

# **Rufford Booster Grant**

## **Final Report (January 2007- April 2008)**

### **Regeneration mechanisms of the two most important arboreal species in Semiarid Chaco Forest in Argentina: shrub facilitation in a domestic livestock grazing gradient**

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#### **Executive Summary**

During the first phase of the project (1st and 2nd RSG) I established that the two most important tree species in semiarid Chaco forest, quebracho blanco (*Aspidosperma quebracho-blanco*) and quebracho colorado (*Schinopsis lorentzii*), have low regeneration rates independent of forest use: on average, fewer than three seedlings per 100 m<sup>2</sup>. This result begs the question: what proximate factors affect regeneration mechanisms in these species?

Objective: Here, my main objective was to investigate (a) whether shrubs acting as “nurse plants” might facilitate the establishment and survival of seedlings of both quebracho species, and (b) how one of the most common land uses (cattle grazing) affects the regeneration process.

Results: Through a study unprecedented for semiarid Chaco I established that regeneration of quebracho colorado was again very low across all experimental and non-experimental treatments. Only 257 of 6000 (4.3%) of experimentally sown chaco quebracho seeds germinated. Germination and seedling survival rates were higher under moderate shade provided by shade cloth than under either the full shade of shrubs or full sunlight. They were also higher within livestock enclosures than outside them, where cattle and goats roamed, suggesting that the presence of domestic livestock has a negative effect on the regeneration of this valuable and highly threatened species. Finally, germination and seedling survival rates also increased inside cages that excluded small herbivores. Evidently, then, seed predation and seedling herbivory depress even further the naturally low rates of quebracho colorado

regeneration. Even in ideal conditions (i.e., without livestock, without small herbivores and with moderate shade), regeneration rates (n° of seedlings) hovered around 10%.

These results apply directly to future management plans of Copo National Park, suggesting that stronger efforts should be made to reduce livestock presence and thereby to enhance regeneration of quebracho Colorado, an exceedingly valuable and overexploited timber species.

Parallel studies on the other key species, quebracho blanco, could not be completed because of massive mortality of quebracho blanco seeds following unusually heavy rains. These studies will be performed during next year's fruiting period.

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## I. PROJECT OBJECTIVES

Our main objective was to investigate whether shrubs might facilitate the establishment and survival of seedlings of both quebracho species, and how one of the most common land uses (cattle grazing) affects the process.

### **Fulfillment of the objectives**

The project objectives were abundantly fulfilled. With support from The Rufford Foundation (through the present funds, RSG Booster Grant) we were able to obtain convincing results using an unprecedented experimental study on the natural regeneration of the two key tree species of the semiarid Chaco forest.

Long-term plans proposed in the August 2006 application to RSG Booster Grant are being achieved satisfactorily:

As regards University Teaching, I still teach both the Experimental Design and the Statistics courses, for students in the careers of Biology, Agricultural Engineering and Engineering in Natural Resources and Environment. Besides, Lic. Carlos Trucco, RSG winner, and I have been invited to dictate jointly a degree course at the Litoral National University, Argentina. At the post-graduate level, I teach courses in two subjects: Master's in Environmental Management at the Catholic University of Salta, and Master's in Sustainable Tourism at National University of Salta. Finally, the National Parks agency of Colombia invited me to teach a post-graduate course for national parks professionals, which was successfully accomplished in October 2007.

As regards Formation of Human Resources, at this moment I am the director of two degree theses in Biology and co-director of three theses in Agricultural Engineering at the National University of Salta.

As regards Research and my professional formation, I took part in directing three research projects (III.1), and I am presently finishing my postdoctoral fellowship. I have been selected to be incorporated in the Career of Scientific Researchers of CONICET, effective on June 1, 2008. Finally, in relation to capacity building and outreach our team has provided a training workshop for forest rangers, teachers and students from the surroundings of Copo National Park, and we have given presentations at schools in the city of Salta in the context of the V National Week of Science and Technology.

