

Medellín, March 24 2008

**Chair of the Research, Conservation and Grants Committee
The Cycad Society
USA**

Dear Chair:

I am pleased to submit a research proposal in hope that you will consider it for funding in the framework of the grant program by The Cycad Society. The title of the research proposal is: **“Recruitment dynamics of *Zamia obliqua* populations and implications for management and conservation”**, and it would be carried out by two researchers in a couple of academic institutions from Colombia (Corporación para Investigaciones Biológicas -CIB, and Universidad de Antioquia). This research proposal addresses a crucial aspect of population viability for a species of *Zamia*, and we think it could generate important detailed information about the recruitment dynamics of cycad populations, which in turn could be used for population analyses useful for management and conservation purposes.

Partial funding statement:

To develop the project objectives, we require funding for field trips and for laboratory genetic analyses. The funding requested to TCS would be employed to address the first objective of the project, and full funding for this part of the project will result in a detailed analysis of the contribution of adults to recruitment in one of the populations proposed for this study. Partial funding for this part of the project could still be useful to carry out the project objective, if the number of individuals included in the genetic analyses is reduced (although the inclusion of most individuals present in the studied populations will be most desirable). Additional funding, requested to the Montgomery Botanical Center would be employed to carry out a second project objective and to extend the genetic analyses to a second population (but carrying out project objective 1 will not depend on obtaining funding by the MBC).

Statement of qualification for the principal investigator (Dr. Cristina López-Gallego):

I have a PhD degree on conservation biology, and I have several years of experience on cycad population research (see projects and papers on cycad biology on my CV). I am a research associate at the Montgomery Botanical Center and a member of the IUCN Cycad Specialist Group, which will facilitate the development of the research project in collaboration with them. This also gives me an overall perspective of research and conservation needs for cycad populations, and allows me be able to incorporate our research results in a more general context for cycad conservation. In Colombia, the research group on biodiversity conservation and use of the CIB (Corporación para Investigaciones Biológicas) has many years of experience working on environmental issues in the region for the proposed research and good relations with the local community, who are interested in projects that could provide information for conservation and use of their natural resources. I think the development of our project in collaboration with CIB, the MBC, and the IUCN CSG can be very effective and will result in useful information for cycad conservation.

Contact Information for Cristina López-Gallego (principal investigator):

- E-mail address: clopezgallego@gmail.com
- Postal address: Kra. 75A #32A-26, Medellín (city), Antioquia (province), COLOMBIA
- Office phone: 574-219-5613 (Medellín, COLOMBIA)
- Fax: 574-219-5622 (Medellín, COLOMBIA)

Please see attached:

1. Research proposal
2. CV for the principal investigator (Cristina López-Gallego)

The letter of recommendation for the principal investigator will be send directly to you (the chair of the Research, Conservation and Grants Committee) by Dr. John Donaldson, from the SANBI (South African National Bioiversity Institute), via e-mail.

Please do not hesitate to contact me if you require additional information to consider our research proposal for your grant program.

Good luck with all your endeavors at The Cycad Society,
Cordially,

Cristina López-Gallego

clopezgallego@gmail.com

Biology Institute, Universidad de Antioquia (Colombia)

Corporación para Investigaciones Biológicas (Colombia)

Research Associate at Montgomery Botanical Center (USA)

RESEARCH PROPOSAL FOR THE CYCAD SOCIETY

Title:

Recruitment dynamics of *Zamia obliqua* populations and implications for management and conservation

Principal Investigators:

Cristina López-Gallego clopezgallego@gmail.com

Biology Institute, Universidad de Antioquia & Research associate MBC

Juan Santiago Zuluaga juazulu@gmail.com

Corporación para Investigaciones Biológicas

Organization:

CORPORACION PARA INVESTIGACIONES BIOLOGICAS (CIB)

Carrera 72A # 78B-141, Medellín, COLOMBIA

Duration of the Project: 12 months

Total Budget	\$8400
Total requested to TCS	\$2550
Total requested to MBC	\$2350
Total shared by CIB	\$3500

