Working address Las Palmeras 3425, Casilla 653	City Santiago	
Home address (main researchers only for legal purposes) Av. Consistorial 3240, Casa Lyon-N, Peñalolen	City Santiago	
Contact phones Office: +56 (2) 9787297 Mobile: + 56 9-2258868	Fax +56 (2) 2727363	E-Mail psabat@uchile.cl apsabat@yahoo.com

2. Curricular data

Title or Deegre (s)	Institution where it was obtained	Date it was obtained
PhD. Ciences (Mention: Biology)	Universidad de Chile	1998
MSc Biology (Mention: Zoology)	Universidad de Chile	1993
BSc Biology	Universidad de Chile	1990

Indicate any other training relative to the researcher´s discipline and expertise.

Postdoctoral training:

- Department of Ecology, P. Universidad Catolica de Chile, Chile (1998 – 1999)

Enclose CV following this records. CV must include:

- Publications of the latest 5 years. (Include ISI and non-ISI publications, books, book chapters, etc.).
- Updated number of citations for each publication,
- National and international congresses where the researcher presented results (either oral or poster).
- Training and formation os researchers and students. Indicate theses tutor and co-tutorships, tutorial seminars, collective courses and others.

- Participation in science & development projects indicating source(s) of funds, period of funding and category within the project.
- Consulting provided to public or private institutions, enterprises and/or individuals only related to the project topic or discipline.
- Any other information that you consider relevant for the functions and compromises taken within this project.
  In all previous activities done in collaboration with other people please include all other persons involved and highlight your collaborator(s) last name(s). Please asterisk those activities that had inter or multidisciplinary aspects.

Publications (2004-present)

ISI publications
(Total Nº of publications = 51, Sum of the Times Cited =345; *h*-index = 10)

1. Sabat P., E. Sepúlveda-Kattan & K. Maldonado (2004) . Physiological and biochemical responses to dietary protein in the omnivore passerine *Zonotrichia capensis* (Emberizidae) Comparative Biochemistry and Physiology A. 137: 391-396. **Total cites: 12**.

2. Sabat P., R. Nespolo & F. Bozinovic (2004) . Water economy of *Cinclodes* (Furnariidae) inhabiting marine and freshwater ecosystems Revista Chilena de Historia Natural. 76: 219-225. **Total cites: 3.**

3. Sabat P., K. Maldonado, A. Rivera-Hutinel & G. Farfan (2004) . Coping with salt without salt glands: osmoregulatory plasticity in three species of coastal songbirds of genus *Cinclodes* (Passeriformes: Furnariidae). Journal of Comparative Physiology B: 174: 415-420. **Total cites: 4.**

4. Naya D. E, G. Farfán, P. Sabat, M. Méndez & F. Bozinovic. (2005). Digestive performance in the andean toad *Bufo spinulosus*: hard-wired or flexible physiology? Comparative Biochemistry and Physiology A 140: 165-170. **Total cites: 8.**

5. Sabat P., J. M. Riveros & C. López-Pinto (2005) Phenotypic flexibility in the intestinal enzymes of the African clawed frog *Xenopus laevis*. Comparative Biochemistry and Physiology A 140: 135-139. **Total cites: 9.**

6. Guerrero-Bosagna C., P. Sabat & L. Valladares. (2005) Environmental signalling and evolutionary change: can exposure of pregnant mammals to environmental estrogens lead to epigenetically-induced evolutionary changes in embryos? Evolution and Development: 7:341-350. **Total cites: 16**

7. Novoa F., A. Rivera-Hutinel, M. Rosenmann & P. Sabat (2005) Intraspecific differences in metabolic rate in *Chroeomys olivaceus* (Rodentia: Muridae): effect of thermal acclimation in arid and mesic habitats. Revista Chilena de historia Natural: 78207-214. **Total cites: 2.**

8. Sabat P. & C. Martinez del Rio. (2005) Seasonal changes in the use of marine food resources by *Cinclodes nigrofumosus* (Furnariidae, aves): carbon isotopes and osmoregulatory physiology. Revista Chilena de historia Natural: 78:253-260. **Total cites: 2.**

9. Canals M., C. Atala, R. Olivares, F. Guajardo, D. Figueroa, P. Sabat & M. Rosenmann (2005) Functional and structural optimization of the respiratory system of the bat *Tadarida brasiliensis* (Chiroptera; Molossidae): Does airway matter? Journal of Experimental Biology 208:3987-3995. **Total cites: 7.**

10. Sabat P., K. Maldonado & C. Martinez del Rio (2006) Osmoregulatory capacity and the ability to use marine food sources in two coastal songbirds (*Cinclodes*: Furnariidae) along a latitudinal gradient. Oecologia. 148:250-257. **Total cites: 5.**

11. Bakken B.H. & P. Sabat (2006) Gastrointestinal and renal responses to water intake in the green-backed firecrown (*Sephanoides sephanoides*), a South American hummingbird. American Journal of Physiology. 291: R830-R836. **Total cites: 5.**

12. Sabat P., G. Cavieres, C. Veloso & M. Canals (2006) Water and energy economy of an omnivorous bird: population differences in the rufous-collared sparrow. Comparative Biochemistry and Physiology. A 144: 485-490. **Total cites: 3.**

13. Sabat P., K. Maldonado, M. Canals & C. Martinez del Rio (2006) Osmoregulation and adaptive radiation in the ovenbird genus *Cinclodes* (Passeriformes: Furnariidae): renal form and function are associated with ecological diversification. Functional Ecology. 20:799-805. **Total cites: 2.**

14. Gatica, C. D.L., S. P. Gonzalez, R. A. Vasquez & P. Sabat (2006) On the elationship between sugar digestion and diet preference in two Chilean avian species belonging to the muscicapoidea superfamily. Revista Chilena de Historia Natural. 79: 287-294. **Total cites: 0.**

15. Castañeda L.E., P. Sabat, S. P. Gonzalez & R. F. Nespolo (2006) Digestive plasticity in tadpoles of the chilean giant frog (*Caudiverbera caudiverbera*): Factorial Effects of Diet and Temperature. Physiological and Biochemical Zoology. 79:919–926. **Total cites: 1.**

16. Bakken B.H., and P. Sabat (2007). Evaporative water loss and dehydration during the night in hummingbirds. Revista Chilena de Historia Natural. 80: 267-274. **Total cites: 2.**

17. Canals M., C. Donoso, D. Figueroa. & P. Sabat (2007) Pulmonary hematological parameters, energetic flight demands and their correlation with oxygen diffusion capacity in the lungs. Revista Chilena de Historia Natural. 80: 275-284. **Total cites: 1.**

18. Figueroa D., R. Olivares, M. Salaberry, P. Sabat & M. Canals. (2007). Interplay between the morphometry of the lungs and the mode of locomotion in birds and mammals. Biological Research. 40: 193-201. **Total cites: 1.**

19. Aldea P. & P. Sabat (2007). Osmoregulatory responses to dietary protein and water intake in the granivorous *Zonotrichia capensis* (Passerine, Emberizidae). Revista Chilena de historia Natural. 80: 447-454. **Total cites: 1.**

20. Naya D. E., L. A. Ebensperger, P. Sabat & F. Bozinovic (2008). Digestive and metabolic flexibility allows female degus to cope with lactation costs. Physiological and Biochemical Zoology. 81(2):186–194. **Total cites: 1.**

21. Merino S. , J. Moreno, R. A. Vásquez, J. Martínez, I. Sánchez-Monsálvez, C. F. Estades, S. Ippi, P. Sabat, R. Rozzi & S. Mcgehee. (2008). Haematozoa in forest birds from southern Chile: Looking for latitudinal gradients in prevalence and parasite lineage richness. Austral Ecology. 33, 329-340. **Total cites: 0.**

22. Sepúlveda M., M. A. Vidal, J. M. Fariña & P. Sabat. (2008). Seasonal and geographic variation in thermal biology of the lizard *Microlophus atacamensis* (Squamata:Tropiduridae). Journal of Thermal Biology. 33: 141-148. **Total cites: 0.**

23. Sabat P., & Bozinovic F. (2008). Do changes in dietary chemistry during ontogeny affect digestive performance in adults of the herbivorous rodent *Octodon degus*? Comparative Biochemistry and Physiology A. 81: 186- 194. **Total cites: 1.**

24. Wingfield J. C., T. I. Moore, R. V. Vasquez, P. Sabat, S. Busch, A. Clark, E. Addis, F. Prado, & H. Wada. (2008). Modulation of the adrenocortical responses to acute stress in northern and southern populations of *Zonotrichia*. Ornitología Neotropical.19: 241-251. **Total cites: 1.**

25. Bakken B.H., and P. Sabat. (2008). The mechanisms and ecology of water balance in hummingbirds. Ornitología Neotropical.19: 501-509. **Total cites: 1.**

26. Canals, M., C. Veloso & P. Sabat. (2008). The proximal airway of the bat *Tadarida brasiliesis*. A minimum entropy production design. Journal of Comparative Physiology B. 178: 377-384. **Total cites: 2.**

27. Cavieres G. & P. Sabat (2008). Geographic variation in the response to thermal acclimation in Rufous-collared Sparrows: are physiological flexibility and environmental heterogeneity correlated? Functional Ecology. 22, 509-515. **Total cites: 3.**

28. Maldonado K., G. Cavieres, C. Veloso, M. Canals & P Sabat. (2009). Physiological responses in Rufous-collared Sparrows to thermal acclimation and seasonal acclimatization. Journal of Comparative Physiology B. 179:335-343. **Total cites: 0.**

29. Sabat P., S. Gonzalez-Vejares & K. Maldonado. (2009). Diet and habitat aridity affect osmoregulatory physiology: An intraspecific field study along environmental gradients in the Rufous-Collared Sparrow. Comparative Biochemistry and Physiology A. 152: 322-326 **Total cites: 0.**

30. Naya D., C. Veloso, P. Sabat & F. Bozinovic (2009). Physiological flexibility in the hibernating Andean lizard *Liolaemus nigroviridis.* Journal of Experimental Zoology. 311A:270–277. **Total cites: 0.**

31. Martínez del Rio C., P. Sabat, R. Andreson-Sprecher & S. P. Gonzalez. (2009). Dietary and isotopic specialization: the isotopic niche of three *Cinclodes* ovenbirds. Oecologia. Accepted.

32. Canals M., D. P. Figueroa, J. P. Miranda & P. Sabat (2009). Effects of environmental temperature on oxygen diffusion capacity during post-natal development in the altricial rodent, *Phyllotis darwini.* Revista Chilena de Historia Natural. 82: 153-162. **Total cites: 0**.

33. Naya D., C. Veloso, P. Sabat & F. Bozinovic (2009). The effect of short- and long-term fasting on digestive and metabolic flexibility in the Andean toad, *Bufo spinulosus*. Journal of Experimental Biology. Accepted.

34. Canals M., D. P. Figueroa, J. P. Miranda & P. Sabat (2009). Effect of gestational and postnatal environmental temperature on metabolic rate in the altricial rodent, *Phyllotis darwini*. Journal of Thermal Biology. Accepted.

35. Barceló G., J. Salinas, G. Cavieres, M. Canals & P. Sabat. (2009). Thermal history can affect the short-term thermal acclimation of basal metabolic rate in the passerine *Zonotrichia capensis*. Journal of Thermal Biology. Accepted.

Book chapters

a. **SABAT** P (2003) Mecanismos de Regulación Osmótica en Aves: desde La Bioquímica a la Conducta. In: Fisiología Ecológica y Evolutiva: conceptos y casos de estudio en animales. F Bozinovic (ed.), Ediciones Universidad Católica de Chile, Santiago, Chile.

b. DANIEL E. NAYA, FRANCISCO BOZINOVIC & **PABLO SABAT**. (2008) Ecología Nutricional y Flexibilidad Digestiva en Anfibios. In Herpetologia de Chile. Vidal M & Labra A (Eds). Science Verlag Chile, Santiago. Chile.

Presentations at National/International Congresses (2004 – present)

2004 Plasticidad fenotípica de la morfología y actividad enzimática digestiva: efectos de la temperatura y dieta en Caudiverbera caudiverbera. Castañeda LE, Gonzalez S, Sabat P, & Nespolo R. XLVII Reunión de la Sociedad de Biología de Chile Noviembre 2004, Pucon, Chile.

2005 Energética y osmoregulación en paseriformes: variación geográfica en *Zonotrichia capensis*. Sabat P, Veloso C, Canals M &Cavieres G XLVIII Reunión de la Sociedad de Biología de Chile Octubre 2004, Pucon, Chile.

2005 Efecto del tamaño corporal sobre las capacidades digestivas y osmoregulatorias en paseriformes de ambientes terrestres. Sepúlveda M, Maldonado K, & Sabat P. XLVIII Reunión de la Sociedad de Biología de Chile Octubre 2004, Pucon, Chile.

2005 Morfometría pulmonar de aves y mamíferos cursoriales y voladores. Figueroa D, Olivares R, Salaberry M, Sabat P & Canals M. XLVIII Reunión de la Sociedad de Biología de Chile Octubre 2004, Pucon, Chile.

2006 Sepúlveda, M., P. Sabat & JM. Fariña. 2006. Patrones de actividad y abundanciapoblacional de Microlophus atacamensis (Squamata : Tropiduridae). XV Congreso de la Sociedad de Ecología de Chile. 27 a 29 de Julio de 2006, La Serena, Chile.

2006 Sobreviviendo al ataque de un parasitoide: el caso del chinchemolle y el tachínido. Veloso, C., Canals, M. & Sabat, P. XV Congreso de la Sociedad de Ecología de Chile. 27 a 29 de Julio de 2006, La Serena, Chile.

2006 Respuesta hematológica de mamíferos y aves frente al requerimiento energético del vuelo y su correlato con la capacidad de difusión de oxígeno. Canals, M., Donoso, C.,Figueroa, D. & Sabat P XV Congreso de la Sociedad de Ecología de Chile. 27 a 29 de Julio de 2006, La Serena, Chile.

2006 Flexibilidad del metabolismo basal y la perdida de agua evaporativa: un estudio de Campo y experimental en Zonotrichia capensis. Maldonado K., Cavieres G., Veloso C., Canals M. & Sabat P. XV Congreso de la Sociedad de Ecología de Chile. 27 a 29 de Julio de 2006, La Serena, Chile.

2008 Variacion geográfica en respuesta a la aclimatación térmica en Zonotrichia capensis. ¿estan correlacionadas la flexibilidad fisiológica y la heterogeneidad ambiental? Cavieres G. & P. Sabat. LI Reunión de la Sociedad de Biología de Chile Noviembre 2008, Pucon, Chile. Biological research 41. Suppl. A: R-34.

2008 Flexibilidad fisiológica en aves: ¿importa la historia térmica? LI Reunión de la Sociedad de Biología de Chile Noviembre 2008, Pucon, Chile. Biological research 41. Suppl. A: R-148.

2008 Variación geográfica y flexibilidad fenotípica en el gasto energético y asimilación de nutrientes en tres poblaciones de Zonotrichia capensis. Maldonado, K, Gonzalez-Vejares S & P Sabat. LI Reunión de la Sociedad de Biología de Chile Noviembre 2008, Pucon, Chile. Biological research 41. Suppl. A: R-43.

2008 Efectos de la temperatura ambiental en la habilidad termorregulatoria y la capacidad de difusión de oxígeno durante el desarrollo de Phyllotis Darwini. Canals M., Figueroa D.P., Miranda J.P. & Sabat P. LI Reunión de la Sociedad de Biología de Chile Noviembre 2008, Pucon, Chile. Biological research 41. Suppl. A: R-61

2004 Desempeño digestivo en *Bufo spinulosus*: rigidez o flexibilidad fisiologica? Naya D, Farfan G, Sabat P, Mendez M. & Bozinovic F. II Reunión binacional de Ecología Noviembre 2004, Mendoza, Argentina.