## II. PARTICIPANTS

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| <b>PARTICIPANTS</b> | <b>PROJECT INVOLVEMENT</b> | <b>INSTITUTION</b>  |
|---------------------|----------------------------|---|
| Dr. Andrés Tálamo   | <b>Leader</b>              | Post-doctoral Fellow, CONICET.<br>Assistant Professor of Experimental Design, UNSa. |
| Dr. Alicia Barchuk  | <b>Advisor</b>             | PhD in Agricultural Sciences<br>Professor of Agricultural Ecology, UNCó             |
| Federico Mohr       | <b>Research Assistant</b>  | Biology Student, UNSa.  |
| Silvana Cardozo     | <b>Research Assistant</b>  | Biology Student, UNSa.  |
| Carolina Yánez      | <b>Research Assistant</b>  | Biology Student, UNSa.  |
| Gustavo Maras       | <b>Research Assistant</b>  | Biology Student, UNSa.  |
| Ezequiel Tordoya    | <b>Research Assistant</b>  | Biology Student, UNSa.  |

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### III. ACTIVITIES DEVELOPED (January 2007 – April 2008)

#### III.1. RESEARCH ACTIVITIES

##### Publications (on related subjects)

Perovic, P., C. Trucco, A. **Tálamo**, V. Quiroga, D. Ramallo, A. Lacci, A. Baungardner and F. Mohr. 2008. *Technical Guide for Biodiversity Monitoring*. Biodiversity Monitoring Program, Copo National Park, Copo Province Park and Reserve and Buffer Zone. APN/GEF/BIRF.

##### Publications (on other subjects)

Caziani S.M., O. Rocha Olivio, E. Rodríguez Ramírez, M. Romano, E. J. Derlindati, A. **Tálamo**, D. Ricalde, C. Quiroga, J. P. Contreras, M. Valqui and H. Sosa. 2007. *Seasonal distribution, abundance, and nesting of Puna, Andean and Chilean flamingos*. The Condor 109(2): 276-287

##### Publications under revision (on related subjects)

**Tálamo** A., Trucco C.E., Caziani S. (under revision). *Woody vegetation of an abandoned road with presence and absence of livestock in a semiarid Chaco forest sector*. Ecología Austral. MS N° 767

##### Publications in progress related with the research project

**Tálamo** A., Barchuk A., (in progress). *Effects of the exclusion of livestock and of different types of shadow on the germination and growing of quebracho colorado in the semiarid Chaco forest, Argentina*.

**Tálamo** A., Barchuk A., (in progress). *Spatial distribution of quebracho colorado and blanco in two sites experiencing contrasting cattle grazing intensities in semiarid Chaco forest, Argentina*.

##### Publications in progress (on related subjects)

**Tálamo** A., Caziani S.M. *Inventories of woody plants biodiversity in semiarid Argentine Chaco: applying species accumulation functions* (Chapter 3, Doctoral Thesis)

**Tálamo A.**, Caziani S.M. *Alpha, beta and gamma diversity of woody plants in semiarid Chaco forest, Argentina* (Chapter 4, Doctoral Thesis)

**Tálamo A.**, Caziani S.M. *Woody plant composition, diversity and structure in sites with different levels of selective and integral logging in semiarid Chaco: stand scale* (Chapter 5, Doctoral Thesis)

**Tálamo A.**, Caziani S.M. *Regeneration of woody plants in areas with selective logging in semiarid Chaco forest: micro-site scale* (Chapter 6, Doctoral Thesis).

### **Technical reports (on related subjects)**

Perovic P., Trucco C., **Tálamo A.**, Ramallo D., Baumgardner A., Lacci A. Mohr F., Bonduri Y., Quiroga V., 2008. *First biodiversity monitoring of the Copo Conservation Unit. Biodiversity Monitoring Program – Copo National Park, Copo Province Park and Reserve and Buffer Zone.* APN/GEF/BIRF.

### **Congress communications**

Lozano L.B., Ortín P.S., Visuara M., Boldrini C., **Tálamo A.**, Vinocour R. (2007). *Plot production evaluation of nopalito (Opuntia ficus-indica L. (Mill)) introduced in the Lerma Valley, Argentina.* VI International Congress on Cactus Pear and Cochineal. VI General Meeting of FAO-CACTUSNET. October 22-26, 2007.