PROJECT ABSTRACT

Population viability of many tropical long-lived plants depends on adult survival and recruitment ability. Little is known about variation in recruitment rates between individuals, and the factors associated with fecundity and successful recruitment in populations of cycads. The main goal of this project is to explore the relative contribution of adults to population recruitment in two populations of *Zamia obliqua* with contrasting individual distribution, and to evaluate environmental and other factors potentially associated with the recruitment success of individuals in these populations. To this end, we will sample all individuals in the populations and use molecular markers to estimate family relationships among them and establish parents and their relative contribution to recruitment. In addition, we will explore the effects of environmental factors on the recruitment success of individuals in the populations. Detailed information about the recruitment dynamics of populations would be valuable for population management for conservation and potential sustainable use. In particular, we expect to contribute to an important aspect for understanding the demographic dynamics of cycad populations and to provide useful recommendations for the potential exploitation and propagation of the species in local community nurseries.

PROJECT DESCRIPTION

Research rationale and justification

Population viability of many rainforest tropical long-lived plants seems to depend critically on adult survival and the recruitment ability of adults in the population. Nevertheless, variation in the contribution of adults to recruitment is widespread in natural populations of plants. Variation in adult fecundity and recruitment rates would result in a differential contribution of individuals to population regeneration. This variation in fecundity, germination, and seedling survival rates among individuals could have environmental and genetic components. Exploring the factors associated with variation in the recruitment ability of individuals in the populations would therefore provide information about crucial processes affecting population viability. Furthermore, detailed information about individuals and factors contributing to successful population recruitment would be valuable for population management for conservation and for the potential use of population in sustainable ways.

Little is now about factors affecting the recruitment dynamics and potential variation in recruitment rates in populations of neotropical cycads. The main goal of this research will be to explore in detail the recruitment dynamics of populations of *Zamia obliqua* in the Chocó regio of Colombia to identify factors crucial for population persistence and to use this information for population management and potential use by local communities. To that end, *we will explore in detail the relative contribution of adults to the recruitment of two populations with contrasting individual distribution and evaluate genetic and environmental factors potentially associated with the recruitment success of individuals in these populations.* Based on information available in the scientific literature for other long-lived tropical plant species and our own field observations, our hypothesis is that a relative small number of adults contribute disproportionately to population recruitment (i.e. the production of seedlings), and that increased recruitment ability of these individuals could be associated with their establishment in favorable environments. In addition, we hypothesize that seeds produced by the few highly successful adult individuals in the populations can establish (germinate and have high seedling survival) themselves in a variety of environments (i.e. genetic effects are more important than environmental effects in seedling establishment).

Project objectives

1. Examine the genetic composition of the seedlings and juveniles in two populations to establish the number of families present in the recruits, predict the potential number of parents contributing to population regeneration, and identify potential factors associated with differences in recruitment ability among adults.
2. Explore potential differences in seedling establishment among individuals from different families (with different parents) and the role of environmental factors versus genetic factors (the 'family' effect) on the successful recruitment of seeds into the seedling and juvenile stages.

Methods

We will sample all non-adult and adult individuals present in two populations of *Z. obliqua* in the region of Cabo Corrientes in the Chocó Province of Colombia (a biodiversity hotspot). All individuals in these populations have been permanently marked, are mapped spatially, and add up to ca. 400 individuals. Both populations are located in the understory of relatively undisturbed rainforest, but differ on individual density and distribution. We will collect leaf samples for genetic analyses from all individuals in the populations and

perform environmental measurements on adults and recruits during a first field trip to the population localities. After 10 months, we will sample the populations in a second field trip to record seedling/juvenile mortality and determine potential associations between survival rates and environmental factors. Specifically, for each objective we will use these type of analyses:

