"*Enicognathus ferrugineus* (Aves, Psittacidae) dietary, reproductive and habitat selection aspects in *Araucaria araucana* forests."

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Title of Application: "*Enicognathus ferrugineus* (Aves, Psittacidae) dietary, reproductive and habitat selection aspects in *Araucaria araucana* forests."

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PROJECT OBJECTIVES

The aim of this long-term project is to elucidate how *Araucaria araucana* forest operates as a complex and unique environment on which a wide variety of cavity nesters depend. Although in the last 30 years 64% of these forests have been eliminated and the remaining forest has been highly fragmented, they have never been subject to systematic faunal surveys. One of the most representative endemic cavity nesters is the Austral Parakeet, whose distribution will be surely diminished due to *Araucaria* conservation problems. This work will allow us to propose management guidelines and recommendations to government agencies.

Fulfilment of the objectives

The project objectives were thoroughly fulfilled. With support from The Rufford Foundation (through the present funds, RSG) we were able to obtain convincing preliminary results regarding cavities availability in araucaria forests, austral parakeet cavity selection for nesting, breeding behaviour and diet.

Background information

Araucaria araucana forest, a unique and relict forest with restricted distribution, presents a wide variety of conservation problems caused mainly by human actions, which affects its entire fauna community.

This study is the first step of a long-term study with the aim of having a better knowledge about Araucarias, its bird community and mainly its cavity nesters, a group that is especially likely to be sensitive to forest changes. Why cavity nesters? They are good estimators about forest "health" as suitable habitat. Cavity availability is a major factor to study in order to evaluate conservation risks of cavity nesters and, in this particular case; almost all resident and endemic birds of these forests are cavity nesters.

Furthermore, one of the most emblematic secondary cavity nester is the endemic Austral Parakeet, *Enicognathus ferrugineus*, the southernmost distributed psittacid of the world. This parakeet may be used as key species to evaluate Araucaria forest as a suitable ambient for cavity nesters by understanding their habitat requirements. That its distribution is linked to this threatened habitat shows its vulnerability. Its biology, ecology and population status are largely unknown, highlighting the importance of understanding ecological and reproductive requirements in Araucaria forest.

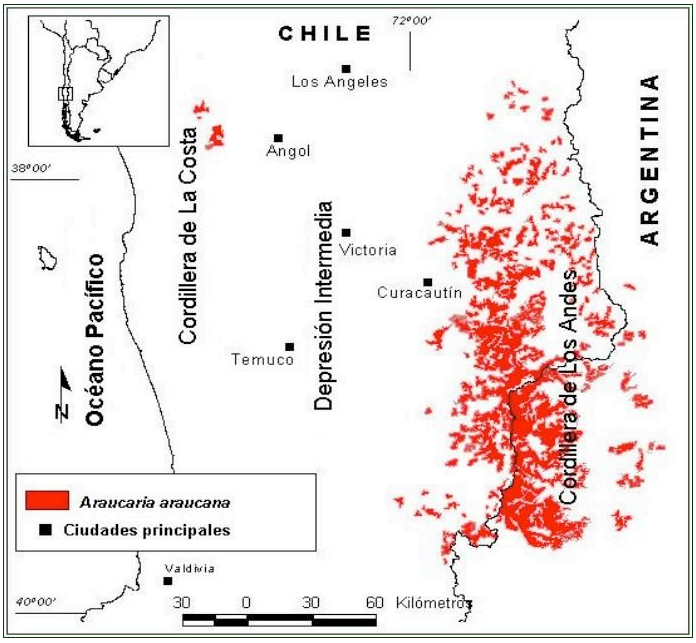
Austral Parakeet is one of the biggest cavity nesters inhabiting araucaria forest. I choose it as key specie for this environment because is very selective regarding food (Diaz & Kitzberger 2006) and cavities (Diaz, unpublished data) features to nest. These two aspects are primarily utilized to detect habitat use and selection by these parakeets,

as food selection concerns species diversity and availability, and suitable cavities concern the presence of special features on individual trees and their selection.

On the other hand, Araucarias produce big quantities of pollen and seeds, both known to be eaten by Austral parakeet (Shepherd et al, 2008). But this may change over the years, because araucarias have a special characteristic regarding seed production: some years they produce little amounts and some others they produce lots of seed. This is called *masting* (Sanguinetti & Kitzberger 2008). These masting years vs. low production years may affect Austral Parakeets in different aspects of food searching, nest location, brood size, brood exit, etc.

Austral Parakeet presents trade problems involved local communities (see Diario el Cordillerano and Ecos del Parque reports). That way, we create an Environment Education Program based on ambient interpretation as conservation strategy. This is a key aspect to guarantee sustainable use of the forest by tourists and local people, mostly from Mapuche indigenous communities.

STUDY AREA



Fuente: Laboratorio de SIG, Instituto de SIlvicultura, UACh.