Ortín P.S., Saravia Arias P., **Tálamo A.**, Lozano L.B., Boldrini C., Vinocour R. (2007). *Evaluation of fruit quality of four ecotypes of yellow and green prickly pear at harvest.* VI International Congress on Cactus Pear and Cochineal. VI General Meeting of FAO-CACTUSNET. October 22-26, 2007.

Ortín P.S., Lera L.A., **Tálamo A.**, Lozano L.B., Boldrini C., Vinocour R., Visuara M. (2007). *Comparison of fruit quality for export of purple and green cactus pear.* VI International Congress on Cactus Pear and Cochineal. VI General Meeting of FAO-CACTUSNET. October 22-26, 2007.

Boldrini C., Gonzales M., Ortín S.P., **Tálamo A.**, Lozano L., Vinocour R. 2007. *Production of grana cochinilla (Dactylopius coccus) in chapped cladodes under semi controlled conditions.* II Latin-American Forum on Mountains. September 11-14, 2007, Tilcara, Jujuy, Argentina.

Trucco C.E., **Tálamo A.** 2006. *Livestock rising and forest use in semiarid Chaco*. Invited presentation in Symposium about the Argentine Chaco in the framework of the XXII Argentine Congress of Ecology. August 22 - 25, 2006. Córdoba, Argentina.

**Tálamo A.**, Caziani S.M., Lopez de Casenave J. 2006. *Regeneration of woody plants in micro-sites created by selective logging in semiarid Chaco forest*. Poster presentation. XXII Argentine Congress of Ecology. August 22 - 25, 2006. Córdoba, Argentina.

### **Participation in research projects**

Director of Research Project: “Patterns and mechanisms of quebracho blanco and colorado regeneration in semiarid Chaco forest”. Project N° 1671. Research Council of National University of Salta. 2008-2010.

Co-director of Research Project “Analysis of the impact of the expansion of the agrarian border in Salta’s Chaco”. Project N° 1647. January 2008 - December 2008. Director: Ing. Pablo Colina.

Co-director of Research Project: “Diversity and habitat disturbances in the western Chaco: plant, mammal and bird communities in sites subject to different use histories”. Project N° 1573. Research Council of National University of Salta. Director. E. J. Derlindati. 2007-2009.

## **III.2. TEACHING AND DEVELOPMENT EXPERIENCE**

### **Post-graduate Teaching**

Responsible Teacher (together with Lic. Carlos Trucco and Alfredo Berduc) of the course “*Introduction to the design of field studies in biology and related fields*”. Organized by IADIZA-CRICYT (Mendoza). To be taught October 6 - 10, 2008. 52 hours.

Instructor of the course “Study Design of Biologic Monitoring in Colombia National Parks”. Taught October 16 - 26, 2007, Iguaque Flora and Fauna Sanctuary, Boyacá Province, Colombia. Technical Sub-direction, National Parks of Colombia.



Teacher of the Module “Environmental Research” of the Master’s in Environmental Management. Business School, Catholic University of Salta. October 8 to 12, 2007.

Teacher of the Subject “Tourism and Natural Assets of the Region”. Subject 5 of the Module 2. Master’s in Sustainable Tourism, Post-graduate School, Natural Sciences Faculty, National University of Salta. September 7 – 8, 2007.

Teacher of the Module “Environmental Research” of the Master’s in Environmental Management. Business School, Catholic University of Salta. June 4 to 8, 2007.

### **Degree Teaching**

Professor of the Course “Introduction to the design of field studies on biology and related fields”. August 30 to September, 2007. Humanities and Sciences Faculty, Litoral National University. Teachers: Andrés Tálamo, Carlos E. Trucco and Alfredo Berduc. 52 hours.

Professor of field and laboratory practice “Introduction to the design of field studies on biology and related fields” for students of the careers Licenciatura in Biological Sciences and Profesardo in Biological Sciences. Exp. 10139/2006. Taught first and second semesters in 2006. R-DNAT-2007 N° 0042 and in 2007 (Resolution under review).

### **Other teaching**

Instructor of the workshop “Ecology within the reach of everybody” for school teachers and students in the city of Salta, June 15, 2007. V Week of Science and Technology.