1. We will use molecular markers (potentially microsatellites developed for other *Zamia* species, otherwise AFLPs) to estimate relatedness coefficients among seedlings and juveniles, and genetic analyses to explore the genealogy of each population to identify the number of families and the potential number of parents contributing to recruitment. Then, using parentage analyses, we will determine the identity of parents for families present in the recruits and compare the relative contribution of parents to population recruitment has been hypothesized, we will explore whether the relative contribution to recruitment by adults is associated with their establishment in advantageous environments (for example site with higher light availability, lower probability of desiccation, etc).
2. We will test for associations between seedling establishment and environmental factors at a detailed spatial scale, by monitoring seed germination (if enough seeds are available in the natural populations) and seedling survival during 10 months. Then, we will contrast genetic effects (effects due to shared parents) and environmental effects on seedling establishment by comparing individual performance (germination and seedling survival) among families and in relation to the environment (light environment and soil properties mainly).

HOW THE PROJECT FITS THE INTERESTS OF THE CYCAD SOCIETY

We expect to provide detailed information about the recruitment dynamics of *Z. obliqua* populations in their natural habitat, particularly to explore the relative contribution of adults into the recruits and the factors that may be associated with recruitment success in these populations. This information would contribute to our understanding of the processes that are crucial for population viability of cycad populations. We plan to keep monitoring fecundity, recruitment, and survival rates in the studied populations, and to use the information generated by this project, a previous project funded by TCS on these populations, and other research efforts, to use population models to evaluate conservation, management, and potential exploitation strategies for the populations of *Z. obliqua* in the Chocó region of Colombia. In particular, we expect to continue generating useful biological information to develop adequate strategies for the local communities to propagate cycads in a local community nursery. These short- and long-term objectives addressing the needs for detailed biological information to support conservation and management strategies for cycad populations are directly related to the main goals for research and conservation of The Cycad Society.

TIMETABLE FOR THE PROJECT

The project will be carried out in two phases:

- First phase (6 months): During a first field trip, we will collect leaf samples for genetic analyses (for both populations, i.e. for about 400 individuals). In addition, we will perform detailed environmental measurements on all individuals in both populations. In the laboratory, we will standardize the protocols for genetic analysis and carry out the analyses for one of the populations (ca. 200 individuals). This first phase addresses objective 1 of this project and funding for this phase is being requested to TCS.

- Second phase (6 months): We will continue with genetic analyses, using the individuals of the second population (ca. 200 individuals), and monitor individual survival in the populations in a second field trip. This second phase will also contribute information for objective 1, and will generate the data to address objective 2 of this project.

activity	month											
	1	2	3	4	5	6	7	8	9	10	11	12
Field trip 1	x											
Standardization of genetic protocols		x										
Genetic analysis for population 1			x	x	x	x						
Genetic analysis for population 2							x	x	x	x		
Field trip 2											x	
Final data analysis and report												x

DETAILED BUDGET FOR THE PROJECT

The project will be carried out in two phases, which can be developed independently (and produce independent results, for project objectives 1 and 2). Funding for the first phase is being requested to The Cycad Society (TCS), and funding for the second phase is being requested to the Montgomery Botanical Center (MBC).

item for first phase of the project	US\$ requested to TCS	US\$ cost sharing by CIB
Field trip 1 - Transportation to site	250	000
Field trip 1 - Daily expenses for 15 days*	600	150
Supplies for sampling in the field	000	250
Genetic analyses: DNA extraction (\$2.5/rxn)	500	000
Genetic analyses: PCR reactions (\$3/rxn)	600	000
Genetic analyses: Genotyping (\$3/rxn)	600	000
Equipment for genetic analyses	000	3000
TOTAL for first phase	2550	3400

Other sources from which funds are currently being sought for the project:

- Montgomery Botanical Center

item for second phase of the project	US\$ requested to MBC	US\$ cost sharing by CIB
Genetic analyses: DNA extraction (\$2.5/rxn)	500	000
Genetic analyses: PCR reactions (\$3/rxn)	600	000
Genetic analyses: Genotyping (\$3/rxn)	600	000
Field trip 2 - Transportation to site	250	000
Field trip 2 - Daily expenses for 10 days*	400	100
TOTAL for second phase	2350	100

Total budget of the project:

Total requested to TCS \$2550
Total requested to MBC \$2350
Total shared by CIB \$3500
GRAND TOTAL \$8400

* This budget item includes expenses for lodging, food, and for some days, a field assistant.