Fig. 1:
Location of study site in Lanin National Park, Lanin Volcano northern forests (S 39º 35.322´ W 71º 25.762´, 1156 m.s.n.m.), 90 km from the closest argentine city, Junin de los Andes, Neuquen Province.

Red areas indicates Austral Parakeet distribution, along temperate forests in both sides of Patagonia Andes.

Study area is a glacial valley that has been modified along the years by historic fire events mainly from lightning and volcanism, resulting in different-aged stands found in a patchy distribution. Stands vary form mono-specific and old lenga forest (*Nothofagus pumilio*) in the higher slopes to mix forest of lenga and *Araucaria araucana* and some small areas with other *Nothofagus* (*N. dombeyi, N. antarctica, N. obliqua, N. Alpina),* with under forest dominated by *Alstroemeria aurea* and *Berberis serrato-dentata*. Lengas varies between 10-20 m high, and 40-120 cm of diameter, and bare many holes (natural ones or excavated by woodpeckers) used by Austral Parakeets.

Araucaria varies between 15-30 m high, and 30-300 cm of diameter. Apparently, araucarias don't bare as many holes as lengas, and they tend not to rot as much as *Nothofagus*. On the other hand, araucarias can produce big amounts of big seeds (± 5 cm long) that are fed by different species of mammals and birds (Gonzales et al 2007, Shepherd et al 2008).

METHODS

During autumn, winter and spring 2008 I visited the forest and made daily surveys on population size, feeding behaviour and flocks movements and use of habitat.

Before reproductive season starts, I started living in the field with one assistant and three volunteers that help me with surveys. We worked almost 20 days each month, from November 2008 to march 2009 (85 days in total). Occasional help was provided by foreign volunteers of GVI (Global Vision International). Main daily tasks were walking along the forest making observations about habitat use (different behaviours of flocks over the trees or bushes), dietary behaviour and selection, cavities surveys, nest searching and breeding behaviour (nestlings phenology).

Cavities availability and Nest selectivity

To understand if parakeets select particular characteristics of nesting trees, plots of 24 m of diameter were randomly placed. Trees of more than 28 cm of diameter at breast height (DBH) were identified and DBH measured (established as two cm smaller than the smallest founded nest). Species identifications were made directly in the field. Only snags (standing dead trees) of more than 28 cm DBH with holes were counted and DBH measured. We marked every tree of the plot with at least one hole with particular features (entrance more than 4 x 6 cm, cavity with more than 5 cm of depth and 25 cm of internal diameter. Data obtained from 44 natural nests, as minimal requirements for the specie). Cavities were inspected with a camera system to know if it was a nest or not (only cavities with eggs or nestlings were defined as nests). That way, **cavity availability** for breeding was calculated as number of suitable cavities/number of total trees surveyed. For every tree bearing a hole or nest, the following measures were made: cavity features (entrance high and width, depth, external and internal diameter at nest height), DBH of the tree, specie, tree high and canopy size, and **selectivity** analyses were performed.

Breeding

Nest searching was made mainly at two times: 1) during November (pre-reproductive season couples clean, modify and defend cavities they will use for reproduction, and we can search for this kind of behaviour to find nests) and 2) February (nestlings are hatched and begging can be heard from a distance after and before alimentary sessions, over 4-5 times a day). After we find a new nest, cavities were inspected with a camera system attached to an extensible pole of 8 m. Only cavities with eggs or nestlings were defined as **nests**. Nests were visited every 15 days and number of eggs and nestlings were registered. Internal shape of all nests made it impossible to access the cavities, such that, I could not obtain eggs and nestlings measures.

Diet.

Eighteen 200 m long transects were established, at least 150 m apart one from each other. 20 Plots of 1 x1 m were placed along transects. Twice a month I registered the number of plants per species and their vegetative structure changes (buds, seeds, flowers and seeds or fruits) as a percentage per plant, along the seasons.

Particularly for araucaria, we quantify pollen and seed production. For that, we made male cone counts (structure bearing pollen) during spring and female cone counts (structure bearing seeds) during summer. Previous data about this forest seed production was obtained from Lanin National Park.

Feeding events were registered along the seasons and along the forest. Several data were obtained from each observation: number of parakeets eating, item and species they fed on, feeding bout length (initial and final time) and location (GPS point).

RESULTS:

Cavities availability and Nest selectivity

Cavity availability survey was harder than planned, requiring intense long working days to properly complete the datasheets. We successfully complete 18 plots, which is enough to have a preliminary view regarding cavities availability in these forests, but not enough to understand cavity selection of austral parakeets or other cavity nesters. Future plans will determine cavities, nest tree and nest plot features that austral parakeet and other cavity nesters select for nesting.

Nesting *cavities* availability was higher on lenga trees (n=1492) than in araucaria trees (n=1140) (Fig. 1). Moreover, every lenga provided over 5 to 7 *holes*, but araucaria only provided 1-2 *hole. Holes* are different from *cavities* as *holes* are EVERY hole in the tree, and *cavities* only the one suitable for nesting.