## **III.3. ACADEMIC TRAINING**

### **Post-graduate Courses**

Agroecology. Faculty of Agricultural Sciences. National University of Córdoba. Instructors: Dr. Miguel Altieri and Dra. Alicia Barchuk. March 26 to 30, 2007.

## **III.4. FORMATION OF HUMAN RESOURCES**

Director of 2 undergraduate theses for Biology and Co-director of 3 theses for Agricultural Engineering careers (Natural Sciences Faculty, Salta National University).

## IV. DIFFICULTIES

Apparently, the excessive humidity resulting from abnormally high rainfall during January – March 2007 caused massive germination failure in seeds of quebracho blanco, due mainly to fungal infection. Therefore, in this report I do not present results for this species. I propose to repeat the experiment on quebracho blanco in the next fruiting season, expecting that such unusual rainfall will not occur two years in a row.

## V. TECHNICAL REPORT

### Introduction

The first phase of this project (1st and 2nd RSG) established that natural regeneration of the two most important tree species in semiarid Chaco, quebracho blanco (*Aspidosperma quebracho-blanco*) and quebracho colorado (*Schinopsis lorentzii*), is low independent of forest use: fewer than three seedlings per 100 m<sup>2</sup>. The question then arises as to what proximate factors affect regeneration mechanisms in these species.

### Objectives

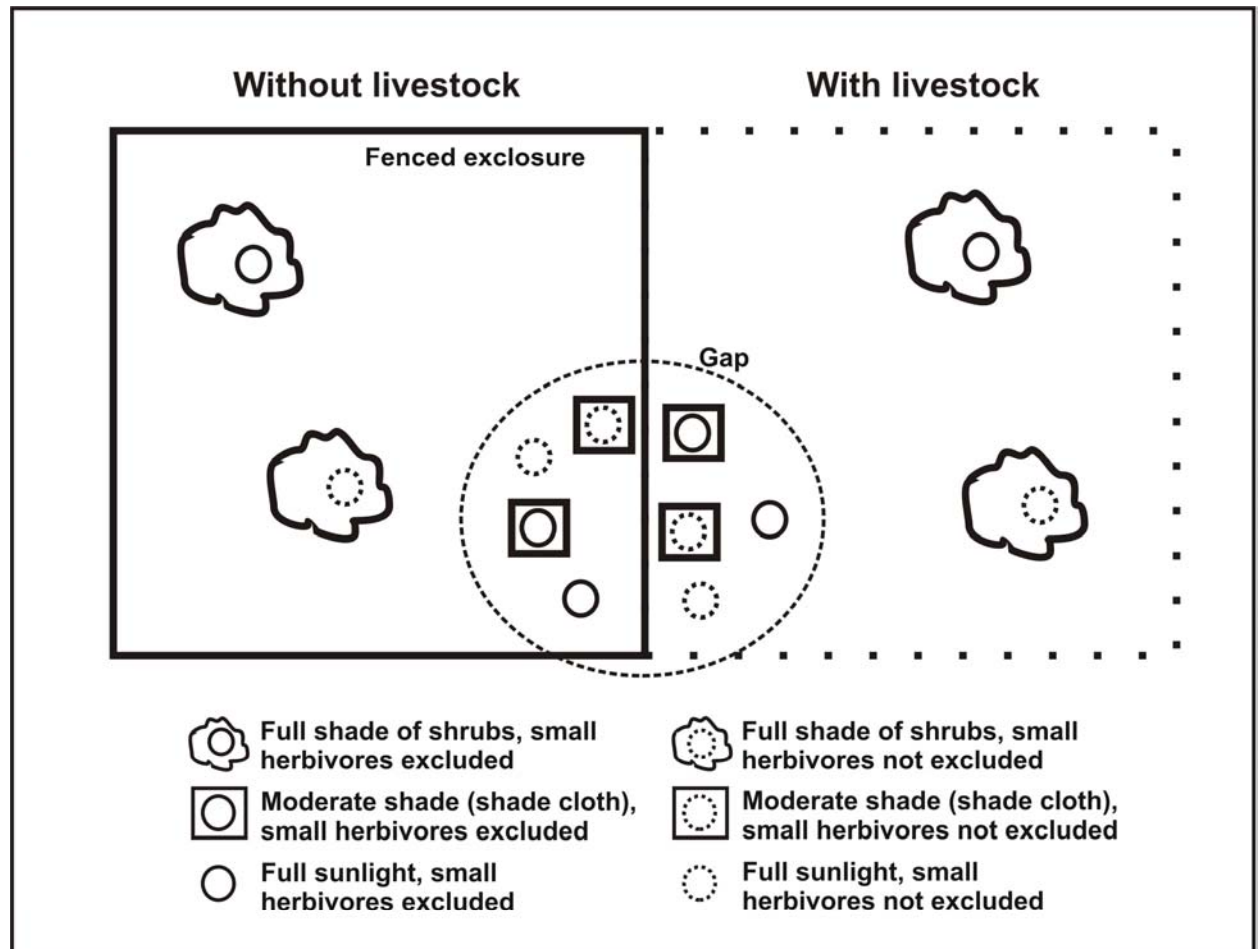
The main objective was to investigate whether shrubs facilitate the establishment and survival of seedlings of both quebracho species, and how one of the most common land uses (cattle grazing) affects the process.