C.V.
M. CRISTINA LOPEZ-GALLEGO
PHD IN CONSERVATION BIOLOGY, UNIVERSITY OF NEW ORLEANS, USA

Personal information

Name: M. Cristina López-Gallego
Citizenship: Colombian - Mexican
E-mail: clopezgallego (at) gmail.com
Phone: 574-238-6112
Address: Kra. 75A #32A-26, Medellin, Antioquia, Colombia

Education

- 2001-2007 Ph.D. Conservation Biology
 Department of Biological Sciences, University of New Orleans, USA
 Dissertation: *Effects of habitat degradation on the evolutionary dynamics of populations of a rainforest cycad (Gymnospermae)*. Main advisor: Dr. P. O'Neil & Dr. S. Johnson, University of New Orleans (USA)
- 1992-1999 B.Sc. Biology, Major in Botany
 Biology Department, Universidad de Antioquia, Colombia
 Thesis: *Population structure and habitat conditions of Zamia melanorrhachis populations in forest fragments*. Main Advisor: Dr. Alicia Uribe, Universidad de Antioquia (Colombia)

Other academic training

- 2002 Summer institute in statistical genetics (International, Graduate level: 9 days)
 North Carolina State University. Raleigh (NC), USA
- 1999 Course on molecular genetic techniques for biodiversity studies (International, Graduate level: 80 hours)
 CIAT & Instituto Alexander von Humboldt. Palmira, Colombia
- 1999 Course in tropical ecology and conservation 99-2 (International: Graduate level: 8 weeks)
 Organization for Tropical Studies. Costa Rica
- 1997 First course in experimental design in conservation biology (Colombia, Graduate level: 168 hours)
 Instituto Alexander von Humboldt. Villa-de-Leyva, Colombia

Research & Teaching interests

I am interested in exploring the role of different evolutionary forces (like natural selection, phenotypic plasticity, and genetic drift) on the variation in life-history and other traits in response to environmental changes, particularly anthropogenic habitat changes in tropical plant populations.

I am interested in further developing projects and courses in evolutionary ecology and conservation biology.

Research grants (as principal investigator)

- 2005-2006 *Genetic variation in traits under selection in populations of Zamia fairchildiana in Costa Rica*
 Grant from The Montgomery Botanical Center (USA). US\$6000
- 2005 *Adaptive divergence following habitat degradation in a tropical cycad*
 Grant from Association for Women in Science & Sigma-Xi (USA). US\$500
- 2003-2004 *The effects of habitat degradation on the life-history of Zamia fairchildiana populations*
 Grant from The Cycad Society & University of New Orleans (USA). US\$2500
- 2002 *Phenotypic variability in native and disturbed-habitat populations of Zamia fairchildiana in Costa Rica*
 Pilot Project Grant from Organization for Tropical Studies (Costa Rica). US\$1500
- 1998-1999 *Population ecology of Zamia melanorrhachis populations from different forest-fragments*
 Grant from Wildlife Conservation Society & Instituto Alexander von Humboldt (Colombia). US\$1500
- 1997 *Diagnosis of conservation status of Zamia species in the Antioquia Province, Colombia*
 Research Grant from Universidad de Antioquia (Colombia). US\$300.