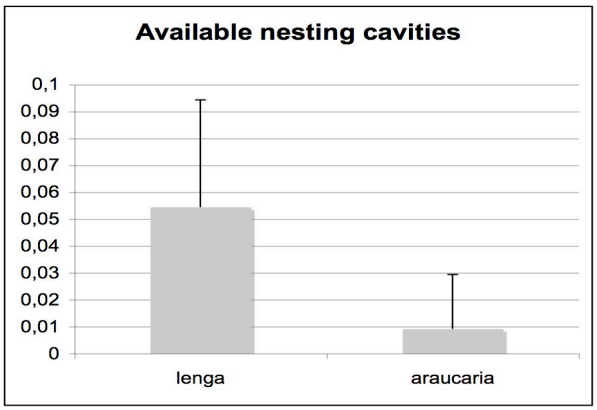


Fig. 1: available nesting cavities over the field area (performed for 18 plots).

Through March 2008, we found 44 austral parakeet nests. This brings us a preliminary idea about cavity, nest tree and nest plot characteristics selected by austral parakeets used for nesting. On the other hand, a higher nest number is required to understand austral parakeets nesting preferences in different levels. For this I intend to

find more nests during the next breeding season, which will allow me to do finest statistical analysis on selectivity.

From the 44 nests studied, 31 were old woodpecker nests and 13 were natural holes, and 36 were located on principal trunk of the tree but only 8 in secondary trunks. Almost all nests were in or surrounded by lengas (Fig 2), and they were not selected by their canopy size or diameter (Fig 3 and 4), but nests tend to be on bigger trees regarding both characteristics. No differences were found between nest (DBH) and nest tree (DNS) diameter (Fig 4) but give us the tree diameter class of size they select to nest. Finally, hole entrance measures show an elliptical shape on most of the nests (width: 60 ± 20 mm, height: 116 ± 44 mm, n=29), and contrary to what I thought, there were selected also big holes (as new woodpecker abandoned holes). This assumption was made from the knowledge that big cavity entrance (bigger than the external thoracic "diameter" of the bird) has higher probabilities of predation than smaller ones. They may be avoiding predation by tending to select deep cavities (43, 38 ± 25,93 mm, n=18).

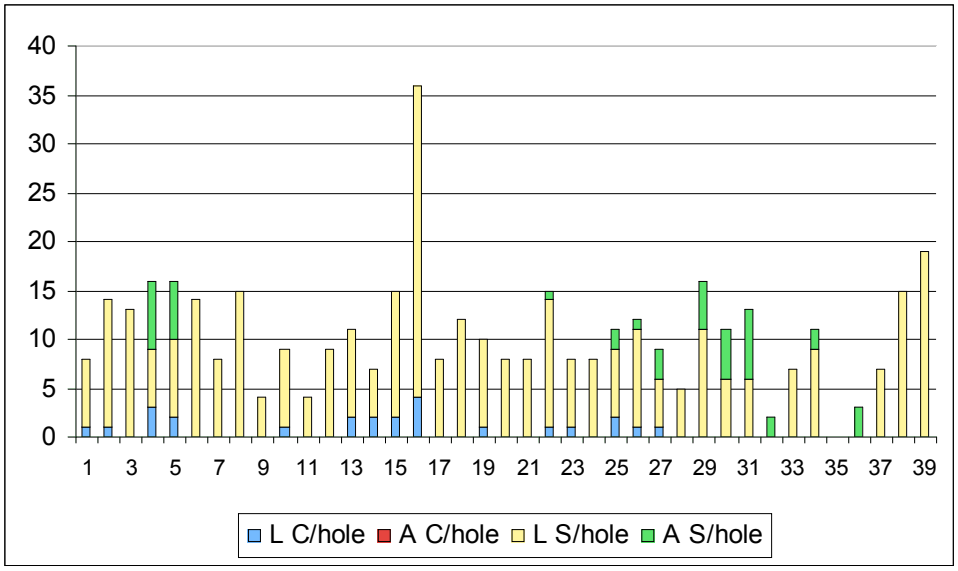


Fig. 2: number of lengas (L) and araucarias (A) with (C) and without (S) holes on each of the **nest** plots. (Each number on the horizontal axis is ONE nest plot)

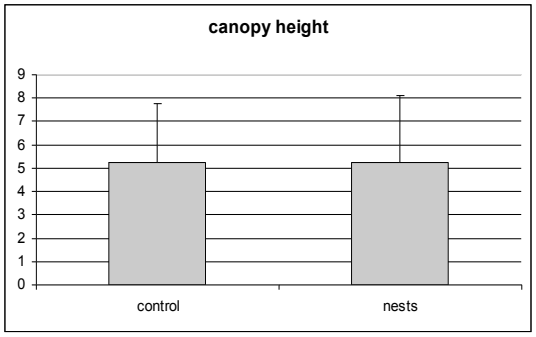


Fig. 3: Canopy height (difference between nest tree height and lowest branch height, n=38) of control trees (trees with holes and no nests) and nests trees.