### Methods

To assess whether or not shrubs might facilitate both species' germination and establishment and to evaluate which mechanisms might be responsible (shade, nutrients or protection against herbivores) I conducted an experimental study with the following treatments:

- 1- Seeds planted in full shade of shrubs, small herbivores not excluded
- 2- Seeds planted in full shade of shrubs, small herbivores excluded
- 3- Seeds planted in full sunlight, small herbivores not excluded.
- 4- Seeds planted in full sunlight, small herbivores excluded.
- 5- Moderate shade (shade cloth), small herbivores not excluded.
- 6- Moderate shade (shade cloth), small herbivores excluded.

These six small-scale experimental treatments were nested within the factor “large herbivores” with two levels: presence of domestic livestock (cattle and goats), and exclusion of livestock, with 5 replicates of each level in a block design. Figure 1 shows one block.



**Figure 1.** Diagram of one block of the field experiment, with the 6 small-scale treatments nested within the factor “large herbivores”.

The experimental unit consisted of a group of 100 fruits of quebracho colorado (each fruit contains one seed). In total we sowed 6000 fruits of this species, all in February 2007. We recorded the first germination one month later, in March, and continued to collect data in May, July, September, November (2007), January and March (2008).

The livestock enclosures consisted of a 50 m X 50 m fence of 7 wire strands (Fig. 2). Small-herbivore enclosures consisted of circular, roofed screen cages (Fig. 2). Artificial shade was produced with 1 m x 1 m squares of shade cloth (50%) supported by 4 wooden stakes (Fig. 2).



**Figure 2.** The corner of a livestock enclosure, showing the 7-strand fence, exclosures for small herbivores and the shade cloth that generated moderate shade.

## **Results and Discussion**

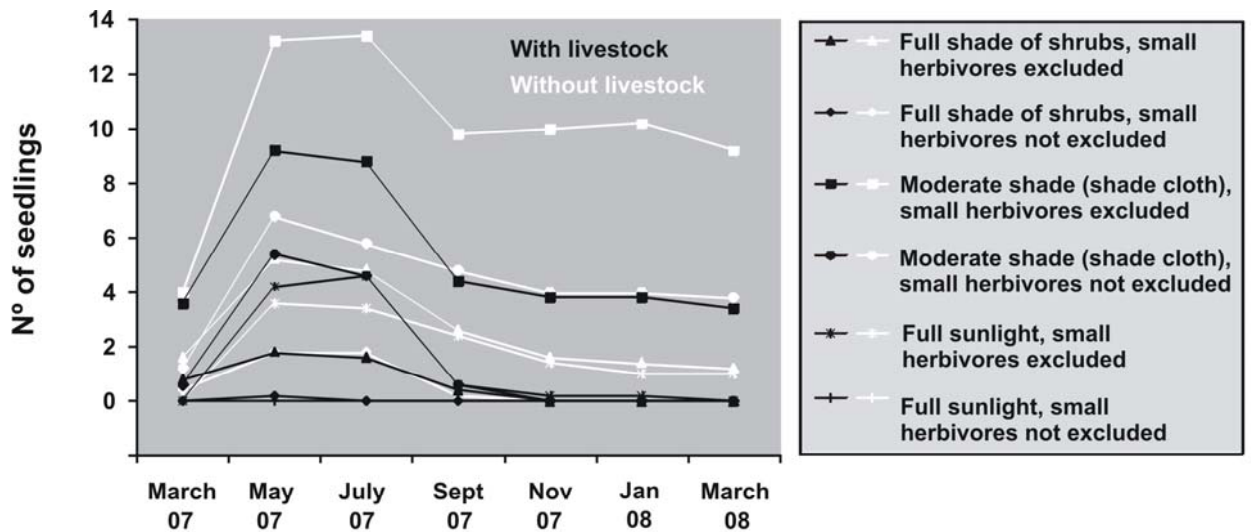
Quebracho blanco germination was practically nil, apparently due to the excess humidity caused by extremely heavy rains just after the experiment was set up in 2007 (Figure 3). For this reason, here I only report on the quebracho colorado results.