2004 Optimización morfofuncional del pulmón y la vía aérea del quiróptero Tadarida brasiliensis. Canas M, Olivares R, Guajardo R, Sabat P, & Rosenmann M.. II Reunión binacional de Ecología Noviembre 2004, Mendoza, Argentina.

2004 Evaluación del efecto de la urbanización sobre el estado de salud y estrés fisiológico en distintos ambientes de Zonotrichia capensis. Gonzalez SP, Wingfield J & Sabat P. II Reunión binacional de Ecología Noviembre 2004, Mendoza, Argentina.

2004 Efecto de la dieta en las actividades enzimática y renal en aves paseriformes. Sepúlveda M, Maldonado K Gonzalez SP & Sabat P.II Reunión binacional de Ecología Noviembre 2004, Mendoza, Argentina.

2006 Fariña, JM., M. Sepúlveda & P. Sabat. Latitudinal variation in metabolic rate: an intraspecific comparison in the lizard *Microlophus atacamensis*. Second Gordon Research Conference on the Metabolic Basis of Ecology and Evolution. 9-14 July 2006, Maine, USA.

2006 Sandra P. Gonzalez, Carolina DL. Gatica, RA. Vasquez & P Sabat Digestión de azúcar y preferencias dietarias en dos aves de la superfamilia Muscicapoidea. XI Congreso Nacional y VIII Iberoamericano de Etología. Puerto de la Cruz, Tenerife España. 19 al 22 de Septiembre de 2006

2006 Sabat P, Maldonado K, Caviares G, Veloso C Canals M. Aclimatación versus aclimatización : Flexibilidad fisiológica de Zonotrichia capensis en un ambiente estacional. XI Congreso Nacional y VIII Iberoamericano de Etología. Puerto de la Cruz, Tenerife España. 19 al 22 de Septiembre de 2006

2006 John Wingfield, Ignacio Moore, Rodrigo Vasquez, Pablo Sabat, Shallin Busch, Aaron Clark, Elizabeth Addis, Federico Prado, and Haruka Wada. Hormone-behavior interrelationships in tropical and austral populations of Rufous-collared Sparrows, Zonotrichia capensis. IV North American Ornithological Conference October 3-7, 2006 · 3-7 Octubre 2006, Veracruz, México.

2006 Santiago Merino, Juan Moreno, Rodrigo A Vasquez, Javier Martinez, Cristian F Estades, Silvina Ippi, Pablo Sabat, Ricardo Roíz & Sven McGehee. Prevalencia y distribución de parasitosis sanguínes en aves forestales de Chile. XVIII Congreso Español y III Ibérico de ornitología. Octubre 12-155, Alicante, España.

2006 Lopez-Calleja MV, Fernandez MJ, Sabat P, Bozinovic FP Why Hummingbirds require little protein. JOURNAL OF ORNITHOLOGY 147 (5): 203-204 Suppl. 1, AUG 2006

2007 Martinez del Río C and P Sabat Neutrons, Niches, and Adaptive Radiation in Cinclodes Ovenbirds SICB Annual Meeting January 3-7, Phoenix, AZ.

2007 Hartman Bakken B and **SABAT**, P. Mechanisms of water balance in hummingbirds. SICB Annual Meeting January 3-7, Phoenix, AZ.

2007 Hartman Bakken, Bradley; Sabat, Pablo The ecology and mechanisms of water balance in hummingbirds. En Simposio: Colibríes: Avances Recientes en Fisiología, Conducta y Ecología en el Neotrópico. VIII Congreso de ornitología neotropical. Maturin, Venezuela, mayo 13-19, 2007

2007 Cavieres G., Maldonado K., Soto-Gamboa M., Sabat P., (2007) Environmental heterogeneity and variability of the plastic answer in the energetic trait of Zonotrichia capensis along a latitudinal gradient. 7th International Congress of Comparative Physiology and Biochemistry. Salvador, Bahia, Brasil.

2007 Cavieres G., Veloso C., Canals M., Sabat P.Diferencias poblacionales en la pérdida total de agua evaporativa y gasto energético en Zonotrichia capensis en un gradiente de aridez. III Reunión Binacional de Ecología. Sociedad de Ecología de Chile. Asociación Argentina de Ecología, La Serena, Chile.

2007 Canals, M, Donoso, C, Figueroa D and Sabat P. Pulmonary hematological parameters, energetic fligths demands and their correlation with oxygen difusión capacity in the lungs. 7th International Congress of Comparative Physiology and Biochemistry. Salvador, Bahia, Brasil.

2007 Veloso C., C Sepulveda, Canals M and Sabat P Thermal Biology of Liolaemus lemniscatus (Iguanidae) from low and high altitude populations in Central Chile. 7th International Congress of Comparative Physiology and Biochemistry. Salvador, Bahia, Brasil.

2008 Maldonado K, Cavieres G & Sabat P Trophic niche modulate physiological specialization in digestive and renal traits: A field study of sparrows (Zonotrichia capensis) along a latitudinal gradient. 25th Congress of the new European Society of Comparative Biochemistry and Physiology, Ravenna, Italy, September 7–11 2008. Comparative Biochemistry and Physiology - Part A: Molecular & Integrative Physiology Volume 151, Issue 1, Supplement 1

2004 Relación entre la habilidad de concentración de la orina, morfología renal y hábitos dietarios en cinco paseriformes de diferentes ambientes. Sabat P. Taller: Interacciones Fisiología- Ecología bajo una perspectiva evolutiva. Dieta y función digestiva como un caso de estudio. Coordinador: Enrique Caviedes-Vidal. II Reunión binacional de Ecología Noviembre 2004, Mendoza, Argentina.

2007 Acclimation to hydric stress in birds. A field and a laboratory study. Symposium: The complex interplay between diet and phenotypic flexibility in metabolism, digestion and osmoregulation. 7th International Congress of Comparative Physiology and Biochemistry. Salvador, Bahia, Brasil.

2007 Introduction to the symposium on physiological ecology of animals living on extreme environment. Sabat P. En simposio "La vida al límite: ecología fisiológica en ambientes extremos". III Reunión Binacional de Ecología. Sociedad de Ecología de Chile. Asociación Argentina de Ecología, La Serena, Chile

2008. Uso de isótopos estables en ecología: variabilidad intraespecifica en la dieta y fisiología digestiva en lagartos. Sabat P. Simposio I: adquisición de energía en reptiles y anfibios desde la mirada de la fisiología ecológica. IX congreso de herpetología de argentina 7 al 10 de octubre de 2008, San Luis, Argentina.

Human Capital Training

Thesis supervision

2008-present Natalia Ramirez. Master's thesis. Universidad de Chile (Tutor)
2008-present Karin Maldonado. PhD thesis. Universidad de Chile (Tutor)
2008-present JJohnatan Salinas. BSc's thesis. Universidad de Chile (Tutor)

2008 Grisel Cavieres MSc´s thesis. Universidad de Chile (Tutor)
2007 Maritza Sepulveda. PhD´s thesis. Universidad de Chile (Tutor)
2006 Carlos Guerrero-Bosagna. PhD´s thesis. Universidad de Chile (Co-tutor)
2006 Patricia Aldea MSc´s thesis. Universidad de Chile (Tutor)
2005 Sandra Gonzalez. BSc's thesis. Universidad de Chile (Tutor)

Undergraduate courses

1999-Present Zoology. Universidad de Chile, Chile

Graduate courses

2002-Present Animal Physiology. Universidad de Chile, Chile

Participation in research projects

1991-1992	Ecofisiología de Zonotrichia capensis: cambios estacionales en el gasto y la adquisición de energía.. Principal Investigador: F Novoa (Universidad de Chile), Co-Principal Investigador: F Bozinovic (Universidad de Chile). Assistant researcher. Funded by FONDECYT (Fondo Nacional de Ciencia y Tecnologia) (Chile).
1993-1994	Fisiología ecológica de los procesos de alimentación y mecanismos de digestión: el caso de los micromamíferos fungívoros. Principal Investigador: F Bozinovic (Universidad de Chile). MsC student (1993) and Assistant researcher (1994).). Funded by FONDECYT (Fondo Nacional de Ciencia y Tecnologia) (Chile).
1995-1997	Características digestivas y conductuales de alimentación de aves paserinas en Chile central: un estudio estacional. Principal Investigador: F. Novoa (U Chile).Associate Researcher Funded by FONDECYT (Fondo Nacional de Ciencia y Tecnologia) (Chile).1950434,.
1995-1998	Calidad de dieta, forrajeo y digestión en endotermos: bases químicas y fisiológicas y consecuencias ecológicas. Principal Investigador: F Bozinovic (Universidad de Chile). Associate Researcher. Funded by FONDECYT (Fondo Nacional de Ciencia y Tecnologia) (Chile).1950394.
1996-1997	Plasticidad digestiva en roedores: costos asociados a la aclimatación. Principal Investigator. Funded by FONDECYT (Fondo Nacional de Ciencia y Tecnologia) (Chile). 2960013
1998	Determinación de restricciones fisiológicas alimentarias en individuos juveniles de *Phenicoparrus jamesi* y *P. andinus*: disacaridasas, esterasa y aminopeptidasa-N. Principal Investigador. Funded by Centro de Ecología Aplicada Ltda. Minera Escondida Ltda.
1998-2000	Autoecología de tres especies del género *Cinclodes* (Paseriformes, Furnaridae): plasticidad fenotípica y adaptación a ambientes salobres. Principal Investigador. Funded by FONDECYT (Fondo Nacional de Ciencia y Tecnologia) (Chile).3980027.

2001-2005 Ecofisiología de la osmoregulación en *Cinclodes* (Paseriformes: Furnaridae) Plasticidad fenotípica, variación geográfica y estacional en las capacidades máximas de excreción. Principal Investigador. Funded by FONDECYT (Fondo Nacional de Ciencia y Tecnologia) (Chile). 1010647.

2004-2008 Efecto del ambiente térmico sobre parámetros que caracterizan la optimización estructural y funcional del aparato respiratorio durante el desarrollo post-natal. Principal Investigador: M.. Canals (U Chile). Co-investigator. Funded by FONDECYT (1040649, Fondo Nacional de Ciencia y Tecnologia) (Chile)..

2004-2005 Conexiones energeticas entre ecosistemas marinos y terrestres: variaciones espacio-temporales de pequena y gran escala en el uso de recursos intermareales por parte del reptil *Microlophus atacamensis* (Squamata Tropiduridae)" Principal Investigador José M. Fariña (PUC). Associate Researcher. Funded by FONDECYT (1040783, Fondo Nacional de Ciencia y Tecnologia) (Chile).

2005-2006 Determinación de los factores que afectan a la incidencia de parasitosis en aves en ambos hemisferios. Principal Investigator Funded by CSIC-15/04. (Spain).

2005-2008 Economía Hídrica y Energética de Aves Pequeñas: variación fenotípica y flexibilidad fisiológica en *Zonotrichia capensis* a lo largo de un gradiente latitudinal. Principal Investigador. Funded by FONDECYT (1050196, Fondo Nacional de Ciencia y Tecnologia) (Chile).

2005-2006 Autoecología de *Agathemera crassa*: efecto de la estacionalidad y de la carga parasitaria sobre la adquisición y gasto de materia y energía. Principal investigador: C. Veloso (UChile). Co-Principal investigator. Funded by DID (Departamento e Investigación, Universidad de Chile). I 05/02-2.

2005-2006 Incidencia y transmisión de enfermedades parasitarias en la fauna silvestre de Chile y Perú: Implicaciones para la conservación de especies amenazadas. Principal Investigador: S. Merino (CSIC, Spain) Co-Investigador. Funded by BBVA (Spain).

2007 – 2011: The individual basis of biodiversity: patterns, process and mechanisms in time and space. Principal Investigator Francisco Bozinovic (P. Universidad Católica de Chile). Associate researcher Funded by FONDECYT (Fondo Nacional de Ciencia y Tecnología) (Chile).

2008-2011 Estrategias nutricionales e integración fisiológica: procesos de adquisición, uso y gasto de energía en aves paseriformes. Principal Investigador. Funded by FONDECYT (Fondo Nacional de Ciencia y Tecnologia) (Chile). 1080077

2008-2010 Compromisos entre la regulación hidrica y el gasto de energía en la araña migalomorfa Paraphisa parvula. Principal Investigador: M. Canals (U Chile). Co-investigator. Funded by (Fondo Nacional de Ciencia y Tecnologia) (Chile).

2009-2011 The functional ecology of an adaptive radiation: stable isotopes, niches, phylogenies and kidneys. Principal Investigator: C. Martinez del Río (U Wyoming). Associate Researcher. Funded by NSF (National Science Fundation, USA).

2009-2012 Animal Personalities And The Underlying Roles of behavioral innovation and decision-making. Principal Investigador: R. Vasquez (U Chile). Co-Principal investigador. Funded by (Fondo Nacional de Ciencia y Tecnologia, 10800038) (Chile).

Advisory / consulting services

2007-present Proposal Evaluation Committee Member (Fondo Nacional de Ciencia y Tecnología, Chile.

2000-present Referee for CONICYT-FONDECYT projects (Chile)

2006-present Referee for CONICYT-ECOS projects (Chile)

2006-present Referee for CONACYT projects (Argentina)

2008-present Member of the board Programa Capital Humano CONICYT

2002-present Referee for the following ISI journals:

- Auk
- Condor
- Comparative Biochemistry and Physiology
- Functional Ecology
- Journal of Comparative Physiology B
- Journal of Experimental Biology
- Journal of Mammalogy
- Physiological and Biochemical Zoology
- Revista Chilena de Historia Natural

Memberships

1995-present Society of Biology, Chile

2008-present Society for the Study of Evolution

Linkage / cooperation with other national and foreign investigators

	Collaborator	Affiliation	Type of cooperation (years)
National collaboration	Roberto Nespolo	UACh (Chile)	Research (6 years)

	Francisco Bozinovic	PUC (Chile)	Research (15 years)
	Mauricio Canals	UChile (Chile)	Research (10 years)
	Claudio Veloso	UChile (Chile)	Research (10 years)
	Rodrigo Vasquez	UChile (Chile)	Research (5 years)
	J. Miguel Fariña	PUC (Chile)	Research (5 years)
	Luis Ebensperguer	PUC (Chile)	Research (3 years)
International collaborators	Carlos Martinez del Rio	U of Wyoming (USA)	Research (10 years)
	John Wingfield	U of Washington (USA)	Research (5 years)
	Ariovaldo Cruz-Neto	UNESP (Brasil)	Research (5 years)
	Carlos Navas	USP (Brasil)	Research (5 years)
	Daniel Naya	U la Republica (Uruguay)	Research (5 years)
	Juan Carlos Sanchez-Hernandez	Universidad de Castilla-La Mancha (Spain)	Research (1 year)

Dissemination and Transfer

Invited seminars

2000, 2005. Departamento de Ecologia. P. Universidad Católica de Chile, Chile

V. RESEARCH TEAM (Must be filled in by main and associated researchers).

1. Personal data

Name Enrico Landaeta Rezende		
Institution (Department, Faculty or other) Department de Genètica i Microbiologia, Universidad Autònoma de Barcelona (Spain)		
Current position (Si es independiente indicarlo aquí) Investigador Ramón y Cajal		
Working address Facultat de Biociències, Edifici Cn Universitat Autònoma de Barcelona 08193 Bellaterra (Barcelona) SPAIN		City Barcelona
Home address (main researchers only for legal purposes) Soler i Rovirosa 11-13, 4º1º		City Barcelona
Contact phones +34 93 581 4705	Fax +34 93 581 2387	E-Mail enrico.rezende@uab.cat

2. Curricular data

Title or Deegre (s)	Institution where it was obtained	Date it was obtained
PhD	University of California, Riverside (USA)	2005
BSc	Universidad de Chile	1998

Indicate any other training relative to the researcher´s discipline and expertise.