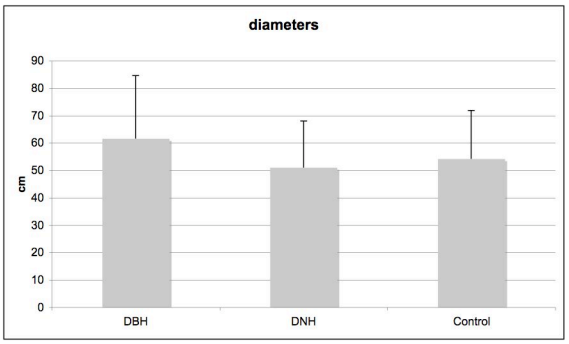


Fig. 4: Diameter at **B**rest **H**eight (DBH, n=44), **D**iameter at **N**est **H**eight (DNH, n= 22) and Control Diameter (trees with holes and no nests, n=44).

Breeding

Preliminary data from 2008 reproductive season is presented in this report, as its revelations were the trigger for this project. That way, I can use 2008 data to compare it with 2009 and see some tendencies and to relate it with environmental information. Notice that 2008 number of nests and broods are smaller than 2009, because they were not the aim of my research at that time.

Analyzing 44 nests, we notice a big tendency of bigger brood size in 2009 with almost 90% of survivorship between egg and nestling stages (Fig. 6). This could be in response to diminishing population (see *UNFORESEEN EVENTS* #1**)** and will be measured and followed in future surveys (breeding season 2009-10). We also followed 20 broods (not all the 44 nests were suitable to see eggs and nestlings), being ALL 100% successful (there were no detections of brood failure). Nestling survival was higher in 2009, but areas with araucaria show more variation (Fig. 7). Therefore, areas without araucarias (with no variation) may be more stable for nestling, and they may be more selected, as they are areas with higher available holes and cavities (Fig 1). A higher number of nests are required to assess this assumption.

An important highlight is that ALL austral parakeet population of Lanin forest of 2008-09 reproductive season bred, which is an exceptional case for this species (it is quite common to see non-reproductive individuals over the summer, but this year was not the case).

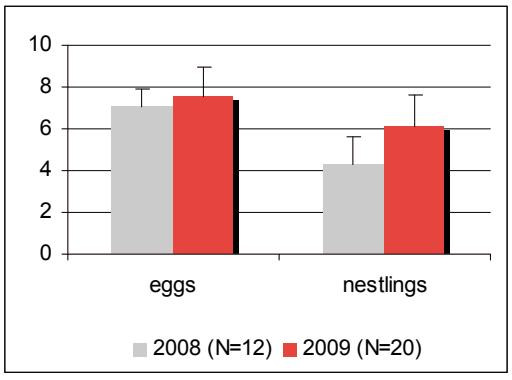


Fig 5: number of eggs and nestlings.

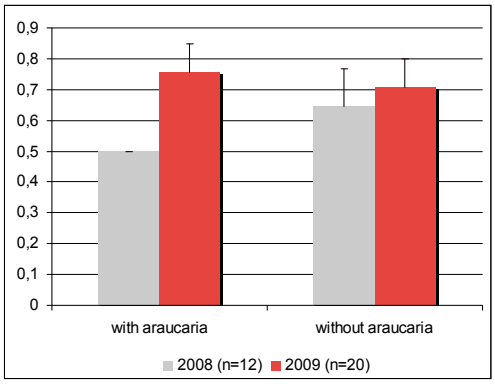


Fig 6: nestling survival between years.