**Figure 3.** Alone seedling of quebracho blanco, surrounded by seeds attacked by fungus (arrows)..

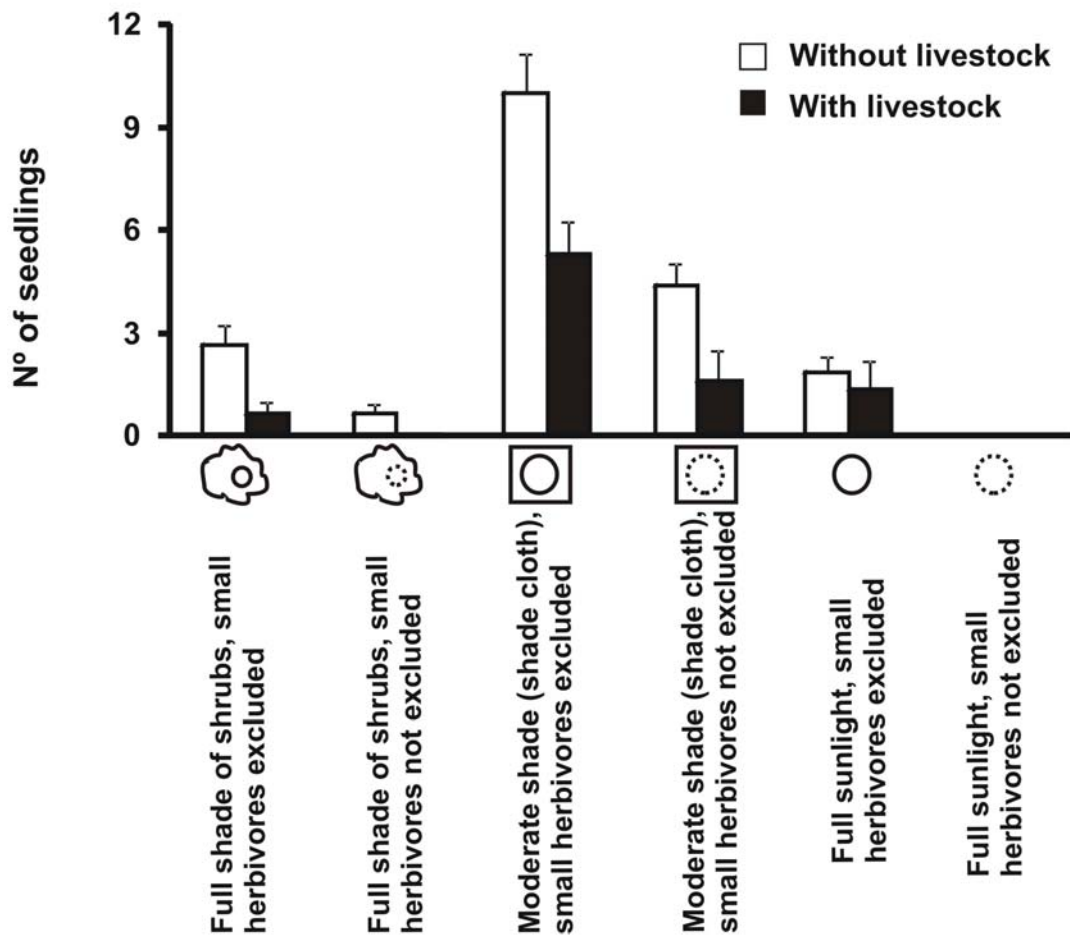
### Querbracho colorado germination and seedling survival

Across all treatments, germination of quebracho colorado seeds in the month of higher germination (May, 2007) was very low (257 germinated seeds of a total of 6000 seeds sown seeds, this is 4.3 %). The germination curve in the studied months shows that after that maximum, the germination lowered progressively until the last sampling on March 2008 (Fig 4).