Enclose CV following this records. CV must include:

- Publications of the latest 5 years. (Include ISI and non-ISI publications, books, book chapters, etc.).
- Updated number of citations for each publication,
- National and international congresses where the researcher presented results (either oral or poster).
- Training and formation os researchers and students. Indicate theses tutor and co-tutorships, tutorial seminars, collective courses and others.
- Participation in science & development projects indicating source(s) of funds, period of funding and category within the project.

- Consulting provided to public or private institutions, enterprises and/or individuals only related to the project topic or discipline.
- Any other information that you consider relevant for the functions and compromises taken within this project.

In all previous activities done in collaboration with other people please include all other persons involved and highlight your collaborator(s) last name(s). Please asterisk those activities that had inter or multidisciplinary aspects.

Publications (2004-present)

ISI publications
(Total Nº of publications = 34, Sum of the Times Cited = 434; *h*-index = 13)

ISI publications
(Total Nº of publications = 34, Sum of the Times Cited = 434; *h*-index = 13)

1. Rezende E.L., M.A. Chappell & K.A. Hammond (2009) Cold-acclimation in *Peromyscus*: individual variation and sex effects in maximum and daily metabolism, organ mass and body composition. Journal of Experimental Biology, In press.

2. Gaston K.J., S.L. Chown, P. Calosi, J. Bernardo, D.T. Bilton, A. Clarke, S. Clusella-Trullas, C.K. Ghalambor, M. Konarzewski, L.S. Peck, W.P. Porter, H.O. Pörtner, E.L. Rezende, P.M. Schulte, J. Stillman, J.S. Terblanche & M. van Kleunen (2009) Macrophysiology: a conceptual re-unification. American Naturalist, In press.

3. Rezende E.L., E.M. Albert, M.A. Fortuna & J. Bascompte (2009) Compartments in a marine food web are associated with phylogeny, body mass, and habitat structure. Ecology Letters, In press.

4. Rezende E.L., F.R. Gomes, M.A. Chappell & T. Garland, Jr. (2009) Running behavior and its energy costs in mice selectively bred for high voluntary locomotor activity. Physiological and Biochemical Zoology, In press.

5. Gomes F.R., E.L. Rezende, M.B. Grizante & C.A.Navas (2009) The evolution of jumping performance in anurans: morphological correlates and ecological implications. Journal of Evolutionary Biology 22: 1088-1097. [doi: 10.1111/j.1420-9101.2009.01718.x]
   Total citations: 0

6. Gomes F.R., E.L. Rezende, J.L. Malisch, S.K. Lee, D.K. Rivas, S.A. Kelly, C. Lytle, B.B. Yaspelkis III & T. Garland, Jr. (2009) Glycogen storage and muscle glucose transporters (GLUT-4) of mice selectively bred for high voluntary wheel running. Journal of Experimental Biology 212: 238-248. [doi:10.1242/jeb.025296]

Total citations: 2

7. Russell G.A., E.L. Rezende & K.A. Hammond (2008) Development partly determines the aerobic performance of adult deer mice, *Peromyscus maniculatus*. Journal of Experimental Biology 211: 35-41. [doi:10.1242/jeb.012658].
Featured in:
- Inside JEB: Phillips K. (2008) Birth altitude affects aerobic performance. J.Exp.Biol. 211:ii.
Total citations: 1

8. Rezende E.L., J.E. Lavabre, P.R. Guimaraes, P. Jordano & J. Bascompte (2007) Non-random coextinctions in phylogenetically structured mutualistic networks. Nature 448: 925-928. [doi:10.1038/nature05956]
Featured in:
-- Nature 'News and Views': Renner S.S. (2007) Structure in mutualistic networks. Nature 448: 877-879.
-- Investigación y Ciencia (Spanish edition of Scientific American): Bascompte J. & Jordano P. (2008) Redes mutualistas de especies. Investigación y Ciencia 384: 50-59.
Total citations: 21

9. Girard I., E.L. Rezende & T. Garland, Jr. (2007) Leptin levels and body composition of mice selectively bred for high voluntary activity. Physiological and Biochemical Zoology 80: 568-579. [doi: 10.1086/521086]
Total citations: 3

10. Chappell M.A., K.A. Hammond, R.A. Cardullo, G.A. Russell, E.L. Rezende & C. Miller (2007) Deer mouse aerobic performance across altitudes: effects of developmental history and temperature acclimation. Physiological and Biochemical Zoology 80: 652-662. [doi: 10.1086/521202]
Total citations: 2

11. Rezende E.L., P. Jordano & J. Bascompte (2007) Effects of phenotypic complementarity and phylogeny on the nested structure of mutualistic networks. Oikos 116:1919-1929. [doi: 10.1111/j.2007.0030-1299.16029.x]
Total citations: 9

12. Malisch, J.L., W. Saltzman, F.R. Gomes, E.L. Rezende, D.R. Jeske & T. Garland, Jr. (2007). Basal and stress-induced plasma corticosterone concentrations of mice selectively bred for high voluntary wheel running. Physiological and Biochemical Zoology 80: 146-156.
Total citations: 12

13. Rezende E.L., F.R. Gomes, J.L. Malisch, M.A. Chappell & T. Garland, Jr. (2006) Maximal oxygen consumption in relation to subordinate traits in lines of house mice selectively bred for high voluntary wheel running. Journal of Applied Physiology 101: 477-485.
Total citations: 13

14. Diaz, G.B., R.A. Ojeda & E.L. Rezende (2006) Renal morphology, phylogenetic history and desert adaptation in South American hystricognath rodents. Functional Ecology 20: 609-620.
Total citations: 2

15. Rezende E.L., T. Garland, Jr., M.A. Chappell, J.L. Malisch & F.R. Gomes (2006) Maximum aerobic performance in lines of *Mus* selected for high wheel-running activity: effects of selection, oxygen availability and the mini-muscle phenotype. Journal of Experimental Biology 209: 115-127.
Total citations: 11

16. Rezende E.L., S.A. Kelly, T. Garland, Jr., F.R. Gomes & M.A. Chappell (2006) Effects of size, sex and voluntary running speeds on costs of transport in lines of laboratory mice selected for high wheel-running activity. Physiological and Biochemical Zoology 79: 83-99.
Total citations: 22

17. Syme D.A., K. Evashuk, B. Grintuch, E.L. Rezende & T. Garland, Jr. (2005) Contractile abilities of normal and "mini" triceps surae muscles from mice (*Mus domesticus*) selectively bred for high voluntary wheel running. Journal of Applied Physiology 99: 1308-1316.
Total citations: 16

18. Garland T., Jr., A.F. Bennett & E.L. Rezende (2005) Phylogenetic approaches in comparative physiology. Journal of Experimental Biology 208: 3015-3035.
Total citations: 88

19. Rezende E.L., F.R. Gomes, C.K. Ghalambor, G.A. Russell & M.A. Chappell (2005) An evolutionary frame of work to study physiological adaptation to high altitudes. Revista Chilena de Historia Natural 78: 323-336.
Total citations: 5

20. Rezende E.L., M.A. Chappell, F.R. Gomes, J.L Malisch & T. Garland, Jr. (2005) Maximal metabolic rates during voluntary exercise, forced exercise, and cold exposure in house mice selectively bred for high wheel running. Journal of Experimental Biology 208: 2447-2458.
Total citations: 15

21. Chappell M.A., T. Garland, Jr., E.L. Rezende & F.R. Gomes (2004) Voluntary running in deer mice: speed, distance, energy costs, and temperature effects. Journal of Experimental Biology 207: 3839-3854.
Featured in:
-- Inside JEB: Van Bergen Y. (2004) Deer mice run for fun. J.Exp.Biol. 207:ii.
Total citations: 19

22. Rezende E.L., F. Bozinovic & T. Garland, Jr. (2004) Climatic adaptation and the evolution of maximum and basal rates of metabolism in rodents. Evolution 58: 1361-1374.
Total citations: 47

23. Rezende E.L., M.A. Chappell & K.A. Hammond (2004) Cold-acclimation in *Peromyscus*: temporal effects and individual variation on maximum metabolism and ventilatory traits. Journal of Experimental Biology 207: 295-305.
Total citations: 16

Presentations at National/International Congresses

Workshops

1. Rezende E.L. & J. Bascompte (2008) Phylogenetic effects in ecological networks of species interactions. BCNetWorkshop: Trends and Perspectives in Complex Networksenrico0861 [http://complex.ffn.ub.es/bcnetworkshop/]

Symposia

1. Rezende E.L. (2008) The comparative method to study evolutionary novelties and key innovations. Sponsor of "Phylogenetic approaches in macrophysiology", organized by Dr. Ted Garland. Macrophysiology Meeting, University of Plymouth, UK.

Published abstracts

1. Lavabre J.E., E.L. Rezende, P.R. Guimarães, Jr., P. Jordano & J. Bascompte (2007) Phylogenetic structure in mutualistic networks. Ecological Society of America, 92nd Meeting, San Jose CA, USA. [http://eco.confex.com/eco/2007/techprogram/P3899.htm].

2. Rezende E.L. & T. Garland, Jr. (2006) Maximal metabolic rates during exercise and cold exposure in house mice selectively bred for high wheel running. Society for Experimental Biology, Canterbury, UK. SEB Abstracts [A2.16]. Comparative Biochemistry and Physiology, Part A 143:S64.

3. Girard I., E.L. Rezende & T. Garland, Jr. (2005) Lower leptin levels in mice selected for high voluntary wheel running. SICB abstracts [P2.115], p. 287. Integrative and Comparative Biology 44:701. [http://www.sicb.org/meetings/2005/schedule/abstractdetails.php3?id=815]

4. Gomes F.R., E.L. Rezende, J.L. Bunkers, D.A. Rivas, B.B. Yaspelkis III & T. Garland Jr. (2005) Muscle glucose transporters (Glut-4) and glycogen storage of mice selectively bred for high activity levels. SICB abstracts [9.8], p. 146. Integrative and Comparative Biology 44:560. [http://www.sicb.org/meetings/2005/schedule/abstractdetails.php3?id=633]

5. Chappell M.A., E.L. Rezende & F.R. Gomes (2004) Energetics of voluntary running in deer mice. SICB abstracts [43.3], p. 284. Integrative and Comparative Biology 43: 984. [http://www.sicb.org/meetings/2004/schedule/abstractdetails.php3?id=361].

6. Gomes F.R., E.L. Rezende, J.L. Bunkers & T. Garland, Jr. (2004) Organ masses and carbohydrate metabolism of mice artificially selected for high voluntary wheel running. SICB abstracts [29.2], p. 212. Integrative and Comparative Biology 43: 912. [http://www.sicb.org/meetings/2004/schedule/abstractdetails.php3?id=366].

7. Bunkers J.L., F. Gomes, E.L. Rezende, W. Saltzman & T. Garland, Jr. (2004) Plasma corticosterone of mice selectively bred for high voluntary wheel running: levels at rest and following restraint stress.

SICB Abstracts [15.2], p. 139. Integrative and Comparative Biology 43: 839. [http://www.sicb.org/meetings/2004/schedule/abstractdetails.php3?id=303].

Human Capital Training

Undergraduate courses

2005 Teaching assistant in "Introductory Genetics (Bio 102)". University of California, Riverside. Dr. Angela Burk-Herrick.

2004 Teaching assistant in "Human Anatomy and Physiology (Bio 171; upper division class)". University of California, Riverside. Dr. Roger D. Farley.

2004 Teaching assistant and guest lecturer (2 lectures) in "Human Genetics (Bio 034)". University of California, Riverside. Dr. Susan Gershman and Dr. Susana Peluc.

2004 Teaching assistant of "Vertebrate Anatomy II (Bio 161B; upper division class)". University of California, Riverside. Dr. Ted Garland, Jr., Dr. Kimberly A. Hammond and Michael Fugate.

2004-2005 Teaching assistant of "Vertebrate Anatomy (Bio 161A; upper division class)". Discussion leader. University of California, Riverside. Dr. Mark Springer, Dr. David Reznick and Michael Fugate.

1997-1998 Teaching assistant of "Zoology II". Facultad de Ciencias, Universidad de Chile. Dr. F. Fernando Novoa.

1997-1998 Teaching assistant of "Zoology I". Facultad de Ciencias, Universidad de Chile. Dr. Michel Salaberry.

Graduate courses

2004 Guest lecturer in "Ecofisiología Evolutiva (Zool 404, graduate course)". Universidad Austral, Valdivia, Chile. Dr. M. Soto-Gamboa and Dr. R.F. Nespolo.

Participation in research projects

2008 Associate researcher at the Departament de Genètica i de Microbiologia, Universitat Autònoma de Barcelona.

2005-2007 Associate postdoctoral researcher for EURYI grant "Networks of Plant-Animal Interactions: the Architecture of Biodiversity" awarded to Dr. Jordi Bascompte. Estación Biológica de Doñana, Consejo Superior de Investigaciones Científicas (CSIC), Spain.

2003 Research assistant in "Phylogenetic analyses of the evolution of continuous characters". Dr. Theodore Garland Jr. NSF Systematic Biology Program DEB-0196384.

2002-2003 Research assistant in "Responses to artificial selection for voluntary activity in house mice". Dr. Theodore Garland Jr. NSF Ecological and Evolutionary Physiology Program IBN-0212567.

2002-2003 Associated researcher in "Genetics and plasticity in adaptation to altitude in the deer mouse". Dr. Kimberly A. Hammond and Dr. Mark A. Chappell. NSF Division of Environmental Biology DEB-0111604.

1999-2001 Associated researcher at Departamento de Ecología, Facultad de Ciencias Biológicas, P. Universidad Católica de Chile, Santiago, Chile.

1999-2001 Research assistant in "Ecología conductual y fisiología de endotermos pequeños: compromisos y restricciones en la regulación del balance energético y presupuesto de tiempo". Dr. F. Bozinovic. FONDECYT 1980959.

1998 Research assistant in "Plasticidad fenotípica en la tasa metabólica máxima de Abrothrix olivaceus (Rodentia): Un estudio experimental". Dr. F.F. Novoa. FONDECYT 1980762.

1997 Associated researcher in "Biodiversidad, clima y evolución adaptativa en vertebrados e insectos fitófagos de los biomas áridos del norte de Chile". Programa Sectorial Biomas y Climas Terrestres y Marinos del Norte de Chile. Dr. A. Spotorno and Dr. M. Rosenmann. FONDECYT 5960017.

Advisory / consulting services

2007-present Referee for CONICYT-FONDECYT projects

2002-present Referee for the following ISI journals:

- American Naturalist
- Evolution
- Physiological and Biochemical Zoology
- Journal of Experimental Biology
- Functional Ecology
- Oikos
- Physiology & Behavior
- Proceedings of the Royal Society B: Biological Sciences
- Zoology
- Medicine & Science in Sports & Exercise
- Comparative Biochemistry and Physiology
- Proceedings of the National Academy of Sciences (PNAS)
- Water Air & Soil Pollution
- BMC Evolutionary Biology
- Oecologia
- Evolutionary Ecology
- American Journal of Physiology
- Revista Chilena de Historia Natural

Memberships

1999-present Sociedad de Biología de Chile (Chile)

1999-present Sociedad de Ecología de Chile (Chile)

2002-present Society for Integrative and Comparative Biology

Linkage / cooperation with other national and foreign investigators

	Collaborator	Affiliation	Type of cooperation (years)
National collaboration	Leonardo Bacigalupe	UConcepción	Research (10 years)
	Roberto Nespolo	UACh	Research (10 years)
	Francisco Bozinovic	PUC Chile	Research (10 years)
	Mauricio Soto-Gamboa	UACh, Fac. Cs.	Research (3 years)
International collaborators			

Dissemination and Transfer

Invited workshops and seminars

2009 University of Bern, Switzerland. Inter-University Doctoral Program in Ecology and Evolution. Workshop on the use of phylogenetic statistical methods. Title: "Phylogenetic independent contrasts". http://www.unil.ch/ee/page64341.html

2009 University of Michigan, Ann Arbor. 5th Annual University of Michigan Early Career Scientists Symposium: Using Phylogenies in Ecology. Seminar title: 'Phylogenetic effects in ecological networks of species interactions.' http://sitemaker.umich.edu/ecss2009/invited_speakers

2008 Universitat Autònoma de Barcelona (UAB), Spain. Seminar title: 'Phylogenetic comparative methods and their application in evolutionary biology.'