Diet

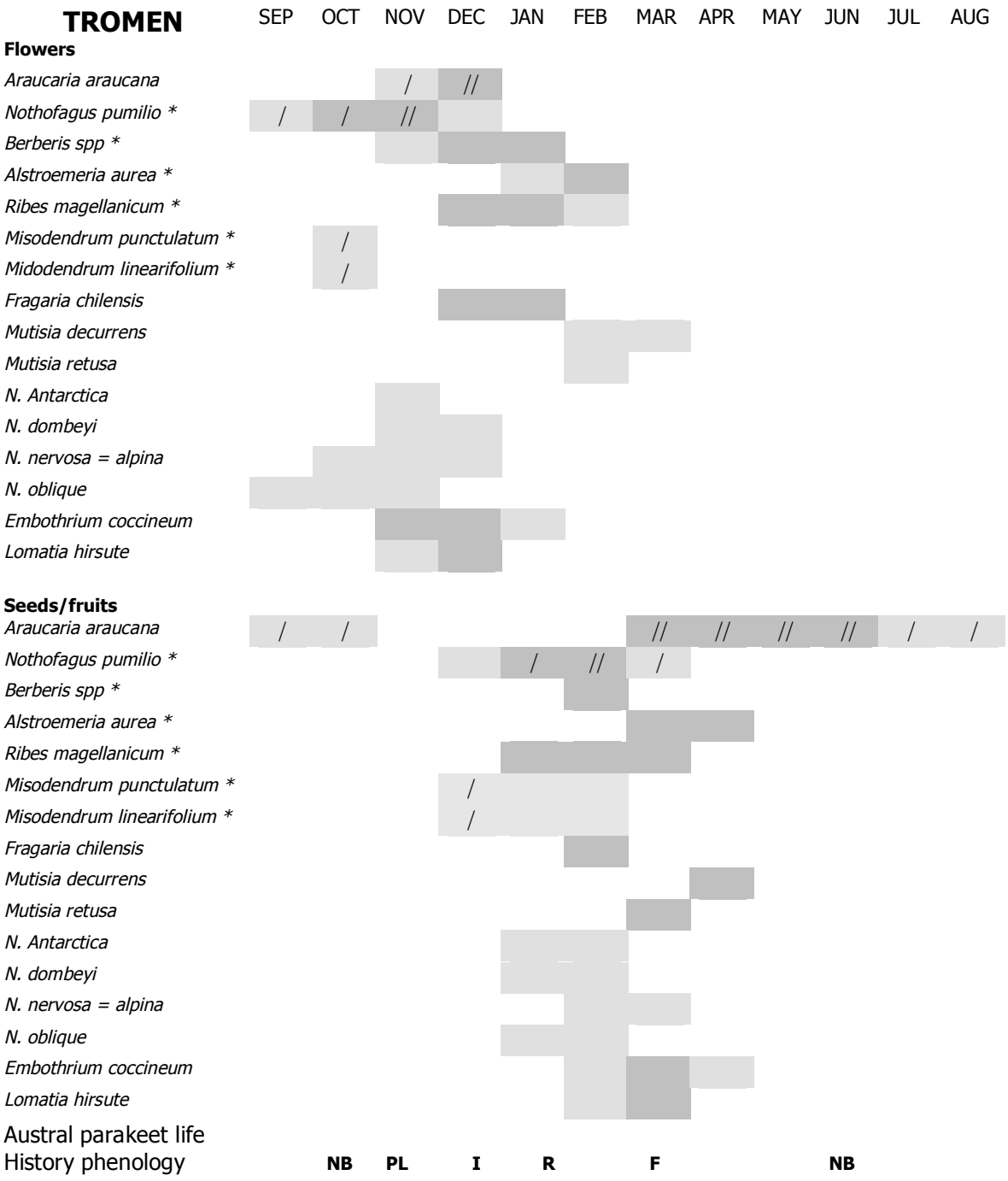


Table 1: Availability and use of food items: (Grey bars) common; (black bars) abundant; (/) occasional use, and (//) heavy use. Bottom line shows temporal relationship of diet composition with parakeet's life history phenology. PL, prelaying (courtship, copulations, hole prospection, nest conditioning); I, egg laying and incubation; R, brood-rearing period; F, fledging; NB, non-breeding period.

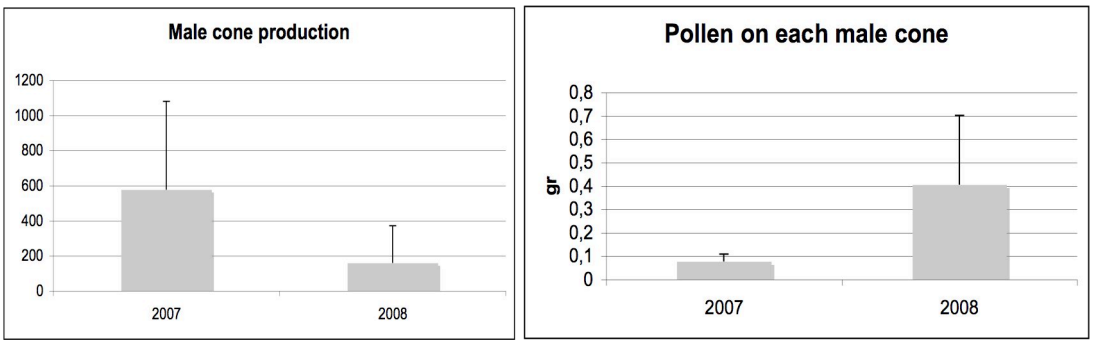


Fig. 7 and 8: average number of male cone production (number of cones per tree) and pollen production (per cone) between years.