Participation in research projects (as research assistant)

- 2006-2007 *Molecular evolutionary ecology of developmental signaling pathways in complex environments*
USA-NSF FIBR Research grant to Dr. Johanna Schmitt, Brown University (USA)
In collaboration with University of Oulu (Finland) & Universidad Politecnica de Valencia (España)
- 2002-2005 *Estimating the evolutionary change in growth trajectories in the perennial plant Lythrum salicaria*
USA-NSF Research grant to Dr. Pamela O'Neil, University of New Orleans (USA)
In collaboration with the Darling Marine Center, University of Maine (USA)

Peer-reviewed publications

- 2008 López-Gallego, C. 2008. *Demographic variation in cycad populations inhabiting contrasting forest fragments*. Biodiversity & Conservation in press
- 2003 Marulanda, L. O. *et al.* (Lopez-Gallego, C. 6th out of 7 authors). 2003. *Structure and composition of vegetation in a tropical dry forest remnant in San Sebastian, Magdalena (Colombia)*. Actualidades Biologicas 25: 17-30
- 2001 López-Gallego, C. & A. Idarraga. 2001. *Conservation status of Zamia species in the Antioquia Province (Colombia)*. Actualidades Biologicas 23: 23-31

Non peer-reviewed publications

- 2008 López-Gallego, C. 2008. *Interested in contributing to cycad conservation? Guidelines for establishing your own population monitoring program*. The Cycad Newsletter 30(4):36-37
- 2006 López-Gallego, C. 2006. *Can cycads persist in disturbed habitats? A study of local adaptation of Zamia fairchildiana populations in disturbed forests in Costa Rica*. The Cycad Newsletter 29(1):8-9

Publications in review

- 2008 López-Gallego, C. & P. O'Neil. *Life-history variation following habitat degradation associated with differing fine-scale spatial genetic structure in a rainforest cycad*. Submitted to Conservation Genetics
- 2008 López-Gallego, C. & P. O'Neil. *Home-site advantage in seedling establishment after habitat degradation in a long-lived cycad*. Submitted to Biological Conservation
- 2008 López-Gallego, C. & P. O'Neil. *Heritability estimation and the potential response to selection after habitat degradation in natural populations of a long-lived cycad*. To be submitted to Evolution

Presentations in scientific meetings

- 2008 *Effects of habitat degradation on the within and between population genetic structure of a rainforest Zamia*
VIII International Conference on Cycad Biology. Panama, Panama
- 2007 *Adaptive divergence in response to anthropogenic habitat disturbance in a long-lived rainforest cycad*
Society for Conservation Biology annual meeting. Port Elizabeth, South Africa
- 2007 *Habitat disturbance, the evolutionary dynamics of cycad populations, and conservation implications*
IV Colombian Botany Meeting. Medellin, Colombia
- 2005 *Life-history divergence between populations of a tropical cycad from native and disturbed habitats*
Ecological Society of America & IX International Congress of Ecology. Montreal, Canada
- 2005 *Natural selection in Zamia fairchildiana populations from native and disturbed habitats*
VII International Conference on Cycad Biology. Xalapa, Mexico
- 2004 *Identifying life-history traits with large impact on population fitness in the invasive plant Lythrum salicaria*
Society for the Study of Evolution annual meeting. Fort Collins, USA
- 2000 *Population density and population structure in fragmented populations of a tropical cycad*
II Ecological Society of America & British Ecological Society joint meeting. Orlando, USA
- 1999 *Population ecology of Zamia melanorrhachis populations in fragmented habitats*
II Colombian Congress in Biodiversity and Conservation. Bogota, Colombia

Academic distinctions

- 1999 Best student oral session, II Colombian Congress in Biodiversity and Conservation
Universidad Javeriana, Colombia. Fellowship awarded for attendance to an international meeting in ecology
- 1999 Best student graduated in the Biology program in 1999
Universidad de Antioquia, Colombia. Fellowship awarded for Master degree studies at UdeA (declined)

Teaching experience

- 2007-2008 Instructor. *Plant Ecology*, Theory and Laboratory sections
Biology Institute, Universidad de Antioquia, Colombia
- 2002-2005 Teaching assistant. *Population genetics and evolutionary ecology*, Laboratory sections
Department of Biological Sciences, University of New Orleans, USA
- 2001-2002 Teaching assistant. *Introductory biology*, Laboratory sections
Department of Biological Sciences, University of New Orleans, USA