2008 III Workshop of the Evolutionary Biology Group (collaboration between Universitat Autònoma de Barcelona and Universitat de Barcelona). Seminar title: 'Evolutionary physiology and the evolution of integrated phenotypes'.

2007 Universidad de Santiago de Chile (USACH), Chile. Seminar title: 'Networks and phylogenies: merging two fields to study plant-animal interactions.'

2005 Estación Biológica de Doñana, Consejo Superior de Investigaciones Científicas (CSIC), Spain. Seminar title: 'Introduction to phylogenetic comparative methods.'

2004 Universidad Austral, Valdivia, Chile (UACh). Workshop title: 'The comparative methods in evolutionary physiology.'

2004 Universidad Federal de Santa Catarina (UFSC), Brazil. Seminar title: 'Artificial selection experiments and the evolution of correlated characters.'

VI. INFORMATION BASELINE AND INDICATORS

TablE 1. The following table summarizes the indicator's baseline by the time of this proposal's application.

NUMBER OF RESEARCHERS (Main and associated)	6	
Total amount of funds to this proposal contributed by sources other than CONICYT (in US dollars)	National sources 748.885	International sources 0
INDICATOR'S FOR THE ENTIRE RESEARCH TEAM*		
Total number of ISI publications of the latest 5 years	131	
Total number of ISI publications of the latest 5 years with international co-authors	69	
Total Number of citations associated to the ISI publications of the latest 5	792	

years	
Total number of undergraduate students that are currently trained by all researchers of the team	11
Total number of graduate students that are currently trained by all researchers of the team	7
Total number of postdocs that are currently working with researchers of the team	5

* In the Research Team category are not included managers or administrators that may participate in the proposal with activities other than research.

Table 2. The following table summarizes the expected indicators to be obtained during the execution of this project. If you consider that there are more adequate indicators to those mentioned here please include them. On the other hand, if you consider that some of them do not apply to this project please indicate so in the table.

General Data	Discipline	1.06 Biological Sciences
	Total budget	1.585.316 USD
	Percentage of the total cost of the project financed by other sources than CONICYT	53%
	Nº of main researchers	4
	Nº of associated researchers	2
	Gender (%) of the previous categories	Male (100%)
Scientific production	Nº of ISI publications	10
	Nº of non- ISI publications	0
	Percentage of publications with co-authors external to this proposal	50%
	Percentage of publications co-authored by researchers of this proposal	100%
	Average impact index of the journals with ISI publications	2.5
	Average citations per article	10
	Nº of presentations in national congresses	6

	Nº of presentations in international congresses	4
Comercial production or others	N° of patents solicitated	0
	N° of patents registered	Do not apply
	N° of licenses or Material Transfer Agreements	Do not apply
	Percentage of the project cost financed by enterprises	Do not apply
	Nº of Spin-offs	Do not apply
Training of young researchers and students	Nº of undergraduate students	6
	Nº of Master´s students	2
	Nº of Ph.D's students	5
	Nº of postdocs participating in the project	4
	Nº of undergraduate theses finished	5
	Nº of Master´s theses finished	0
	Nº of Ph.D's theses finished	4
	Percentage of theses co-tutored by researchers participating in this project	100%
	Percentage of theses co-tutored with researchers external to this project	0%
	Nº of stays of students and researchers in other centers or institutions	10
Collaboration and dissemination	N° of visits from students and researchers from other centers and institutions	5
	N° of projects with national collaboration	0
	N° of projects with international collaboration	0
	N° of public and/or private entities (not enterprises) participating	Do not apply
	Nº of extramural events	2
	Nº of mentions of the project in mass media	5
	Nº of total attendants to extramural events	100
	Nº of national academics attending	10
	Nº of international academics attending	0
	Nº of representatives from sectors other than scientifics or academic	10
	Nº of documents resulting from the events	5

VII. BUDGET

7.1. Please use the additional Excell table enclosed as a different file from this form (Appendix 5).

7.2. Justify the requested budget:

Equipment and infrastructure adjustment (if applies)

Equipment acquisition as well as adjustment costs in infrastructure should be justified.

Costs are in US dollars (USD) (actual currency conversion: 1 USD = 538 Chilean pesos). Unless otherwise noted, all amounts are gave for the entire period of the project (3 years).

B. Operational costs

B.1. Laboratory material and supplies

RNA isolation: The cost of RNA isolation and purification is expect around 3.500 USD per year, which includes the cost of RNAeasy isolation kit (Qiagen). In addition, non-durable material and electrophoresis reagents (agarose, ladder, and ethidium bromide) are expected to be around a cost of 1.500 USD per year. **SUB-TOTAL: 15.000 USD.**

Quantitative qPCR assays: Determinations of transcripts levels by qPCR will be performed every year. Two primers for every analyzed genes (reference and regulated genes) are needed (2,000 USD per year). cDNA syntheses will be conducted from total RNA isolated using the AffinityScript qPCR cDNA kit (1.500 USD per year). Reactions for qPCR will be done using the Brilliant SYBR Green qPCR Master Mix (1.500 USD per year). Quantitative analyses will include three experimental replicates, two biological replicates, negative controls and seriated dilution curves for reference and studied genes (26.000 USD). In addition, the estimated cost for laboratory non-durable materials will be 4.000 USD per year. **SUB-TOTAL: 88.500 USD.**

Respirometry: The respirometry supplies that would be needed (tygon tubing, dissecants, CO_2 absorbants, connectors, absorbant acrylic columns) cost about 6,000 USD per year. We will need to manufacturate at least eight different plexiglass wheel metabolic chambers for measurements of MMR which costs about 2.500 USD each (=20.000 USD). **SUB-TOTAL: 36,000 USD.**

B2. Consulting and other services

B3. Seminars, workshops and training services

As indicated in "*Dissemination of results and knowledge transfer"* we will include activities such as courses for biology school teachers, seminars and preparing "explora" project to involve school students in our experiments. **SUB-TOTAL: 5,576 USD**.

B4. Publications, patents and dissemination activities

As indicated in "*Dissemination of results and knowledge transfer"*, we plan to develop a formal strategy for "rapid outreach" of our findings into de community. We ask **5,576 USD** for investing in seminars, courses and dissemination activities.

B5. Minor equipment and accessories

Several small devices such as collar transmitters to locate the tenrecs and echidnas and temperature data loggers to record changes in Tb during metabolic measurements will be needed. Also, mist nets, sherman and tomahawk traps will be needed for small mammals and birds. **SUB-TOTAL: 37.175 USD.**

B6. Medical exams and insurances (A.Ant.)

We ask for insurance given the important traveling component of this proposal, assuming each travel insurance for about 155USD. **SUB-TOTAL: 1.859 USD.**

B7.Tickets and per diem.

We plan to perform five trips for measuring exotic mammals (Australia, South Africa/Madagascar, and Poland). Each ticket for such long trip costs approximately 3000 USD, and three months of stay would cost about 8200 USD. **SUB-TOTAL: 55.762 USD.** The tickets and per-diem of students will be providede by MECESUP AUS0703 (see Appendix 6).

C. EQUIPMENT AND INFRASTRUCTURE ADJUSTMENT

C1. Hardware and goods

In order to perform all the measurements simultaneously in Chile (Valdivia and Santiago), Australia, Poland, South Africa and Madagascar with exactly the same equipment, we will purchase four Sable Systems (www.sablesystems.com) respirometers model FoxBox (ca. 30.000 USD each, including

shipping, insurance and costumes). The equipments will be sent directly from the manufacturer, to the countries indicated before. **SUB-TOTAL: 120.000 USD.**

Thermal-cycler: Setting up of PCR conditions need to be performed previous to qPCR analyses. Due to (i) the intense use of the PCR machines we currently have and (ii) fatal failures for some of them, we urgently need an additional thermal-cycler. **SUB-TOTAL: 10699 USD.**

In order to analyse all the information that will be retrieved from genomic databases (90 genes, approx) per species in several vertebrate species) we have to have enough computer power to do all the work in a reasonable time. For that reason we are askingto to increase the computer facility that we already have and to be able to accomplish our goal. **SUB-TOTAL: 18000 USD.**

C2. Adjustment and improvement of physical spaces
We need appropriate indoor and outdoor vivarium facilities. Large species such as doves and fardelas, will need to be maintained in outdoor bird enclosures and small species need to be maintained in indoor enclosures with controlled temperature and photoperiod. These small arrangement would cost about $3.600 each. **SUB-TOTAL: 7435 USD.**

D. INSTITUTIONAL ADMINISTRATION EXPENSES
D1. General Services or others
For the whole period of the project, we ask **$7435** for mail, accounting services, bank guarantees, and delivery services.

D2. Suport staff for administration (fees)
We ask for 6.200 USD to invest in a part-time account assistant, who will be crucial to maintain our expenses balance of the different teams involved, and also the appropriate division between our different grants. **SUB-TOTAL: 59480 USD.**

Funding by other entities: MECESUP
In the MECESUP project AUS0807, a number of equipments were already approved among which the qPCR thermocycler (ca. 83.600 USD) is supposed to be used in our project (see Appendix 7).
Also, in the MECESUP project AUS0805, three postdocs (during two years) were approved among which we plan to assign two of them (ca. 116.171 USD) to work in our project (see Appendix 8). Similarly, the AUS0807 included a technician for working in the genomics facility, which will contribute to our aims (ca. 67.000 USD).

Funding by other entities: UACH
According to Appendix 9, our molecular genetics laboratory is equiped with hardware and goods for about 171.000 USD and laboratory facilities for about 194.000 USD. Additionally, our institution is giving new funding for 10% of the total amount requested to Conicyt (ca. 82.000 USD) (see Appendix 5), which will be assigned for paying one of the technicians (see Appendix 5: BUDGET). We also considered the salaries of the four main researchers, multiplied by their hourly assgment to the project (ca. 35.000 USD). **SUB-TOTAL: 482.156 USD.**

Personnel justification and detail: Were this proposal granted, this information should be updated at least annually.

Category	Annual amount (US$)	Degree of commitment (Weekly hours)	**Other research commitments financed by CONICYT and other public funds** (Indicate category in the project, weekly hours committed and financial sources)
Director Dr. Roberto F. Nespolo Rossi	$22.300	22	FONDECYT 1090423, IR, 22 hours, $3.717 per year. FONDECYT 1080085, COI, 10 hours, $3.717 per year. PBCT insertion grant, IR, 2 hours, $2.230 per year. MECESUP grant AUS0703 (Director), 3 hours, no salary involved. MECESUP grant (deputy director) AUS0807, 1 hour, no salary involved. MECESUP grant (deputy director) AUS0805, 1 hour, no salary involved.
Main researchers	Annual amount (US$)	Degree of commitment (Weekly hours)	**Other research commitments financed by CONICYT and other public funds** (Indicate category in the project, weekly hours committed and financial sources)
Dr. Juan C. Opazo Carvallo (Deputy Director)	$22.300	22	FONDECYT 11080181, IR, 22 hours, $ 7.435 per year. FONDECYT 1090423, COI, no salary involved.
Dr. Leonardo D. Bacigalupe Cirillo	$22.300	20	FONDECYT 1080085, IR, 22 hours, $ 7.435 per year. FONDECYT 1090423, COI, no salary involved.
Dr. Alfredo Christian Figueroa Caro	$22.300	20	FONDECYT 1090378, IR, 20 hours, $7.435 per year. MECESUP grant AUS0703 (deputy director), 1 hours, no salary involved. MECESUP grant AUS0807 (Director), 1 hour, no salary involved.

Project duties and responsabilities.

The four main researchers worked closely in creating this idea. This is a completely new, coordinated and ambitious research program in which each main researcher has a specific and crucial goal for the attainment of the final objective. The goals of each main researchers, either the genomic analysis of the 90 genes from public databases(Opazo); the functional genomics experiments using qPCR to study the quantitative expression of such genes in the species we will obtain (Figueroa), the bioenergetics measurements in the two laboratories in Chile (Nespolo) and the bioenergetic measurements and its coordination in the five laboratories across Africa, Australia and Europe (Bacigalupe), have sense and scientific impact only in the context of the rest of the researchers duties and goals. In other words, the rationale of this project is that the whole is far more than the parts. It is important to clarify that our team will be composed by over 50 people working in Chile and across the world, but only a part of the costs their salaries are being asked in this project since we already have the approved funds for many of them (see percentages of funding in Appendix 5 and also this section). Regarding the general coordination of the research, although Drs. Nespolo and Opazo are listed as Director and Deputy Director, respectively, this project was the result (and we plan to remain as it is if funded) of a collaborative task repartition in where the Director only assambled and maintained the final version of the

Postdocs –indicate	Annual amount	Degree of	Individual duties and

draft. The Deputy Director provided the genomics and functional genomics feedback, assisted by Dr. Figueroa and the international coordination was performed by Dr. Bacigalupe, who also assisted the Director in the bioenergetics and experimental design part.

number or identify when possible	**per individual when possible (US$)**	**commitment (Weekly hours)**	**responsabilities within the project (they may be doing their own research or be inserted in the research lines of the project-specify)**
Luis Castañeda (Nespolo associated)	22.000	44	Funded by FONDECYT grant 3090056 for postdoctoral research in evolutionary quantitative genetics of *Drosophila* populations
Paulina Artacho (Figueroa associated)	22.000	44	Funded by FONDECYT grant 3080051 for postdoctoral research in evolutionary quantitative genetics of aphids populations.
María Paz Oyarzún (Figueroa associated)	22.000	44	Funded by FONDECYT grant 3090032 for postdoctoral research and IFS grant B/4773-1 in population genetics of insects of commercial importance as pests.
Mauricio Carter (Nespolo associated, prospective)	12.500	22	Funded by FONDECYT 1090423 and FONDECYT 1080085. Working in quantitative genetics of inducible traits in *Daphnia*
Marcela Franco (Nespolo associated, prospective)	22.000	44	Applying for a FONDECYT postdoctoral grant in the physiological ecology of hibernation in the marsupial *Dromiciops gliroides*.
Roger Sepúlveda (Nespolo associated, prospective)	22.000	22	Funded by FONDECYT 1090423 And MECESUP AUS0703
Postdoc 1	29.000	44	Funded by MECESUP AUS0805, for two years, in evolutionary ecology. This personnel would work on the bioenergetic experiments and field work.
Postdoc 2	29.000	44	Funded by MECESUP AUS0805, for two years, in evolutionary ecology. This personnel would work on the functional genomics experiments.
Students (total) Ph.D/Master / undergraduates (specify and indicate numbers of ea. category)	**Annual amount per category (US$)**	**Degree of commitment (Weekly hours)**	**Duties and responsabilities within the project (they may be doing their own theses or be research assistants or other-specify each situation-**
Juan Diego Gaitán (Nespolo associated)	12.500	22	Funded by a Conicyt fellowship, and working in FONDECYT 1090423 (NESPOLO) grant.
Myriam Iturra (Leonardo Bacigalupe)			
Natalia Ramirez (Sabat	7.000	10	Master student

associated)			
Juan Pablo Torres (associated to Figueroa)	12.500	22	Funded by a Conicyt fellowship
Sandra Gonzalez (Sabat associated)	12.500	22	PhD student, Funded by a Conicyt fellowship
Grisel Cavieres (Sabat associated)	12.500	22	PhD student, Funded by a Conicyt fellowship
Karin Maldonado (Sabat associated)	12.500	22	PhD student, Funded by a Conicyt fellowship
Pablo Cortés García (associated to Nespolo)	12.300	44	Prospective graduate student. Presently, a providing technical assistance to the FONDECYT 1090423 (NESPOLO) grant.
Francisca Zepeda (associated to Figueroa)	12.500	22	Funded by a Conicyt fellowship
Marco Cabrera (associated to Figueroa)	12.500	22	Funded by a Conicyt fellowship
Andrea Silva (associated to Figueroa)	12.500	22	Funded by a Conicyt fellowship
Technicians (specify)	**Annual amount per individual (US$)**	**Degree of commitment (Weekly hours)**	**Individual duties and responsabilities within the project**
Lucía Briones (associated to Figueroa)	12.300	44	Research assistant to FONDECYT 109038
Felipe Sepúlveda (associated to Figueroa)	12.300	44	Research assistant to FONDECYT 109038
Manuela Luna (associated to Figueroa)	7.000	10	Research assistant to FONDECYT 109038
Dimar González Soto (associated to Opazo)	4.500	22	Research assistant to FONDECYT 11080181. Finalizing his thesis for the career of Informatics Engineer.
Tecnician 1	33.500	44	Full-time tecnician for the molecular genetics laboratory, asked in this proposal.
Tecnician 2	33.500	44	Full-time tecnician for animal maintenance and respirometry laboratory, asked in this proposal.
Tecnician 3	33.500	44	Full-time tecnician for field work, asked in this proposal.
Tecnician 4	67.000	44	Full-time tecnician for the core facility in genomics and proteomics, provided by MECESUP AUS0807 (see Appendix 7).
Bioinformatician 1	67.000	44	Full-time bioinformatics engineer, provided by UACh as a support for this proposal.