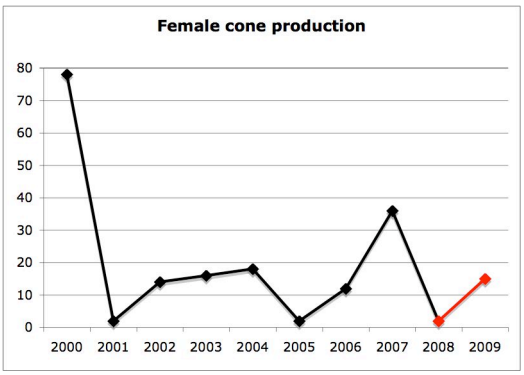


Fig 9: female cone production from the last decade. In red data from the present study, in black data from Lanin National Park.

Dietary data survey was successfully completed in araucaria forests, showing that austral parakeets are temporal specialist birds, with high protein requirements in spring (araucaria and lenga pollen) and carbohydrates all year round (araucaria and lenga seeds)(data obtained from 217 feeding bouts on 438 hours on the field, Table 1).

Austral parakeets use the phenology displacement between lenga and araucaria to fill all the gaps from one dietary item to another, in this way, maximizing their high quality diet. Pollen consumption is high during spring and is the main food supply in pre-reproductive season. How do they use pollen? In a previous study (Díaz & Kitzberger, 2006), I analyzed **lenga** pollen digestibility, and is the highest known from a psittacid (and other birds and mammals). **Araucaria** pollen digestibility will be analyzed this winter.

Araucaria seeds are the most important item of their diet, being used almost all year round. Araucaria Male cone production was higher in 2007 but pollen production was lower than 2008 (Fig. 7 and 8). This inverse tendency may be product of a different viable pollen production that can be compensating both values. This will be analyzed (laboratory tests) this winter.

Figure 9 shows araucaria female cone production from the last decade: several years of high production (*masting*) followed by years of lower seed production. This study is developing in years of low-medium seed production. 2010 is expected to be a masting year.

Was quite astounding to see an important but rare behaviour in psittacids: larvae consumption in pre-reproductive season was very high and diverse (in araucaria male cones and lenga leave gall) and occasional in post-reproductive season (in lenga seed

galls). This behaviour was observed before only on Brazilian parakeets (Martuscelli 1994) and in some New Zealand and Australian parakeets such as keas, rosellas and cockatoos, but only casual observations can be found on literature (Moojen et al. 194, Forshaw 1989, Sazima 1989)

UNFORESEEN EVENTS

1- *Population dynamics*: during winter season I made short daily visits to the study area, to assess flock presence and size in the forest, and cavities utilization. This was complemented with park rangers' observations within the study area (they made an accurate record of flock habitat use). As last summer and autumn were extremely dry, there was not food available in the forest during winter. This, added to last winter's harshness, flocks were obligated to migrate locally to eastern areas searching for extra food sources and refuge. I only had the chance to see a few individuals in the forest during winter. In the beginning of breeding season (November) 2008-09, austral parakeet population show high decrease (about 60%) associated to food scarcity in 2008 or lower return rate of parakeets to this area. This will be tested on future breeding seasons with different araucaria seed production.

2- In March 2009 we had a big fire in Tromen area, surrounding the study area, of almost 3000 ha. Mainly affecting ñire (*Nothofagus antarctica*), shrubs and grassland, but also high forests of araucaria, lenga and cipres (*Austrocedrus chilensis*). This fire could have a major affect on austral parakeet population under study, as this is an important area that they use during pre-reproductive season as extra-food supply when lenga has a low productive year. Future studies will determine if this fire affect the population, its diet or local movement-habitat use seasonal patterns.

3- 2009 dryness will determine an important masting event on araucaria population for 2010 (Sanguinetti, pers. comm.). This may be reflected in an "understanding" by parakeets about forest dynamic, expressed as a successfully 2010 reproductive season, with higher active and successful nests. Future studies will determine if this event affect Tromen austral parakeet population, its reproduction and demography.

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EDUCATIONAL PROJECT and OUTREACH

- I was invited to a special program on El Arka radio, talking about the Project, austral parakeets and their conservation risks. Also I got the chance to transmit newly obtained data on reproduction and ecology of austral parakeets in PsittaScene magazine (World Parrot Trust, international magazine) and Desde la Patagonia Difundiendo Saberes (Universidad Nacional del Comahue, magazine distributed in argentine Patagonia).
- Educational lectures were done in 3 schools of San Carlos de Bariloche, reaching 517 children between 6 and 10 years old, with Nationals Parks Administration and Centro Regional Universitario Bariloche support. Gratefully, Lanin Educational Environment Department and Aves Patagonicas ONG´s teachers of San Martin de los Andes participate in the Educative Project, developing lectures for 120 children. When the lecture was finished, we distribute stickers to all children, designed with an Austral parakeet conservation message.
- Additionally, San Martín de los Andes city council gave the Education Project the special honor of "Council Interest", giving huge importance at educational and conservation level in Neuquen province, as a pioneer to preserve cachañas (local name for Austral parakeet), the icon for araucaria forests.
- During October 2008, within the "world bird month" festivity, I gave a special lecture for general public, distributing stickers to children.
- With Delegación Patagonia de Parques Nacionales support, I designed and distributed 41 educational posters to all information offices of National Parks within austral parakeet distribution. This way, the information reached thousands of tourists that visited all this famous National Parks: Lanin, Nahuel Huapi, Puelo, Los Alerces, Los Glaciares, Perito Moreno y Tierra del Fuego.
- Recently (April 2009), I was invited to do a lecture in Aluminé city (Neuquen province) to speak about araucaria dynamics and relationship with Austral parakeet, within Pehuen festivity, organized by Lanin National Park and Alumine council.
- Finally, I was invited to participate as scientific support in an educational planning linking rural schools and Lanin National Park, that will be start and develop during 2009.