Professional experience

- 2000-2001 Research training program in conservation biology, Wildlife Conservation Society (Colombia)
Carried out research projects on restoration ecology of Andean forests in Colombia (18 months)
- 1999-2000 Jardín Botánico 'Joaquín Antonio Uribe' de Medellín (Colombia)
Carried out projects on plant community ecology and managed herbarium data-base (6 months)
- 1999 Corporación Ambiental, Universidad de Antioquia (Colombia)
Participated in a research project on plant community ecology of dry forests in Colombia (6 months)

Professional services

- 2006 CoFounder: Red Colombiana de Investigadores en Biología Evolutiva (Colombia)
Independent research organization for promoting academic interactions among Colombian researchers
- 2006-2007 Research associate: Montgomery Botanical Center (USA)
Botanical center specialized in cycad and palm biology
- 2005-2007 Member: Cycad Specialist Group (International)
Group within the IUCN (International Union for the Conservation of Nature) for cycad conservation
- 1999 Organizer & Instructor: Course on habitat fragmentation in the tropics
Undergraduate course (40 hours), Universidad de Antioquia, Colombia
- 1997 Organizer: Seminar on applied experiences in natural resources conservation
Academic seminar for conservation, Universidad de Antioquia, Colombia

Membership to societies

- 2002-2007 SCB: Society for Conservation Biology (International)
Founder member and past vice-president of the New Orleans Chapter (USA)
- 1993-1999 ANECB: National Association of Biological Sciences Students (Colombia)
Member and past president of the Antioquia Chapter (Colombia)

Other academic skills

Languages: Fluency in Spanish and English

Computing: Office software, Statistics software (R, SPSS, JMP), Programming (C++)

Personal references

- Dr. Johanna Schmitt. Full Professor, Brown University (USA)
email: Johanna_Schmitt@brown.edu Phone: 1-401-863-2897
- Dr. Pamela O'Neil. Associate Provost, Brown University (USA)
email: Pamela_O'Neil@brown.edu Phone: 1-401-863-2706
- Dr. Steven Johnson. Chair of the Biology Department, University of New Orleans (USA)
email: sgjohnso@uno.edu Teléfono: 1-504-280-6307
- Dr. Carolina Murcia. Investigadora, Fundación Ecoandina (Colombia)
email: carolinamurcia01@gmail.com Phone: 572-683-1103
- Dr. Ricardo Callejas. Profesor, Universidad de Antioquia (Colombia)
email: callejas@matematicas.udea.edu.co Phone: 574-263-5620

President of The Cycad Society
Chair of the Research, Conservation and Grants Committee
The Cycad Society
USA

26 March 2008

Dear Jody

Letter of support for Dr C. Lopez-Gallego's proposal on "Recruitment dynamics of *Zamia obliqua* populations and implications for management and conservation"

I am writing to support the research funding application submitted by Dr Cristina Lopez-Gallego. I have known Cristina for several years and have corresponded with her regularly regarding cycad demographic studies. Her grasp of the key issues in plant demography has always impressed me and I believe that she is one of the best qualified people to undertake the proposed work on cycads. She has combined demographic and genetic studies very effectively. I have also been impressed by Cristina's commitment to her work and her passion for cycads and I am sure that she will deliver on the outputs that she promises.

Research on cycad demographics is desperately needed to gain a better understanding of how cycads respond to both current and possible future conditions. The Cycad Specialist Group has recognised this need and Cristina has been asked to co-ordinate a subcommittee of the CSG focussing on population studies. As a result, I would be delighted if the TCS can support the sort of project that Cristina is proposing.

Best wishes



John Donaldson
Chair: IUCN Cycad Specialist Group
Chief Director: Applied Biodiversity Research
SA National Biodiversity Institute
P/Bag X7, Claremont 7735
South Africa