Administration personnel (specify)	**Annual amount per individual (US$)**	**Degree of commitment (Weekly hours)**	**Individual duties and responsabilities within the project**
Journalist	25.000	22	Part-time. To execute the "rapid outreach" strategy, outlined in part II.
Gladys Espinoza (accountant)	25.000	22	Part-time accountant to maintain the accountant balance between the different teams, and between our different grants. Asked in this proposal.

VIII. LIST OF SUGGESTED REVIEWERS AND THOSE WITH CONFLICT OF INTEREST (OPTIONAL)
Suggested Reviewers:

1. Marek Konarzewski :
marekk@uwb.edu.pl
Institute of Biology, University of Białystok, S´ wierkowa 20B, PO Box 109, 15-950 Białystok, Poland. Tel. (+48 85) 745-73-28

2. Kimberly Hammond
kimberly.hammond@ucr.edu
Department of Biology, University of California, Riverside, California 92521

3. John R. Speakman
j.speakman@abdn.ac.uk
Institute of Biological and Environmental Sciences, University of Aberdeen, Aberdeen AB24 2TZ, UK. Tel. (+44 0) 1224 272879

5. Roger Seymour
roger.seymour@adelaide.edu.au
Department of Ecology and Environmental Biology, University of Adelaide, Adelaide, SA 5005, Australia.

6. Dr. Jack Hayes
jhayes@unr.ed
College of Science, University of Nevada , Reno, NV 89557, 775-784-6076, USA

7. Phillip Withers
c.cooper@curtin.edu.au
Zoology, School of Animal Biology, University of Western Australia, Crawley, Western Australia 6009, Australia

8. John Lighton
john@johnlighton.org
Department of Biological Sciences, University of Nevada at Las Vegas, Las Vegas, NV 89154-4004, USA

The team declare no conflict of interests

XI. APPENDIXES. ADDITIONAL DOCUMENTATION AND REFERENCE.

A.1.1 Application to "Servicio Agrícola y Ganadero" for authorization of capturing the vertebrate species for scientific purposes.

F-PR-VS-001: Formulario de solicitud de captura de animales de especies protegidas de la fauna silvestre, con fines de investigación o exhibición científica				
1. ANTECEDENTES DE INGRESO DE LA SOLICITUD				
N°	Oficina de Partes en que ingresa Valdivia			
Solicitud de Permiso	X	Renovación de permiso		
2. ANTECEDENTES DEL SOLICITANTE				
Nombres	Roberto Fernando			
Apellido paterno	Nespolo		Apellido materno	Rossi
RUT	10.919.685-1			
Dirección	Instituto de Ecología y Evolución, Universidad Austral de Chile, Casilla 567			
Comuna	Valdivia	Región	Los Ríos	
Teléfono Fijo y Móvil	+56 63 221704 +934 382 25	Correo electrónico	robertonespolorossi@gmail.com	
Título de educación superior y año de titulación: Dr. Ciencias Biológicas, P. Universidad Católica de Chile (2001) Otros estudios:				
Resumen curricular: Experiencia profesional específica (asociada al permiso)				
Nuestra investigación ha estado orientada a conocer los mecanismos que explican los patrones y procesos evolutivos que ocurren a escala ecológica en poblaciones naturales de vertebrados. Dentro de este marco, hemos trabajado con tres aproximaciones principales enfocadas a entender: (i) la asignación y uso de la energía (bioenergética) tanto en el ambiente natural como a nivel mecanicístico en el laboratorio, (ii) los determinantes ecológicos del funcionamiento organísmico (ecofisiología), y (iii) la variación genética/genómica asociada a los rasgos bioenergéticos. Algunas publicaciones representativas de nuestro quehacer en vertebrados durante los últimos 5 años tanto en revistas científicas como de divulgación: **Publicaciones científicas**: Nespolo R.F. & Bacigalupe L.D. (2009) Viability selection on early body mass and the effect of female body size on fecundity: a study on the leaf-eared mouse Phyllotis darwini. Ecological Research. In press.				

Cortes P., Quijano S.A. & Nespolo R.F. (2009) Bioenergetics and inter-individual variation in physiological capacities in a relict mammal, the monito del monte (Dromiciops gliroides). Journal of Experimental Biology 212: 297-207.

Nespolo RF, Artacho, P, Castañeda LE, verdugo C (2008) Short-term thermoregulatory adjustments in a South American anseriform, the black-necked swan (Cygnus melanocoryphus). Comparative Biochemistry and Physiology A 150: 366-368.

Artacho P, Castañeda LE, Soto-Gamboa M, Verdugo C & Nespolo RF (2007). Blood biochemistry in a population of black–necked swans (Cygnus melanocoryphus) in a conservation priority area. Comparative Biochemistry and Physiology A146: 283-290.

Nespolo, RF & M Franco (2007) Metabolic rate is a repeatable trait: a meta analysis. Journal of Experimental Biology 210: 2000-2005.

Artacho, P, Castañeda LE, Soto-Gamboa M, Verdugo C & Nespolo RF (2007) Using haematological parameters to assess the health and nutritional status of an endangered Black-Necked swan population. Comparative Biochemistry and Physiology A147: 1060-1066.

Castañeda LE, Sabat P Gonzales SP & Nespolo RF (2006). Digestive plasticity in tadpoles of the Chilean giant frog (Caudiverbera caudiverbera): factorial effects of diet and temperature. Physiological and Biochemical Zoology 79: 919-926.

Bacigalupe LD, Nespolo RF, Bustamante D & Bozinovic F (2005). Is there a trade-off betweeen energetics and spleen mass? A quantitative genetic study in the leaf-eared mouse. Evolutionary Ecology Research 7: 1-7.

Nespolo RF, Bacigalupe LD, Bustamante D & Bozinovic F (2005). Quantitative genetics of bioenergetics and growth-related traits in the wild mammal, Phyllotis darwini. Evolution 59: 1829-1837.

Bacigalupe LD, Nespolo RF, Bustamante D & Bozinovic F (2004). The quantitative genetics of sustained energy budget in a wild mouse. Evolution 58: 421-429.

Sabat P, Nespolo RF & Bozinovic F (2004). Water economy of three Cinclodes (Furnariidae) species inhabiting marine and freshwater ecosystems. Revista Chilena de Historia Natural 77: 219 – 225.

Bacigalupe LD, Nespolo RF, Opazo J & Bozinovic F (2004). The role of thermal history on phenotypic plasticity in thermogenic capacity and organ size in the leaf-eared mouse Phyllotis darwini. Physiological and Biochemical Zoology 77: 805-815.

Artículos de divulgación

2009 Artículo científico: “Bioenergetics and inter-individual variation in physiological capacities in a relict mammal - the Monito del Monte (Dromiciops gliroides).” (J. Exp. Biol. 212:297-304): Sección de “Ciencia y Tecnología” de los diarios El Mercurio”, “La Tercera”

y “La Nación” newspapers, Junio 24; también:
http://www.20minutos.es/noticia/475482/0/fosil/evolucion/mamiferos/

2009 Artículo científico: “Natural selection reduces energy metabolism in the garden snail Helix aspersa” (Evolution 63:1044-1050): (1) Sección de “Ciencia y Tecnología” de “El Mercurio”, Marzo 2009, (2) BBC-London
http://news.bbc.co.uk/earth/hi/earth_news/newsid_8043000/8043689.stm

2009 Experiencia Explora-Conicyt con dos estudiantes de colegio involucrados en la investigación “Usando un fósil viviente para estudiar el origen de la endotermia”.

2008 “Diario Austral”: reportaje completo describiendo la investigación y la divulgación de nuestro departamento, el Instituto de Ecología y Evolución
http://www.universia.cl/portada/actualidad/noticia_actualidad.jsp?noticia=137109.

3. DESCRIPCIÓN DEL PROYECTO

3.1 Objetivos

(1) Muestrear los principales grupos de la filogenia de aves y mamíferos (junto con algunas especies de anfibios y reptiles) y medir la repetibilidad de rasgos fisiológicos (metabolismo basal, metabolismo máximo, conductancia térmica, tamperatura corporal) en representantes ancestrales y derivados de la filogenia de esos grupos.

(2) Desarrollar un enfoque genómico para identificar la marca de la selección natural sobre los genes asociados con la endotermia

(3) Estudiar la actividad de esos genes en una muestra de las especies del objetivo (1), utilizando PCR cuantitativo

3.2 Detalle de especímenes a capturar o cazar

N°	Nombre Científico	Nombre común	Sexo	Cantidad	Estado de Conservación
1	Calidris alba	Playero blanco	Ambos	31	Preocupación menor[2]
2	Vanellus chilensis	Queltehue	Ambos	33	Preocupación menor[2]
3	Zonotrichia capensis	Chincol	Ambos	35	Preocupación menor[2]
4	Procellaria aequinoctalis	Fardela negra grande	Ambos	18	Vulnerable[2]
5	Puffinus griseus	Fardela negra	Ambos	15	Casi amenazado[2]
6	Dromiciops gliroides	Monito del monte	Ambos	20	Insuficientemente conocida[1]
7	Octodon degus	Degu	Ambos	35	Preocupación menor[2]
8	Bufo spinulosus	Sapo espinoso	Ambos	22	Preocupación menor[2]
9	Fulica armillata	Tagua	Ambos	23	Preocupación menor[2]

Criterios usados en orden jerárquico:
[1]CONAMA Reglamento para la clasificación de especies silvestres (D.S. Nº75/2005) y sus correspondientes decretos de ley.
[2]Lista Roja IUCN, 2009

[3]Estados de conservación descritos por el Reglamento de la Ley de caza Decreto Supremo Nº5, Enero 1998

3.3 Descripción del método de captura o caza.

Aves terrestres: Se capturarán durante el día utilizando redes de niebla. Una vez atrapada, cada individuo será rapidamente removido, y colocada en una jaula individual, donde se le prooverá agua y alimento.
Aves acuáticas: Serán capturados en la noche, con red de tela cónica que permite la inmovilidad del individuo y su adecuado manejo.
Mamíferos: Se capturarán utilizando trampas Sherman con cebo de avena como alimento. Cada individuo será transportado en su trampa. Las trampas se colocarán en el crepúsculo, y desde el amanecer, se chequearán cada 2 horas.
Anfibios: Los métodos de determinación y captura de anfibios, seguirán los protocolos señalados por Heyer et al. 1994, basados en búsquedas y recolecciones mediante transectos al azar en todos los hábitats accesibles. El reconocimiento y determinación específica se realizará a partir de encuentros visuales y acústicos. Las capturas se realizarán directamente en la vegetación y mediante redes de mano cuando éstas se efectúen en cuerpos de agua.

Heyer, R., Donnely, M., Foster, M. 1994. Methods for Measuring and Monitoring Amphibians. Smithsonian Press. New York.

3.4 Lugar captura o caza georeferenciado (WGS 84 y huso).

Calidris alba: Alrededores de Valdivia (39.6° S 73.1° W, GTM -04)
Vanellus chilensis: Alrededores de Valdivia (39.6° S 73.1° W, GTM -04)
Zonotrichia capensis: Alrededores de Valdivia (39.6° S 73.1° W, GTM -04)
Procellaria aequinoctalis: Isla Huafo (43.6° S 74.8° W, GTM -04)
Puffinus griseus: Isla Huafo (43.6° S 74.8° W, GTM -04)
Dromiciops gliroides: Alrededores de Valdivia (39.6° S 73.1° W, GTM -04)
Octodon degus: Quebrada de la Plata, Maipú (33°S, 70°W, GTM -04)
Bufo spinulosus: Alrededores de Santiago (33°S, 70°W, GTM -04)
Fullica armillata: Alrededores de Valdivia (39.6° S 73.1° W, GTM -04)

3.5 Lugar de destino georeferenciado (WGS 84 y huso).

Instituto de Ecología y Evolución (Valdivia, 39.6° S 73.1° W, GTM-04)

3.6.Cronograma de Actividades a realizar y período por el que se solicita el permiso.

Cronograma de actividades para cada especie: Luego de la captura, los individuos serán transportados a las dependencias del Instituto de Ecología y Evolución, donde serán mantenidos en jaulas o acuarios individuales en un vivero climatizado (26 ± 2ºC) con fotoperíodo controlado (14D:10N) y alimento ad libitum. Luego de una semana de aclimatación, se procederá a medir los diferentes rasgos fisiológicos mencionados de acuerdo al siguiente cronograma (se planea realizar 3 veces las mismas mediciones fisiológicas):
Semana 1: Aclimatación
Semana 2: Mediciones tiempo 1

Semana 3: Aclimatación
Semana 4: Mediciones tiempo 2
Semana 5: Aclimatación
Semana 6: Mediciones tiempo 3
Se solicita permiso de captura para las especies mencionadas para todo el período que durará la ejecución del proyecto (Marzo 2010 – Diciembre 2012). Esto es debido a: (i) en ninguna instancia de la ejecución el número total de individuos en el laboratorio (de una o más especies) será superior a 50 y (ii) la eventualidad de no poder obtener la cantidad de individuos deseada durante un único muestreo, y que por lo tanto se requiera de mas instancias de captura. Posteriormente a las mediciones los individuos serán liberados en la población de origen.

Aves marinas: Serán capturadasy anilladas en una de las colonias de nidificación, ubicada en el sector Punta Weather, Isla Guafo; distante a unos 2000 m del faro de la Armada de Chile. Las mediciones fisiológicas serán realizadas en la estación del faro, sin ningún tipo de aclimatación previa, posteriormente a las cuales las aves serán liberadas en la colonia de origen.

3.7. Estado de conservación de las poblaciones locales a intervenir, condiciones de transporte.

Vulnerabilidad: La mayoría de las especies y poblaciones propuestas no presentan problemas de conservación de acuerdo al Reglamento de la CONAMA, la IUCN o el Reglamento de la Ley de Caza.