IMPORTANT OUTCOMES OF THE PROJECT.

- Austral parakeets are highly selective regarding reproductive food. Araucaria is the most important species that provides pollen as well as seeds in high amounts, and both are the most important items on austral parakeets diet. This way, National Parks have a new and powerful tool for management in araucaria forests.
- Austral parakeets fed on insects larvae, unusual behaviour rarely seen before on psittacids. This is not anecdotal but very important, understanding that this specialist bird depend largely on one more item given by araucaria and lenga: insects. One more tool for management.
- Information about cavity availability and cavity selection for nesting will allow us to meet our ultimate goal of providing management guidelines to governmental and non-governmental agencies. Basic information about cavity nesters such as austral parakeets is very important for management and conservation plans of National Parks. This will intensify conservation of this valuable habitat by increasing its knowledge and use this information for management, education and conservation for sustainable purposes.
- Local communities benefited from the project as they were the principal targets of the Environment Education program, from posters, public lectures to school special lectures for children. In this way, conservation ideals were presented in several social levels, as they are part of the nationals' parks they live on (Lanin and Nahuel Huapi).

CONCLUSION

Lenga areas and trees are important for austral parakeets as nesting habitat because they bare more holes and suitable cavities shown by selectivity features. Additionally, survival is higher in lengas and shows less variation than araucarias.

On the other hand, araucarias are the main food supply for austral parakeets throughout the year, pollen being important in pre-reproductive season and seed in post-reproductive season and as first food for nestlings before they fly from the nest.

This balance between nesting and dietary requirements in this area let us have an initial idea about how austral parakeets manage to be residents, at least for most of the year. More data is required to assess the assumptions giving in this report, but basic knowledge about habitat and nesting requirements were obtained. Now we will be able to develop conservation activities for this specie and araucaria forests.

The conservation strategy developed from this long-term research may allow austral parakeets to function as umbrella species for conservation of the araucaria ecosystem as a whole. Araucaria forests remnants are patchy and poorly protected, with 1/3 of the population within Argentina (180.000 ha) and 2/3 in Chile (Gonzales, 2007). Only 36 % of argentine araucaria population is protected by one National Park (Lanin N.P.) and Neuquen Province Protected Areas, but no legislation and control effectively works nowadays. Forests patches outside protected areas suffer intensive use pressure by cattle, logging, firewood and seed collection, and tourism (this last one also inside protected areas). We hope that the information obtained will stimulate National Park Administration, Provinces Government Agencies and private land owners to promote

strong new legislation for sustainable forest management, and to implement new and existing forest management legislation.

TIMESCALE

I receive the grant in March 2008 and started to use it briefly during winter but mostly during austral parakeets reproductive season (November 2008 to march 2009). This grant was a big help to achieve general goals of the project. The project will be continued for two more years to obtain sufficient amount of data that allows us to understand the ecology of austral parakeets and cavity nesters in this changing and extreme environment: araucaria forest.

BUDGET:

Equipment			
Concept	**Organization**	**Budget = £ 4634**	**Expediture £= 4634 (£=5.4 $)**
Digital recording system and wireless camera for austral parakeet nests behaviour surveys.	Rufford	176 £	195
3 pairs of snowshoes for autumn and winter fieldwork.	Rufford	270 £	------
Winters thermal wear for outdoors work under extreme weather conditions: Duvet vest and Gore-Tex pant and jacket.	Rufford	450 £	350
Travel Costs (*)			
Concept	**Organization**	**Cost**	
Transport to the Study area (fuel and bus)	Rufford	622.9 £	630
Transport in the Study Area	PNL	Not mesurable	Not mesurable
Fieldwork expenses			
Concept	**Organization**	**Cost**	
Temporal hosting (+)	PNL, ICE	Not measurable	Not measurable
Food and Hosting (^)	Rufford	1428.8 £	1708
Personal			
Concept	**Organization**	**Cost**	
Fieldwork assistants salary (#)	Rufford	1265 £	1515
Main Researcher salary	CONICET		
Others			
Concept	**Organization**	**Cost**	
Discretionary/contingency (10%)	Rufford	421 £	236

Total expenditure differ slightly between the time I request the grant and I finally got it because of changes in local economy and big raises of local prices. As field assistant and volunteers were very necessary to obtain reliable data, I decided to expend some more money on their expenses (as lodging, transportation and food) and not in personal gear and snowshoes. Snowshoes were not necessary this year because of the big amount of snow we had in winter followed by strong freezing night. That way it was quite easy to do winter survey without this equipment. Park rangers helped me with winter surveys and they let me use their personal snowshoes when needed.