**Figure 4.** Mean number of seedlings for the twelve treatments (six each with and without grazing pressure) across the seven sampling periods of the study.

In each of the 6 small-scale treatments (three levels of shade, with small herbivores excluded or not), the per cent of germination was consistently higher in the livestock exclusions than in sites open to livestock (Fig. 5). Among those 6 small-scale treatments, germination was higher under the partial shade provided by shade cloth than in either full shade of shrubs or full sunlight and higher inside the small herbivore exclusions than outside them (Fig. 5). Under “natural” conditions, with no protection from small herbivores and no shade cloth, the germination percentages were alarmingly low: 0% under full sunlight with or without livestock, and 0.6% under shrubs and without livestock (Fig. 5).



**Figure 5.** Mean number of seedlings (+ SE) for the six small-scale treatments with or without livestock exclusion.

## Conclusions

The results of this first year of experiments are not very encouraging as regards the expectations we had about the natural regeneration of this highly exploited species, quebracho colorado. Among the data per se, excluding livestock had a uniformly positive effect on seedling germination and seedling survival. Technically, domestic animals are prohibited in national parks, yet cattle and goats are common in Copo. Management guidelines should focus on reducing or eliminating that livestock load.

In addition, though, quebracho colorado germination and seedling survival in this study also suffered uniformly in the presence of small herbivores as opposed to the cages that excluded them. At this scale, though, herbivory and seedling removal are natural components of the study system, so it would be illogical to try to develop management guidelines to diminish small herbivore pressure.

Finally, in this study quebracho colorado germinated better under moderate, artificial shade than under full shade from shrubs or in full sunlight. Of course, it is possible that competition from shrubs for nutrients, not the full shade they give, was responsible for lower germination of quebracho seeds.

The experiments suggest that under the current natural conditions in Copo National Park, with livestock, small mammals and other seed predators or herbivores, deep shade from shrubs and patches of full sunlight, regeneration of quebracho colorado will be extraordinarily low and probably incapable of maintaining a stable population. Even under ideal conditions—without livestock, without small herbivores and with artificial shade, the maximum germination and seedling survival rates were low, around 10%. It is possible that this species has a high percentage of seeds with no embryo, as happens with its congener *S. balansae* in the humid Chaco forests to the east.

**VI. APPENDIX****EXPENDITURE**

| <b>Description</b>                                | <b>Booster Grant<br/>(pounds)</b> |
|---|-----------------------------------|
| <b>Travels</b>                                    |                                   |
| Second hand Pick-up                               | 6000                              |
| Vehicle maintenance (spare parts, repairing)      | 892,86                            |
| Gasoline (local travel) (x litro)                 | 417,86                            |
| <b>Field and lab work</b>                         |                                   |
| Food & lodgment (días/persona)                    | 892,86                            |
| Light meter                                       | 89,29                             |
| Plastic caliper                                   | 4,43                              |
| Gloves  | 8,67                              |
| Steel poles of 2.2 m                              | 642,86                            |
| Turnstile   | 47,50                             |
| Rural wire (roll of 500 m)                        | 250                               |
| Wood survey stakes, 1.2 m                         | 159,03                            |
| Iron closing                                      | 53,57                             |
| Fiber plastic mesh (high density) (m2)            | 26,75                             |
| Galvanized ½" (m2)                                | 46,43                             |
| Computer supplies (CDs, floppy disks, toner)      | 71,43                             |
| Bookshop supplies (reams, sheets, notebooks, etc) | 35,71                             |
| Manuscript/report translation                     | 89,29                             |
| <b>TOTAL</b>                                      | <b>9732,81</b>                    |