Condiciones de Transporte: El transporte al Instituto de Ecología y Evolución se hará en camioneta arrendada en los siguientes tiempos: (i) dentro del mismo día de captura cuando los muestreos se realicen en los alrededores de Valdivia, (ii) máximo dos días despues cuando los muestreos se realicen en la zona central (los individuos serán mantenidos durante 2 noches en las dependencias del Departamento de Ciencias Ecológicas, Universidad de Chile).

Mediciones fisiológicas: Las mediciones fisiológicas que se realizarán, no producirán ningún daño en los individuos capturados. Las mismas seguirán todas las disposiciones del Comité de Bioética de la UACh. No obstante, se requerirá sacrificar 3-5 individuos de cada especie para poder realizar los análisis de expresión génica. El resto de los animales serán devueltos a su hábitat original luego de las mediciones.

A.1.2. Reception of the Universidad Austral de Chile bioethics commitee application

De:
Víctor Leyán
A:
Christian Figueroa;
Asunto:
Re: Solicita certificado uso de animales para investigación - Anillos
Fecha:
jueves, 09 de julio de 2009 16:35:21

Estimado Dr. Figueroa

Acuso recibo de los documentos referidos, los que serán incluidos para revisión en la próxima reunión del Comité de Bioética Animal

Atte.,

Víctor Leyán

Comité de Bioética Animal

----- Original Message -----

From: Christian Figueroa

To: vleyan@uach.cl

Sent: Wednesday, July 01, 2009 5:49 PM

Subject: Solicita certificado uso de animales para investigación - Anillos
Estimado Dr. Leyán, Junto con saludarle, le escribo para solicitar certificado de uso de animales en investigación para un proyecto Anillos del Programa de Investigación Asociativa de CONICYT que estamos postulando y que dirige el Dr. Roberto Nespolo. Adjunto envío título del proyecto, resumen, objetivos, hipótesis y métodos. Saludos cordiales, Dr. Christian Figueroa Instituto de Ecología y Evolución

A.1.3. Reception of the Universidad Austral de Chile biosecurity commitee application

Estimado Christian, Acuso recibo del Proyecto de Investigación ANILLOS - CONICYT "SQUEEZING THE VERTEBRATE TREE TO DISENTANGLE THE EVOLUTION OF ENDOTHERMY IN BIRDS AND MAMMALS", Numero de Ingreso 0111- 09. La emisión del Certificado de Bioseguridad de dicho Proyecto se encuentra en trámite. Saludos Cordiales Claudio Rodríguez G. Comité Institucional de Bioseguridad Universidad Austral de Chile "

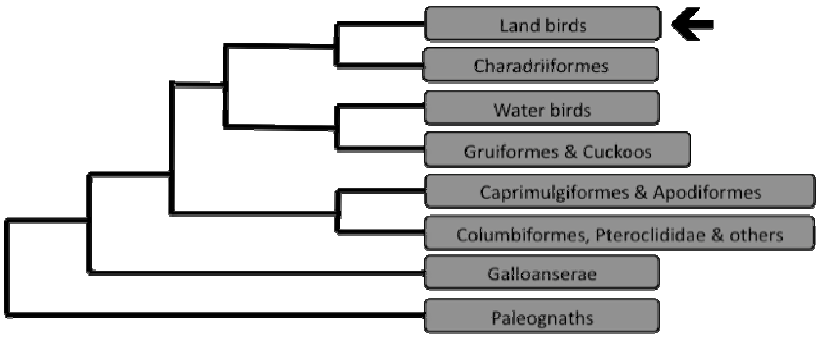
A.2. Review of Anillos Project ACT38 (Evaluators: Dr. Maria Navajas and Dr. Tim Mousseau)

An external evaluation team visited the core facility at the University Austral de Chile in Valdivia, on November 19, 2007. Overall, the team was impressed by the obvious collegiality and cohesiveness of the group and felt that in general; the primary goals of the Anillo program were exemplified in this group. In particular, it was evident that the award had promoted significant multidisciplinary interactions among labs in a way that would not have been possible in the absence of an Anillo award. One significant measure of this activity is the center proposal currently under development by this group for submission in Dec 2008 to continue and expand their association. The review team was particularly impressed that the group had exceeded expectations for scientific productivity (i.e. high quality publications, student and postdoc numbers) despite many technical difficulties in conducting some of the core scientific research, and the "Anillo" group had taken measures to include strategic international collaborations in order to overcome these challenges. In addition, methods and strategies had been modified so as to continue to make progress in measurable (publishable) ways that provided opportunities to move their field forward and generate successful students.

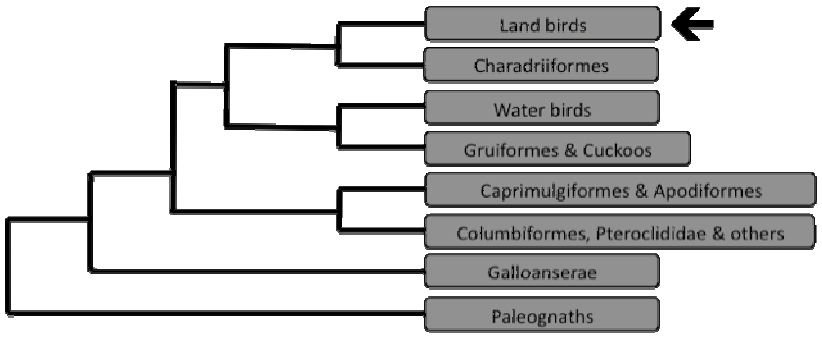
The primary scientific objectives of this grant were to identify generalist and specialist strains of aphids so as to examine phenotypic and genetic components of variation among these strains. The project involved several key stages including isolation of appropriate strains, phenotypic characterization of strains by life history traits, evaluation of strains responses to chemical plant defensive compounds, isolation of EST's for the development of a "gene chip" for gene expression assays, QTL analyses for identification of linkage groups, and finally, an quantitative genetic analysis for measurement of heritability and genetic correlations among traits related to specialization. Although the ACT38 research group has not as yet achieved success for many elements of the proposed program, they are making good progress and the review team was confident that all was being done that could be done to achieve the desired goals of the Anillo program.

A.3.1 Birds' species to be studied. Phylogenetic relationships were obtained from Hackett et al. 2008 (Fig 2, pp 1765). Major clades are: land birds (Passeriformes, Psittaciformes, Falconidade, Caramidae, Coraciiformes, Trogoniformes, Coliiformes, Strigiformes, Accipitridae and Cathartidae), caradriiforms (Charadriiformes), water birds (Pelecaniiformes, Procellariformes, Sphenisciformes and Gaviiformes), gruiforms and cuckoos (Gruiformes, Cuculiformes and Otididae), apodiformes and caprimulgiformes (Caprimulgiformes) , galloanserae (Galliformes and Anseriformes) and paleognaths (Struthioniformes). Columbiformes, Mestornithidae, Pteroclididae, Phaethontidae, Phoenicopteriformes and Podicipediformes were not assigned to a major clade.

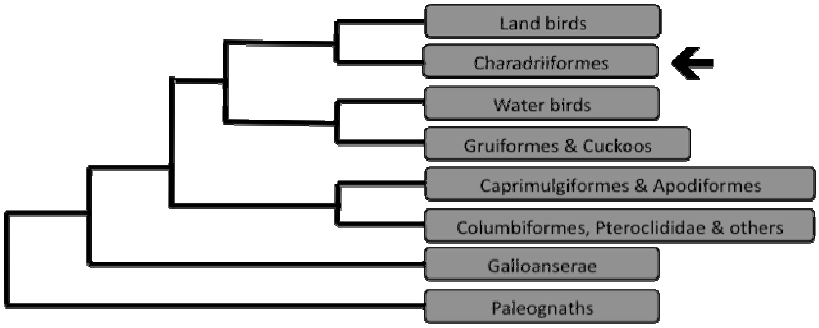
Superorder: Neognathae
Order: Passeriformes
Species: *Passer domesticus*
Availability: Common in Chilean cities. It can be captured by mist nets or obtained from commercial suppliers.



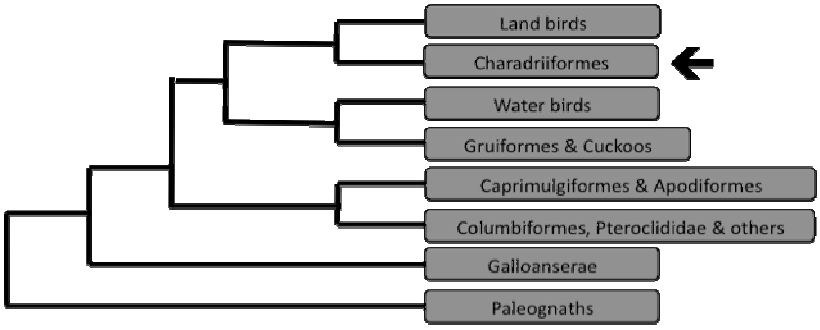
Superorder: Neognathae
Order: Passeriformes
Species: *Zonotrichia capensis*
Availability: Common in Chilean sub-urban areas. It can be captured by mist nets.



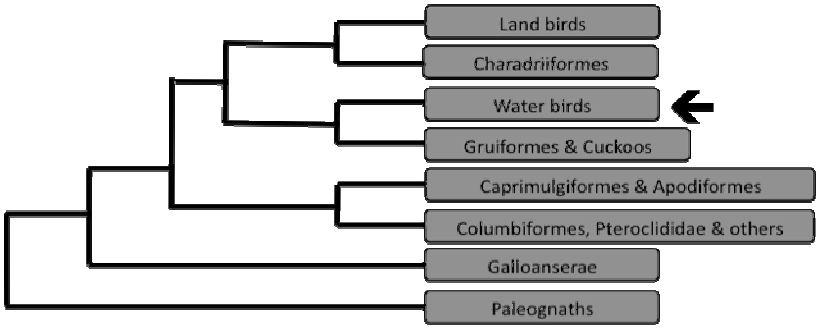
Superorder: Neognathae
Order: Charadriiformes
Species: *Calidris alba*
Availability: Common in Chilean sandy beaches. It can be captured by mist nets.



Superorder: Neognathae
Order: Charadriiformes
Species: *Vanellus chilensis*
Availability: Common in Chilean sub-urban areas. It can be captured by mist nets.

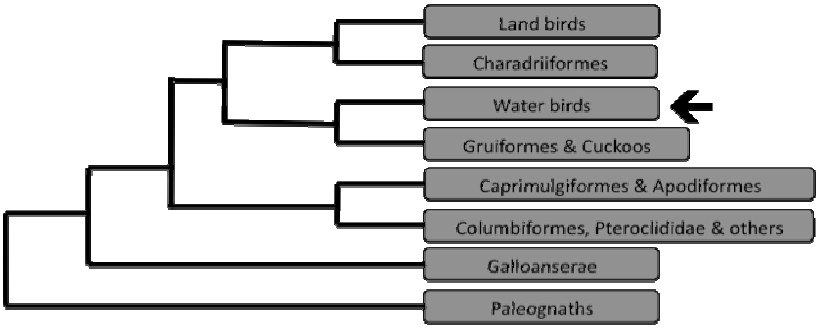


Superorder: Neognathae
Order: Procellariiformes
Species: *Procellaria aequinoctialis*
Availability: Common in Chilean coasts.

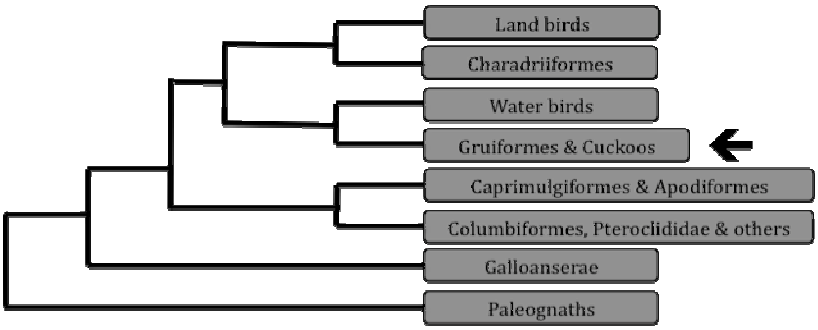


Superorder: Neognathae

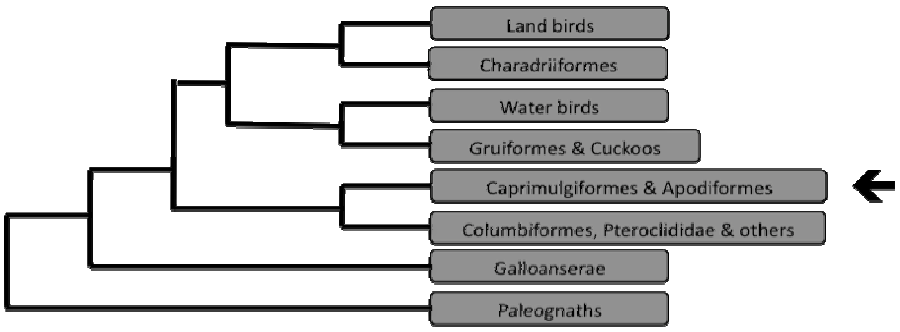
Order: Procellariiformes
Species: *Puffinus griseus*
Availability: Common in Chilean coasts.



Superorder: Neognathae
Order: Gruiformes
Species: *Fulica armillata*
Availability: common in central-south Chile.

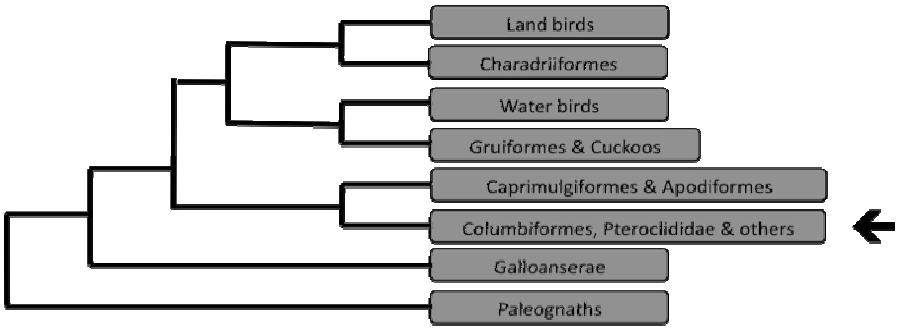


Superorder: Neognathae
Order: Apodiformes
Species: *Sephanoides sephaniodes*
Availability: common in central-south Chile. It can be captured by mist nets

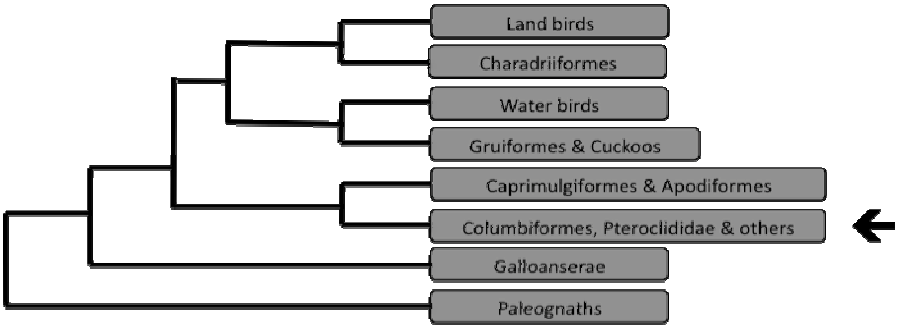


Superorder: Neognathae
Order: Columbiformes
Species: *Columba livia*

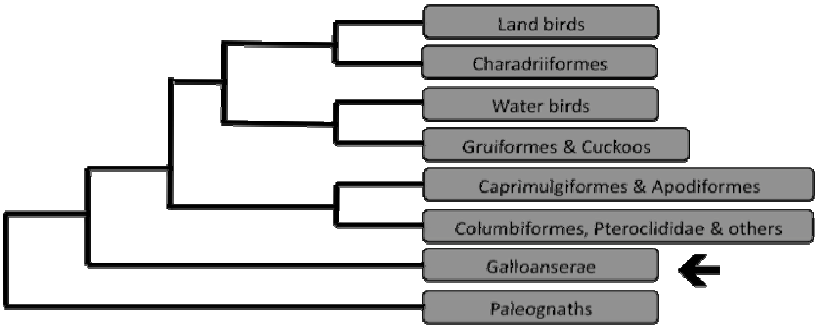
Availability: common in all main Chilean cities. It can be captured by mist nets



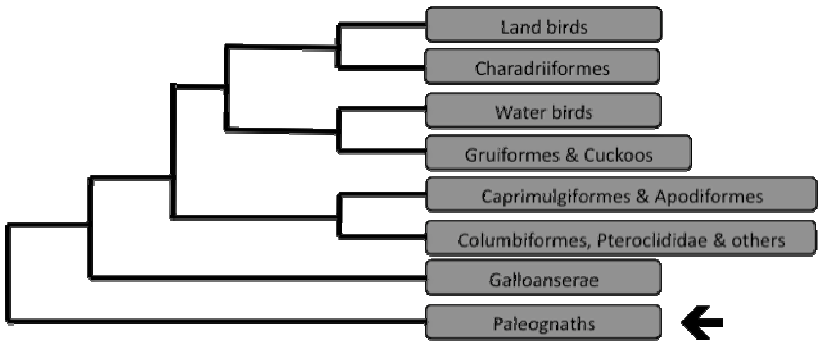
uperorder: Neognathae
Order: Columbiformes
Species: *Zenaida auriculata*
Availability: common in all sub-urban areas. It can be captured by mist nets



Superorder: Neognathae
Order: Galliformes
Species: *Callipepla californica*
Availability: common in central Chile. It can be captured by mist nets or by special bird traps for ground dwellers. It is also available from commercial suppliers.