NEXT STEPS

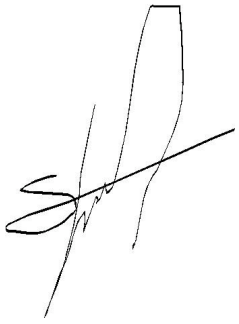
FUTURE PLANS

- To continue with this long-term study about Austral Parakeet ecology in Araucaria forests, focusing on cavity suitability and selection on special features to nesting.
- To continue with Austral Parakeet breeding biology study, focusing on the effects of araucaria masting on brood size and exit. Next year is a masting year, that way I expect a different survival rate and number of nests on the field.
- To continue with educational project in schools of Bariloche and San Martin de los Andes, trying to add rural schools close to field survey (Lanin) area.
- To continue with the Educational Program to enhance local and tourist knowledge on temperate birds forest and mainly on cavity nesters and endemic species, as the Austral Parakeet.
- I will present the results obtained with this RSG in the International Ornithological Congress (Brazil, 2010) and the next Meeting of the Ornithological Meeting of Argentina (June 2009) with the following lecture:
- Public lectures will be made along Patagonia regarding temperate forest avian ecology and specially cavity nesters.
- We will also submit the following manuscript to an international scientific journal: “Austral Parakeet (*Enicognathus ferrugineus*) dietary patterns and habitat use in an Araucaria (*Araucaria araucana*) forest.”

Funding by RSG was and will be acknowledged in each presentation. I used the **logo** in schools lectures regarding Educational Program in San Carlos de Bariloche and San Martin de los Andes. I also used it in the educational posters sent to all Patagonia National Parks, because some of that information came from the project funded by this grant. I will use the logo in Argentine Ornithological Meeting lecture in June 2009.

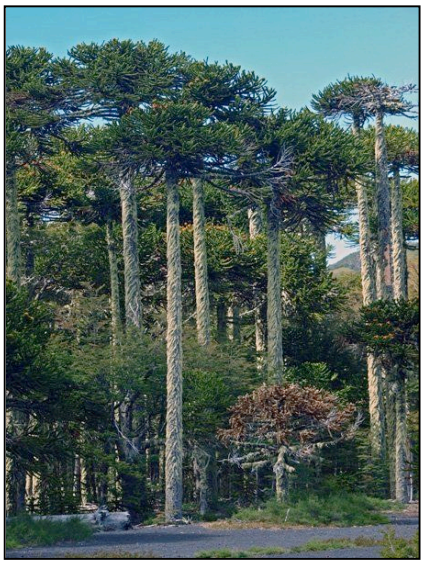
This report contains results of the data collected in the period March 2008-March 2009. We plan to continue our studies on austral parakeets ecology in araucaria forests; particularly we aim to collect more data about habitat use, habitat and cavity preferences and populations dynamics. Our study intends to evaluate mid- and long-term effects of araucaria dynamics (mostly on changing annual seed production) mainly through the continuation of the fieldwork already under course. We will be able to present a more complete set of analysis and more robust results in 2010.

I AGREE TO THIS REPORT BEING PUBLISHED ON THE RUFFORD SMALL GRANTS WEBSITE



Lic. Soledad Díaz
Austral parakeets Project Leader

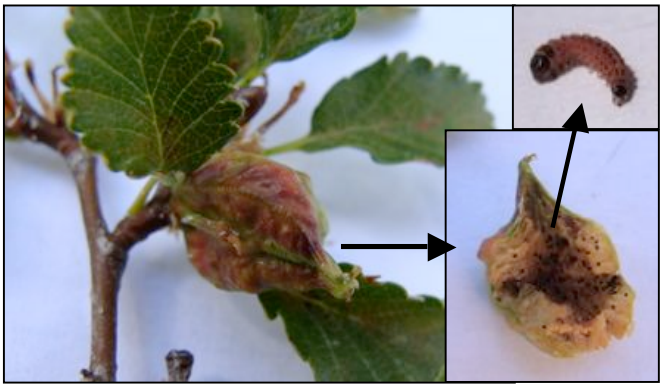
Austral Parakeet



Araucaria araucana forest

Austral parakeet nests.

Cavity survey and nestlings seen by wireless camera system.



Nothofagus pumilio seed gall.

Nothofagus pumilio leave gall.

Educational Program.