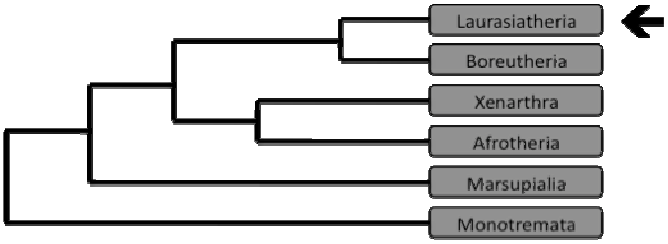


Superorder: Paleognathae
Order: Tinamiformes
Species: *Nothoprocta perdicaria*
Availability: common in north and central Chile. It can be captured by mist nets or by special bird traps for ground dwellers.

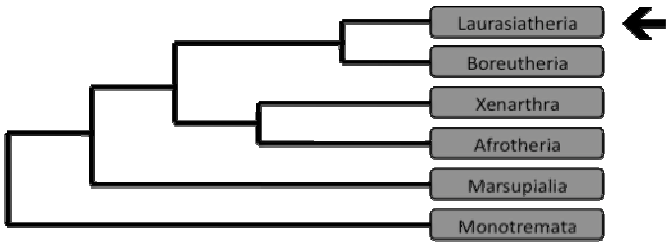

Land birds
Charadriiformes
Water birds
Gruiformes & Cuckoos
Caprimulgiformes & Apodiformes
Columbiformes, Pteroclididae & others
Galloanserae
Paleognaths

A.3.2. Mammals' species to be studied. Phylogenetic relationships were obtained from Wildman et al (2007) and van Rheede 2006.

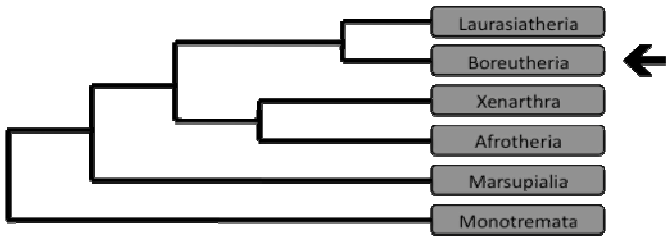
Subclass: Theria
Infraclass: Eutheria
Superorder: Laurasiatheria
Species: *Erinaceus concolor*
Availability: Collaborative work with Dr. Pawel Koteja (Institute of Environmental Sciences, Jagiellonian University, Poland, pawel.koteja@uj.edu.pl, agreement letter attached)



Subclass: Theria
Infraclass: Eutheria
Superorder: Laurasiatheria
Species: *Sorex sp*
Availability: Collaborative work with Dr. Janek Taylor (University of Bialystok, agreement letter attached)

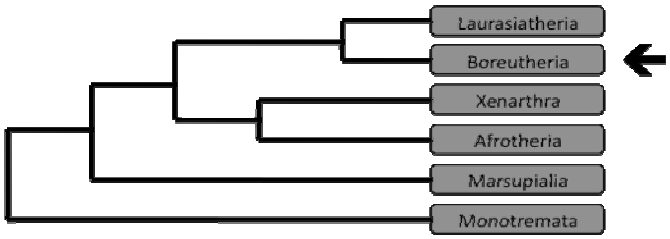


Subclass: Theria
Infraclass: Eutheria
Superorder: Boroeutheria
Species: *Phyllotis darwini*
Availability: Available in central and southern Chile. It can be captured with Sherman traps.

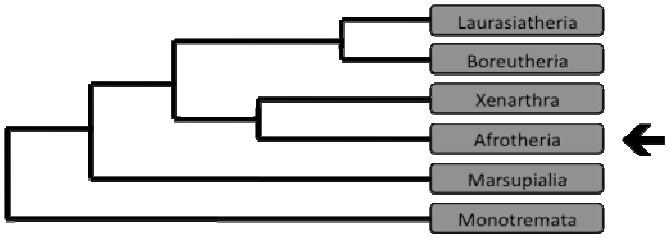


Subclass: Theria
Infraclass: Eutheria
Superorder: Boroeutheria

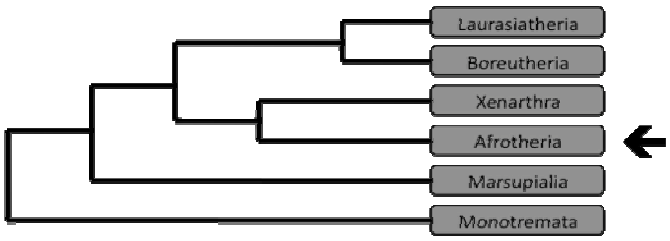
Species: *Octodon degus*
Availability: Available in central Chile. It can be captured with Sherman traps.



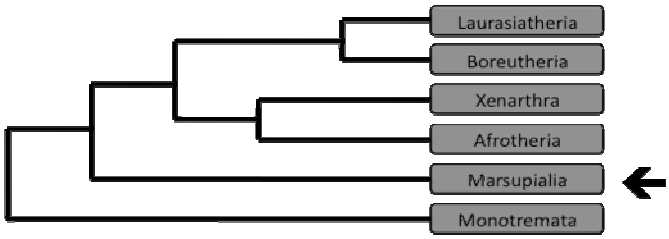
Subclass: Theria
Infraclass: Eutheria
Superorder: Afrotheria
Species: *Elephantulus myurus*
Availability: Collaborative work with Dr. Barry Lovegrove (School of Biological and Conservation Sciences, University of KwaZulu-Natal, South Africa, lovegrove@ukzn.ac.za, agreement letter attached)



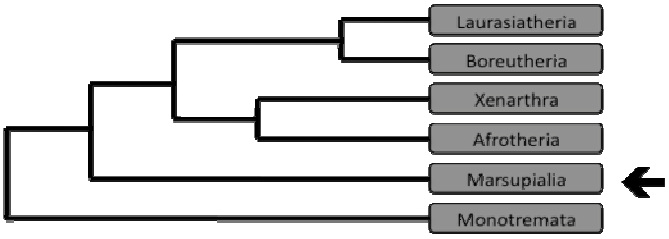
Subclass: Theria
Infraclass: Eutheria
Superorder: Afrotheria
Species: *Tenrec ecaudatus*
Availability: Collaborative work with Dr. Barry Lovegrove (School of Biological and Conservation Sciences, University of KwaZulu-Natal, South Africa, lovegrove@ukzn.ac.za, agreement letter attached)



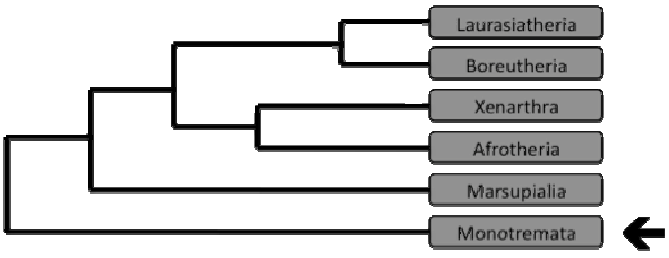
Subclass: Theria
Infraclass: Metatheria
Order: Marsupialia
Species: *Thylamys elegans*
Availability: Available in central Chile. It can be captured with Sherman traps.



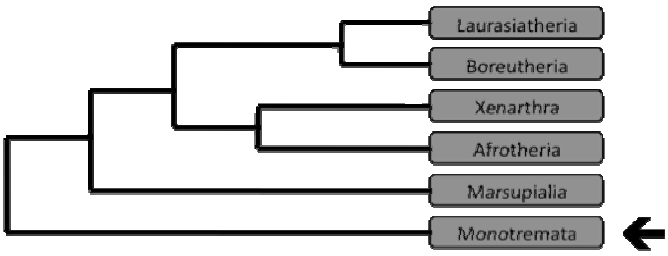
Subclass: Theria
Infraclass: Metatheria
Order: Marsupialia
Species: *Dromiciops gliroides*
Availability: Available in southern Chile. It can be captured with Sherman traps.



Subclass: Prototheria
Order: Monotremata
Species: *Tachyglossus aculeatus*
Availability: Collaborative work with Dr. Stewart Nicol (School of Medicine, University of Tasmania, Australia, s.c.nicol@utas.edu.au, agreement letter attached)



Subclass: Prototheria
Order: Monotremata
Species: *Ornithorhynchus anatinus*
Availability: Collaborative work with Dr. Stewart Nicol (School of Medicine, University of Tasmania, Australia, s.c.nicol@utas.edu.au, agreement letter attached)


Laurasiatheria
Boreutheria
Xenarthra
Afrotheria
Marsupialia
Monotremata

A.3.3. Chilean ectothermic species to be studied.

Class: Reptilia
Order: Squamata
Species: *Liolaemus chiloensis*
***Availability*:** Available in central Chile.

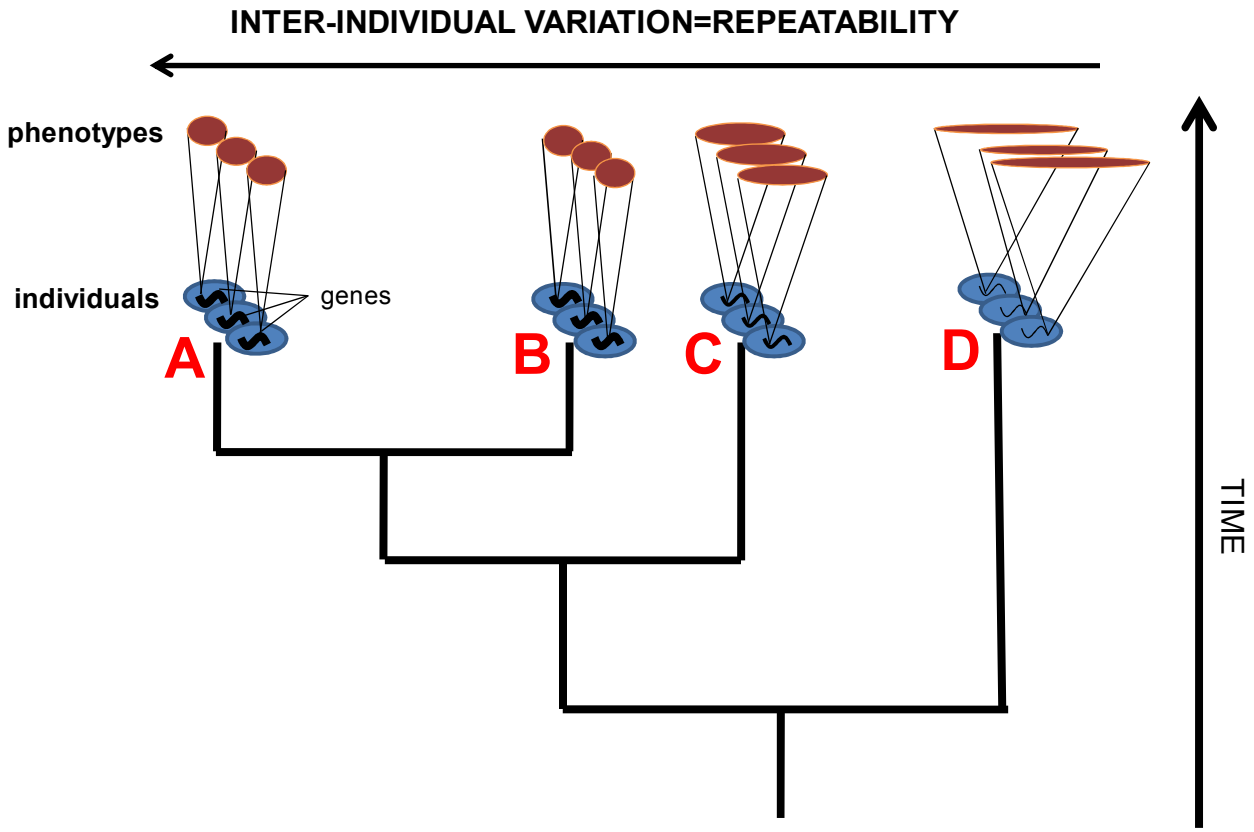
Class: Reptilia
Order: Squamata
Species: *Microlophus atacamensis*
***Availability*:** Available in north Chile.

Class: Amphibia
Order: Anura
Species: *Xenopus laevis*
***Availability*:** Available in central Chile.

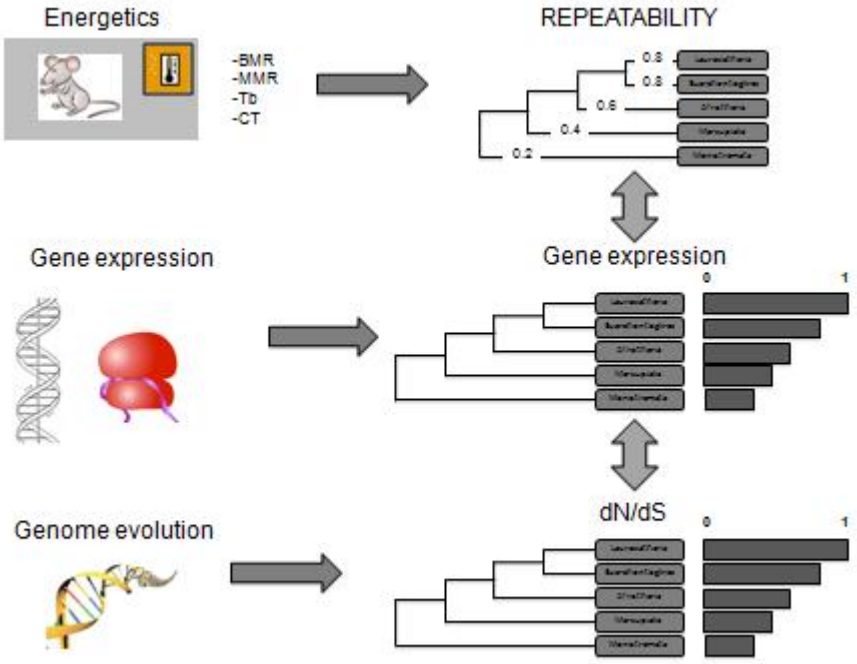
Class: Amphibia
Order: Anura
Species: *Bufo spinulosus*
***Availability*:** Available in central Chile.

A.3.4.1 Two cartoons of the general idea and predictions of our project, i) in a theoretical phylogeny and ii) exemplified with mammals.

i) Phenotypic values are indicated by the thickness of the elypses , their height and bold of the genes indicate gene-expression patterns and the overlap between the elypses indicates inter-individual variation (=repeatability, or the degree of consistency of the trait in the sample).



ii. Repeatabilites, patterns of gene-expression and signatures of selection of what we could observe in the case of mammals.



5. BUDGET

EXPENSES CATEGORY / FINANCIAL SOURCE *(in US dollars)*	AMOUNT REQUESTED TO CONICYT	FINANCIAL CONTRIBUTION BY OTHER PARTIES (*)		
		MAIN INSTITUTION	ASSOCIATED INSTITUTIONS	OTHER ENTITIES (MECESUP)
A. FEES	**368,030**	**117,100**	**0**	**183,086**
A1. Main and associated researchers fees	301,115	33,457	0	0
Director	66,914	8,364	0	0
Main Researchers	200,743	25,093	0	0
Associated Researchers	33,457	0	0	0
A2. Other reseachers and research assistants	66,914	83,643	0	183,086
Postdocs	0	0	0	116,171
Students (all categories)	0	0	0	0
Technicians or other professionals	66,914	66,914	0	66,914
Administration staff	0	16,729	0	0
B. OPERATIONAL COSTS	**245,353**	**0**	**0**	**0**
B1. Laboratory Materials and Supplies	139,405	0	0	0
B2. Consulting and other services	0	0	0	0
B3. Seminars, workshops and training services	5,576	0	0	0
B4. Publications, patents and dissemination activities	5,576	0	0	0
B5. Minor equipment and accesories	37,175	0	0	0
B6. Medical exams and insurances (A.Ant.)	1,859	0	0	0
B7. Tickets and per diems	55,762	0	0	0
C. EQUIPMENT AND INFRASTRUCTURE ADJUSTMENT	**156,134**	**365,056**	**0**	**83,643**
C1. Hardware and goods	148,699	171,004	0	83,643

C2. Adjustment and improvement of physical spaces	7,435	194,052	0	0
D. INSTITUTIONAL ADMINISTRATION EXPENSES	**66,914**	**0**	**0**	**0**
D1. General Services or others	7,435	0	0	0
D2. Suport staff for administration (fees)	59,480	0	0	0
TOTAL BUDGET	***836,431***	***482,156***	***0***	***266,729***
%	*53%*	*30%*	*0%*	*17%*

(*) INSERT AS MANY COLUMNS AS INSTITUTIONS AND OTHER ENTITIES PARTICIPATE

A.6. Summary budget of our approved MECESUP grant AUS0703 (2008-2010; Director: R. Nespolo; Deputy Director: C. Figueroa),which is in its second year of execution. In the "perfeccionamiento" item (first row) are indicated the funds (Chilean pesos) dedicated to travel and maintenance fellowships for PhD students of our graduate program SISTECOL (one dollar=538 Chilean pesos). Travel funds in this grant are for three fellowships each year, including tickets and per diem for three months.

	MeceSup	Institución	Total	% (Por Gasto)
TOTAL PERFECCIONAMIENTO	225.000.000	0	225.000.000	85%
TOTAL GASTOS DE OPERACIÓN EN EFECTIVO	0	40.000.000	40.000.000	15%
TOTAL PROYECTO	**225.000.000**	**40.000.000**	**265.000.000**	**100%**
% (Por Fuente de Financiamiento)	85%	15%	100%	

A.7. Summary budget of our approved MECESUP grant AUS0807 (2009-2011; Director: A. Yañez, Instituto de Bioquímica); Deputy Director: R. Nespolo),which was recently approved. The Li-Cor DNA analysis system and the qPCR equipment are listed in rows 1. and 3. Those equipments will be part of a “core facility” for the Faculty. However, as the other MECESUP listed in this proposal, this one is for the reinforcement of our PhD students, thus our SISTECOL program will have priority (amounts are in Chilean pesos; one dollar=538 Chilean pesos).

BIENES

Descripción	Cantidad	Costo unitario	Costo Total	MeceSup			Institución		
				Año 1	Año 2	Total MeceSup	Año 1	Año 2	To In
Tecnologías de Información y Comunicaciones (TIC`s) (5,2,3,2)									
1...						0			
2..						0			
3...						0			
Total Tecnologías de Información y Comunicaciones (TIC`s)				0	0	0	0	0	
Instrumental Científico Mediano y Mayor (5,2,3,4)									
1..Sistema de Análisis de DNA tipo Li-cor, 4300s.				62000000		62.000.000			
2. Sistema generador de imágenes por fluorescencias IR, tipo Li-cor, modelo odyssey				50000000		50.000.000			
3. PCR Cuantitativo.				45.000.000		45.000.000			
4. Servidor Bioinformática HPCC y servidor Proxy				110.000.000		110.000.000			
5..Sistema Maldi TOF				275.000.000		275.000.000			
6. Analizador de ELISA automático tipo Best 2000 MARCA BIOKIT				0		0	70.000.000		
7. HPLC Masa				100.000.000		100.000.000	80.000.000		
Total Instrumental Científico Mediano y Mayor				642.000.000	0	642.000.000	150.000.000	0	
TOTAL BIENES				**642.000.000**	**0**	**642.000.000**	**150.000.000**	**0**	

A.8. Summary budget of our approved MECESUP grant AUS0805 (2009-2011; Director: C. Figueroa; Deputy Director: R. Nespolo), which was recently approved. The three postdocs to be funded are indicated in the lower panel, from rows 1 to 3. Profiles are “evolutionary ecology”, “population genetics” and “evolutionary genomics”. We plan to engage the evolutionary ecologists and the evolutionary genomicist to this project (amounts are in Chilean pesos; one dollar=538 Chilean pesos).

Descripción	Cantidad	Costo Unitario	Costo Total	MeceSup				Institución		
				Año 1	Año 2	Año 3	Total MeceSup	Año 1	Año 2	Año 3
Contratación de Académicos con grado de Doctor (Bases, 5,2,1,1)										
1. Académico(a) con grado Doctor jornada completa en Sistemática Vegetal Molecular	1	57.000	57.000	19.000	19.000	19.000	57.000			
2. Académico(a) con grado Doctor jornada completa en Ecología de Poblaciones y Comunidades	1	57.000	57.000	19.000	19.000	19.000	57.000			
3. Académico(a) con grado Doctor jornada completa en Biología Evolutiva Experimental	1	57.000	57.000	19.000	19.000	19.000	57.000			
Total Contratación Académicos c. grado Doctor		171.000	171.000	57.000	57.000	57.000	171.000	0	0	0
Contratación de Postdoctorados (5,2,1,2)										
1. Investigador postdoctoral en Ecología Evolutiva	1	31.250	31.250	15.625	15.625		31.250			
2. Investigador postdcotoral en Genética de Poblaciones	1	31.250	31.250	15.625	15.625	0	31.250			
3. Investigador postdoctoral en Genómica Evolutiva	1	31.250	31.250	0	15.625	15.625	31.250			
Total Contratación de Postdoctorados		93.750	93.750	31.250	46.875	15.625	93.750	0	0	0
TOTAL CONTRATACIONES				**88.250**	**103.875**	**72.625**	**264.750**	**0**	**0**	**0**

A.9. Valorizations of our laboratories at the Instituto de Ecología y Evolución.

EXISTING MAJOR EQUIPMENT AND INFRASTRUCTURE	Current value	Remaining useful life
	Thousands of US Dollars	Years
TOTAL MAJOR EQUIPMENT AND INFRASTRUCTURE (1+2)	**365**	**12**
(1) Major Equipment Subtotal	**171**	**6**
open flux respirometer for insects	39	6
Nanodrop spectrophotometer	14	7
real time PCR machine Stratagene	32	8
thermalcycler with gradient Eppendorf	9	5
freezer -80°C Jouan	11	8
refrigerated centrifuge Jouan	6	6
vertical laminar flux cabinet Nuare	5	6
thermalcycler with gradient BioRad	5	5
refrigerated incubator 38l Pitec	6	5
refrigerated incubator 38l Pitec	8	7
refrigerated centrifuge Eppendorf (x2)	13	8
other minor equipment	7	5
volage stabilizers (x5)	4	8
microscopes	6	5
computers (x15) and printers (x5)	5	3
ice maker machine	3	6
(2) Infrastructure subtotal	**194**	**6**
Principal investigators offices (4x9 m2)	22	6
DNA lab (30m2)	19	5
Electrophoresis rooms (11m2)	6	5
RNA lab (22m2)	13	7
Ph.D. student offices (36m2)	22	8
Postdoctoral offices (36m2)	22	5
Stoves room (15m2)	9	8
Greenhouses (26m2)	15	5
M.Sc. Student offices (18m2)	11	3
Ecophysiology lab (18m2)	11	6
PCR lab (15m2)	9	5
Meeting room (15m2)	9	5
Administrative rooms (20m2)	13	5
Respirometry lab (18m2)	11	5

A.10. Quotation of the Sable Systems BoxFox field respirometer.

A. 11. International support letters.

Sable Systems International, Inc.

6000 S Eastern Ave
Bldg 1
Las Vegas NV 89119
Phone # 702/269-4445 Fax # 702/269-4446
www.sablesys.com

Quotation

Date	Quote No
7/2/2009	2354

Universidad Austral de Chile
Instituto de Ecología y Evolución
Facultad de Ciencias
Casilla 567 - Valdivia
CHILE

Universidad Austral de Chile
Roberto Nespolo Rossi
Instituto de Ecología y Evolución

Valid though	Terms and Conditions:
October 31, 2009	LC or ADV

Quantity	Item	Description	Unit Cost	Total, USD
4	FOXBOX-C	FOXBOX-C Field Oxygen & Carbon Dioxide Analysis system with pressure compensated fuel cell oxygen sensor and integrated mass flow system; with serial and analog outputs; analog output range is 0-5V, corresponding to 0-100% or 0-25% oxygen; resolution better than +/-0.001% O2, ,+/-0.001% CO2; includes two thermistor temperature probes, FOXUP software, serial data cable and power supply	10,995.00	43,980.00
	Ship	Shipping and Insurance,	650.00	650.00
		Total for FOXBOX		44,630.00
		Recommended item		
4	RH-300	RH-300 Relative humidity/Dewpoint meter with serial and analog outputs, dewpoint range -40C to condensation point, RH range 0.2% to 100%	1,885.00	7,540.00
	Ship	additional shipping if shipped with the FOXBOX	50.00	50.00
		Total for RH300		7,590.00
	Lead time	Estimated lead time after receipt of a confirmed purchase order is ten weeks or sooner.		
	Terms-LC	Payment terms are payment in advance or payment via a confirmed irrevocable Letter of Credit payable through a US bank. See last page for our other terms & conditions of sale and our warranty.		
	INCOTERM	INCOTERM as Defined by INCOTERM 2000 is DDU Valdivia		
	Destination Cont...	These commodities, technologies or software are offered for sale to the purchaser & country named above in accordance with United States Export Administration Regulations. Diversion contrary to U.S. law prohibited.		

	Total, USD	$52,220.00

Barbara Joos
Joos@sablesys.com

A.11. Suport letters

UNIVERSITY OF BIAŁYSTOK
Institute of Biology

ul. Świerkowa 20 B, 15-950 Białystok
POLAND
tel./fax: (+48) 85 745 73 02

29 June 2009

To whom it may concern

I hereby confirm that I am willing to act as a collaborator in the proposed Anillos Research Project entitled *Evolution of endothermy: squeezing the vertebrate tree*, directed by Dr. Roberto Nespolo. I understand that the role of my team in this collaboration will be to provide space in animal rooms for maintaining shrews, provide laboratory space for metabolic measurements, organize the animals trappings, serve with my experience in metabolic measurements, arrange the permits from Local Bioethical Committee and the Polish Ministry of Environmental Resources necessary to perform the project in Poland. We are looking forward to be able to participate in the program, and are confident that we can make a positive contribution.

Sincerely,

Jan R.E. Taylor
PhD DSc
Associate Professor

phone: (85) 745 73 21
fax. (85) 745 73 02
e-mail: taylor@uwb.edu.pl

Institute of Environmental Sciences
Jagiellonian University
ul. Gronostajowa 7
30-387 Kraków, Poland

July 3, 2009

Dr Roberto Nespolo
Instituto de Ecologia y Evolucion,
Universidad Austral de Chile

I hereby confirm that I am willing to act as a collaborator in your proposed Anillos Research Project entitled *Studying the evolutionary origin of endothermy in birds and mammals*. I understand that the role of my team in this collaboration will be to provide space in animal rooms for maintaining the animals, provide laboratory space for metabolic measurements on the animals, organize the animals trappings, and arrange for the permits from Local Bioethical Committee and the Polish Ministry of Environmental Resources necessary to perform the project in Poland. As this project concerns questions that are also in the center of the research interests of my team, we are looking forward to be able to participate in this very promising program, and are confident that we can make a positive contribution.

Sincerely,

Koteja

Paweł Koteja, PhD
Professor

phone.: (12) 664 5209
fax. (12) 664 6912
e-mail: pawel.koteja@uj.edu.pl

26 June 2009

Dr. Leonardo D Bacigalupe
Departamento de Zoologia
Facultad de Ciencias Naturales y Oceanograficas
Universidad de Concepcion
Barrio Universitario s/n
Casilla 160-C
Concepcion, Chile

Dear Dr Bacigalupe,

RE: Endothermy project

Thank you for inviting me to participate in your proposed research program titled *SQUEEZING THE VERTEBRATE TREE TO DISENTANGLE THE EVOLUTION OF ENDOTHERMY IN BIRDS AND MAMMALS*. I have read your project proposal and fully support its objectives and methods. In respect of the rock elephant shrew *Elephantulus myurus*, I am able to confirm that I will be able to offer laboratory space, holding facilities and research animals. In respect of *Tenrec ecaudatus*, I will be able to offer research animals on a 24h basis, and limited facilities, at my research site in Ankarafantsika, Madagascar.

I trust that you are successful with your application.

Yours sincerely,

Professor Barry Lovegrove

School of Biological and Conservation Sciences (Pietermaritzburg Campus)
Postal Address: Private Bag X01, Scottsville, 3209 South Africa
Telephone: +27 (0)33 260 5104 Facsimile: +27 (0)33 260 5105 Email: sbcs@ukzn.ac.za Website: http://www.ukzn.ac.za/biology
Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

Associate Professor Stewart Nicol
Physiological Ecology
Private Bag 5 Hobart
Tasmania Australia 7001
Telephone (03) 6226 2655
Facsimile (03) 6226 2745

UTAS
FACULTY OF SCIENCE, ENGINEERING & TECHNOLOGY
School of Zoology

Dr Leonardo Bacigalupe
Universidad de Concepcion

29 June 2009

Dear Leonardo,

Thank you for giving me the opportunity to participate in the Anillos Research Project "Evolution of endothermy: squeezing the vertebrate tree" directed by Dr. Roberto Nespolo. I have discussed your proposal in some depth with my colleague Professor Peter Frappell, and we are happy to offer you our full cooperation in making this a successful project. While we will need to discuss the detail of what equipment you provide and what we will provide, you will have access to our facilities and equipment. I will handle all details with respect to permits for use of animals in Tasmania. I look forward to a stimulating and rewarding collaboration.